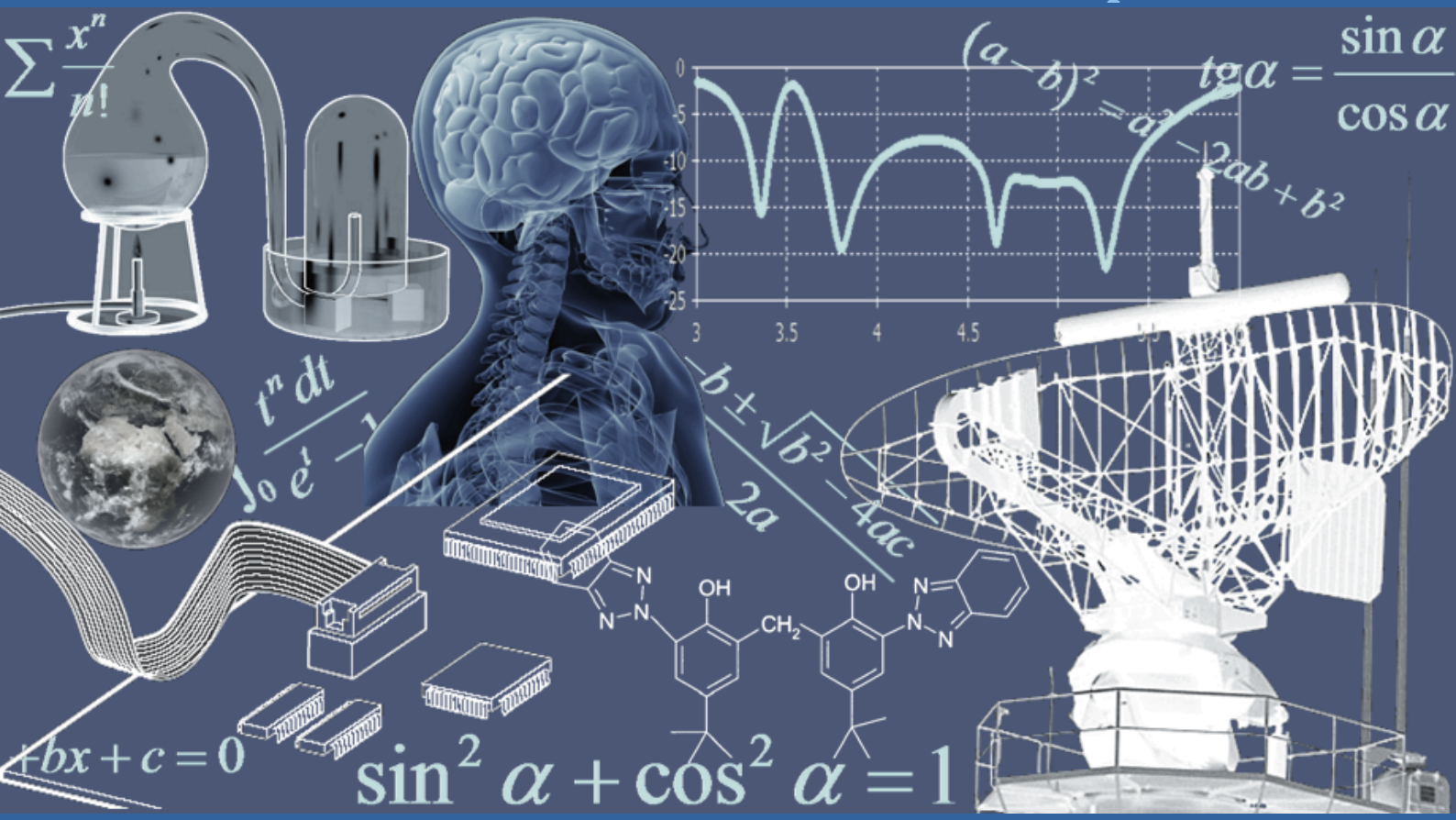
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Etude comparative des caractéristiques morpho-métriques et Biochimiques des dattes commercialisées dans le marché régional de FES / MAROC

[Comparative study of the morpho-metric and Biochemical dates caractere solding in the regional market of FES / MOROCCO]

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ABSTRACT: This study is focused on biochemical and characterization of thirteen varieties of dates fruits sold in "Fez city date wholesale" in Morocco. Varieties are divided into ten Moroccan varieties "Abourar, Boufeggous, Bouskri, Bouslikhéne, Jihel, Khalt, Klane, Mejhoul, Rassltmer and Tarzawa", and three imported varieties "Deglet Baida, Deglet Nour and Lulu". The results show morphological and physic-chemical differences between the studied varieties, especially in color, texture, size and weight criteria of dates. Varieties that validate all quality criteria are Mejhoul and Jihel, which have best characters that give them, appreciated aesthetic appearance.

KEYWORDS: Dates fruit, morpho-metric character, biochemical character.

RESUME: Cette étude porte sur la caractérisation biochimique de treize variétés de dattes commercialisées au sein du marché de gros des dattes de la ville de Fès au Maroc. Les variétés de dattes marocaines sont « Abourar, Boufeggous, Bouskri, Bouslikhéne, Jihel, Khalt, Klane, Mejhoul, Rassltmer et Tarzawa », et les importées sont « Deglet-Baida, Deglet-Nour et Lulu ». Les résultats obtenus révèlent l'existence des différences morphologiques entre les treize variétés et en particulier de point de vue couleur, consistance, taille et poids des dattes. Les variétés des dattes qui valident tous les critères de qualité sont la variété Mejhoul et la variété Jihel. Elles présentent des meilleurs caractères morpho-métriques et qui leur donne un aspect esthétique apprécié.

MOTS-CLEFS: Dattes, caractère morpho-métrique, caractère biochimiques.

1 INTRODUCTION

La culture des palmiers dattiers (*Phoenix dactylifera L*.) est considérée parmi les cultures les plus importantes dans les zones arides et semi-arides. Elle joue un rôle important dans la vie économique et sociale des populations de ces régions **[1].** La production des dattes au Maroc a évolué de 72 700 tonnes enregistré en 2008 à 120 000 tonnes en 2011, de ce fait, elle

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occupe une place importante parmi les productions arboricoles nationales et participe avec une proportion allant de 40 à 60% du revenu annuel. Cette importance économique et sociale de la production dattier au Maroc est, donc, loin d'être négligeable **[2].**

Les dattes se caractérisent par une valeur énergétique élevée apportée par les sucres (environ 3000 calories par kilogramme de dattes) **[3]** ; elles renferment aussi d'autres nutriments essentiels pour l'organisme à savoir les vitamines, les macroéléments et les oligo-éléments.

L'étude des caractéristiques des dattes permet non seulement leur valorisation, mais aussi de fournir, des informations pour leur utilisation en particulier dans des procèdes biotechnologiques. La présente étude recherche les caractéristiques morpho-métriques et biochimiques des variétés de dattes, ce qui pourrait former des critères de caractérisation et d'identification de chaque variété selon le plan morpho-métrique ainsi que sur le plan biochimique.

2 MATERIELS AND METHODES

2.1 MATERIEL VEGETAL

L'étude a été portée sur treize variétés de dattes commercialisées au niveau du souk régional de la ville de FES. Les variétés sont subdivisés en dix variétés marocaine de dattes à savoir « Abourar, Boufeggous, Bouskri, Bouslikhéne, Jihel, Khalt, Klane, Mejhoul, Rassltmer et Tarzawa », et trois variétés des dattes importées « Deglet-Baida, Deglet-Nour et Lulu ».

2.2 METHODES

2.2.1 CARACTERISATION MORPHOLOGIQUE DES DATTES

Les caractéristiques morphologiques ont été mesurées sur 3 fruits prélevés au hasard de chaque variété, pour lesquels sont déterminées les caractéristiques suivantes **[3] :**

- La couleur a été appréciée visuellement ;
- La consistance des dattes :

D'après Espiard **[4],** la consistance de la datte est variable. Selon cette caractéristique, les dattes sont réparties en trois catégories : dattes molles, dattes demi-molles et dattes sèches de consistance dure. En 1973, Munier a défini un indice «r» de qualité ou de dureté comme étant le rapport entre la teneur en sucre sur la teneur en eau des dattes.

r = teneur en sucre/teneur en eau

Le calcul de cet indice permet d'estimer le degré de stabilité du fruit et conduit à la classification suivante :

- dattes molles : $r < 2$
- dattes demi - molles : $2 < r < 3,5$
- dattes sèches : $r > 3,5$

Pour $r = 2$ la stabilité du fruit est optimale et son aptitude à la conservation est très appréciable.

- Les dimensions du fruit de datte (longueur et largeur) sont mesurées en centimètre (cm) à l'aide d'un pied à coulisse.
- Le poids de la datte entière, de la pulpe, et du noyau a été mesuré au moyen d'une balance analytique de précision (± 0,001) de marque (OHAUS). Les rapports de qualité ont été mesurés selon les formules suivantes :

Rapport P/D(%) = (Poids de la pulpe/ poids de la datte entière) * 100

Rapport N/D(%) = (Poids du noyau/ poids de la datte entière) * 100

2.2.2 CARACTERISATION PHYSICOCHIMIQUE DES DATTES

- Evaluation de la teneur en eau

La teneur en eau a été déterminée par dessiccation d'un échantillon de 5g dans une étuve isotherme à une température de 105°C et à la pression atmosphérique normale jusqu'à l'obtention d'une masse constante de l'échantillon **[5]**.

La teneur en eau est calculée selon la formule suivante :

$$TE\ (\%) = [(M1-M2)/M1]*100$$

Avec :

M1 : matière fraîche avant étuvage (g).

M2 : matière fraîche après étuvage (g).

- Dosage des sucres totaux

L'extraction des sucres a été faite par l'addition à 10 g de matière fraiche de 100 ml d'eau distillée sous reflux pendant une heure. L'extrait servira à la détermination des taux de sucres.

Les sucres totaux sont dosés selon la méthode colorimétrique au phénol sulfurique décrite par la méthode de Dubois **[6]**. A 2 ml de l'extrait déjà préparé sont additionnés successivement, 0,1 ml de la solution de phénol à 80% et 6 ml de H_2SO_4. Agiter et laisser reposer pendant 10 min à une température de 25 à 30°C (Apparition de couleur jaune-rouge), puis stopper la réaction par un courant d'eau froide. L'absorbance a été mesurée à une longueur d'onde de 490 nm.

2.3 RESULTATS ET DISCUSSION

2.3.1 COULEURS DES DATTES

La couleur des dattes et leur consistance constitue un critère esthétique important pour la commercialisation des dattes, dont leur image textuelle font des différences d'appréciation d'une datte à l'autre. Les résultats présentés dans le tableau 1 montrent que la couleur des dattes étudiées s'étale entre le jaune orangé doré, marron et le noir, à l'exception de la variété Bouskri qui représente une couleur marron verdâtre due à la présence des tanins en quantités importante dans des stades de maturation avancées.

Tableau 1. Couleurs des dattes

Variétés des dattes	Couleur
Abourar	Marron
Boufeggous	Marron
Bouskri	Marron verdâtre
Bouslikhène	Marron
Deglet baida	Jaune orangé
Deglet nour	Marron
Jihel	Marron
Khalt	Jaune-Marron
Klane	Brun rougeâtre
Lulu	Noir
Mejhoul	Marron
Rassltmer	Jaune doré claire à marron
Tarzawa	Jaune

L'évolution de la couleur des dattes au cours de leur maturation est un bon critère variétal. Cette différence de couleur est due principalement aux pigments caractéristiques pour chaque variété. La couleur très appréciée chez les consommateurs marocains est «l'aspect miel» ou «dorée», les dattes présentant une couleur tendant vers le noir peuvent ne pas présenter une valeur commerciale élevée même si certaines d'entre-elles ont un excellent goût **[2].** Une étude montre que 70% de la valeur économique est représenté par la couleur jaune des dattes en Arabie saoudite et les Émirats arabes **[7]**, concernant l'étude réalisée pour les dattes en Qatar, Bahrain, Kuwait et Oman, les résultats montrent que 64% de la valeur commerciale est représentée par les dattes de couleur rouge **[8]**. La couleur est un critère primordial d'appréciation des dattes dont le choix se diffère d'un pays à autre.

2.3.2 POIDS DE LA PULPE, DU NOYAU ET DE LA DATTE ENTIERE

Le poids des dattes constitue un critère de qualité qui fait la différence entre les différentes variétés. On présente sur le tableau 2 le poids des dattes étudiées et de leurs constituants (pulpe et noyau) ainsi que les rapports Pulpe/ Datte et Noyau / Datte.

La variété qui représente le poids le plus élevé est la variété Mejhoul (14g), avec un rapport Pulpe / Datte de 93,5%. Les variétés Tarzawa, Khalt et Rassltmer présentent le poids le plus faible respectivement de 4,38 g, 4,73g et 4,78g avec un rapport Pulpe / Datte de 85%, 89%, et 87%. On remarque aussi que les variétés importées (Lulu, Deglet nour et Deglet baida) présentent un rapport Pulpe / Datte de plus de 90% malgré leur poids qui est d'environ 6 g, alors que les variétés marocaines Jihel, Boufeggous et Bouslikhène qui ont presque le même poids que les variétés importées ont un rapport Pulpe / Datte seulement de 88%.

Tableau 2. Poids de la datte et de ses constituants

Variétés des dattes	PD	PP	PN	Rapport P/D	Rapport N/D
Abourar	5,99±0,03	5,24±0,06	0,75±0,05	87%	13%
Boufeggous	6,04±0,09	5,29±0,11	0,75±0,05	88%	12%
Bouskri	6,40±0,40	5,62±0,35	0,78±0,08	88%	12%
Bouslikhène	6,15±0,09	5,40±0,11	0,75±0,05	88%	12%
Deglet nour	6,02±0,08	5,40±0,11	0,62±0,03	90%	10%
Degletbaida	5,94±0,08	5,40±0,11	0,54±0,03	91%	9%
Jihel	6,02±0,07	5,25±0,05	0,77±0,03	87%	13%
Khalt	4,73±0,38	4,21±0,37	0,52±0,04	89%	11%
Klane	5,03±0,15	4,34±0,16	0,69±0,01	86%	14%
Lulu	6,02±0,08	5,40±0,11	0,62±0,03	90%	10%
Mejhoul	14,00±0,07	13,10±0,05	0,90±0,03	93,5%	6,5%
Rassltmer	4,78±0,03	4,18±0,09	0,60±0,10	87%	13%
Tarzawa	4,38±0,16	3,71±0,26	0,67±0,15	85%	15%

PD : Poids de datte ; PP : Poids de pulpe ; PN : Poids de noyau ; N/D : noyau/datte

La teneur en pulpe, exprimée en pourcentage pondéral (Poids de la pulpe / Poids de la datte), indique que les dattes étudiées présentent un pourcentage allant de 85 à 93,5%. Les résultats obtenus pour la variété Mejhoul concordent avec ceux de Harrak **[9],** qui signale une valeur de 93,04 %. Pour les variétés Deglet baida et Deglet nour, Sayah **[10]** a trouvé un rapport Pulpe / Datte respectivement de 81,12 % et 93,59 %, pour la variété Deglet baida Acourene, 1997 **[3]** a trouvé une valeur de 80,78%, des valeurs qui ne concordent pas avec les nôtres. Le travail effectué par Acourene, 2013 **[11]** sur la variété Boufeggous, prélevé auprès des oasis algérienne, a donné une valeur de 91,23% alors que la valeur trouvé dans notre travail, concernant la variété Boufeggous cultivée au Maroc, est de 88%. Cette différence pourrait être expliquée par la différence des conditions climatique et de culture des dattes.

Les résultats de l'analyse de la variance du paramètre poids des dattes montrent une différence significative entre les dattes étudiées (Tableau 3), ceci nous a mené de faire une analyse de comparaison de moyenne par le test Tukey, afin de grouper les variétés de dattes présentant des poids similaires (Tableau 4).

Tableau 3. Analyse de la variance (ANOVA1) du paramètre poids des dattes

	F value	Probabilité (5%)	F critique
Poids des dattes	**229,547655**	**3,426510-23**	**2,14792623**

Tableau 4. Classification des variétés de dattes étudiées en groupes homogènes, selon le test Tukey, pour le paramètre « poids des dattes »

Modalité	Moyenne estimés	Groupes
Abourar	5,99	B
Boufeggous	6,04	B
Bouskri	6,40	B
Bouslikhène	6,15	B
Deglet nour	6,02	B
Deglet baida	5,94	B
Jihel	6,02	B
Khalt	4,73	C
Klane	5,03	C
Lulu	6,02	B
Mejhoul	14,00	A
Rassltmer	4,78	C
Tarzawa	4,38	C

Les valeurs sont des moyennes (n=3) ± σ. Les moyennes suivies de la même lettre dans la même colonne ne sont pas significativement différentes selon une analyse de la variance et de test de comparaison « Tukey-XLSTAT-Pro »

Le tableau 4 montre que les variétés Abourar, Boufeggous, Bouskri, Bouslikhène, Deglet nour, Deglet baida, jihel et Lulu forment un groupe « B » homogène, présentant un poids supérieur en comparaison avec le groupe « C » qui rassemble les variétés Khalt, Klane, Rassltmer et Tarzawa. La variété Mejhoul quant à elle, présente un poids très important de 14g, ce qui lui a permet de se regrouper seule indépendamment aux autres variétés de dattes étudiées (Groupe « A »).

2.3.3 CARACTERISATION DE LA LONGUEUR ET LARGEUR DES DATTES

La qualité des dattes s'évalue aussi par les caractères morpho-mètriques du fruit. Le tableau 5 présente les valeurs de la longueur et la largeur des treize variétés étudiées.

La taille des différentes variétés de dattes se varie entre 3,20 à 5,80 cm de longueur moyenne et de 1,5 à 2 cm de largeur moyenne. On remarque que la variété Mejhoul présente la taille la plus grande avec une Longueur de 5,80 cm et une largeur de 2 cm, suivie par la variété Jihel qui a une Longueur de 5,76 cm et de 1,89cm de largeur. La variété qui présente la taille la plus petite est la variété Bouskri avec 3,20 cm de longueur et 1,52 cm de largeur.

Tableau 5. Longueur et largeur des dattes

Variétés des dattes	Longueur	Largeur
Abourar	4,60±0,17	1,90±0,10
Boufeggous	4,61±0,15	1,90±0,10
Bouskri	3,20±0,20	1,52±0,02
Bouslikhène	4,34±0,10	1,80±0,01
Degletbaida	4,32±0,11	1,51±0,02
Degletnour	4,10±0,21	1,51±0,02
Jihel	5,76±0,12	1,89±0,02
Khalt	3,37±0,35	1,73±0,21
Klane	3,90±0,10	1,50±0,06
Lulu	3,34±0,10	1,51±0,02
Mejhoul	5,80±0,10	2,00±0,10
Rassltmer	3,50±0,00	1,60±0,10
Tarzawa	3,35±0,10	1,54±0,05

L'analyse de la variance à un seul facteur (ANOVA1) des paramètres « longueur et largeur », montrent une différence significative à un seuil de probabilité de 5% entre les variétés de dattes étudiées (tableau 6).

Tableau 6. Analyse de la variance (ANOVA1) des paramètres longueur et largeur de dattes étudiées

	F value	Probabilité (5%)	F critique
Longueur des dattes	97,120	1,9685.10-18	2,14792623
Largeur des dattes	15,726	5,6842. 10-2	2,14792623

En comparaison avec d'autres études, on constate que les caractéristiques morpho-métriques des dattes se différent d'une variété à l'autre et d'une région à l'autre. Les paramètres morpho-métriques des variétés pakistanaises étudiées par Ghulam et al., 2010 **[12]** comprisent entre 2 à 6 cm de longueur et 1,5 à 4,5 cm de largeur. Les variétés des dattes iraniennes étudiées par Acourene **[13]** varient de 3,3 à 4,2 cm de longueur et 1,8 cm à 2,5 cm de largeur. Cette différenciation morphologique pourrait être due aux différentes techniques de pollinisation du palmier dattier utilisées **[14], [15].**

Une datte est dite de meilleure qualité sur le plan morpho-métrique doit atteindre les critères ci-dessous :

- Poids de la datte ≥6g
- Poids de la Pulpe ≥ 5g
- Longueur de la datte ≥3,5cm
- Largeur de la datte ≥1,5 cm

Il apparait sur le tableau 7 que les variétés des dattes qui valident tous les critères décrites ci-dessus sont la variété Mejhoul et la variété Jihel. Elles présentent des meilleurs caractères morpho-métriques et qui leur donne un aspect esthétique apprécié (tableau7).

Tableau 7. Critères de qualité des dattes étudiées

Variétés	Poids ≥6g	PP≥ 5g	longueur≥3,5cm	largeur≥1,5 cm
Abourar		**X**	**X**	**X**
Boufeggous	**X**	**X**		**X**
Bouskri	**X**	**X**		**X**
Bouslikhene	**X**	**X**		**X**
Degletbaida	**X**	**X**		**X**
DegletNour	**X**	**X**		**X**
Jihel	**X**	**X**	**X**	**X**
Khalt				**X**
Klane			**X**	**X**
Lulu	**X**	**X**		**X**
Mejhoul	**X**	**X**	**X**	**X**
Rasltmer			**X**	**X**
Tarzawa				**X**

2.3.4 LA TENEUR EN EAU DES DATTES ETUDIEES

La teneur en eau est un paramètre fondamental à des raisons capitales : pour la détermination et la conduite rationnelles des opérations de récolte, de stockage ou de conservation. Selon les auteurs **[16], [17],** une datte à une humidité comprise entre 10 et 24 % est dite de bon caractère. Dans notre étude, les treize variétés des dattes ont des teneurs en eau variables comprise entre 15% à 30%. On remarque que les teneurs en eau des variétés Abourar, Boufeggous, Bouskri, Bouslikhène, Khlat et Mejhoul dépassent 24%, ce qui leur rendre susceptible aux altérations microbiennes, contrairement aux autres variétés. Le tableau 8 résume les teneurs en eau trouvé dans les variétés de dattes

Tableau 8. Teneur de dattes étudiées

Variétés de Dattes	% Teneur en eau
Abourar	26,7±1,13
Boufeggous	26,7±0,64
Bouskri	25,0±0,23
Bouslikhène	27,0±0,80
Deglet baida	15,0±0,06
Deglet nour	24,0±0,95
Jihel	24,0±1,00
Khalt	26,0±0,85
Klane	23,6±0,55
Lulu	23,0±1,50
Mejhoul	30,2±0,93
Rassltmer	20,0±0,10
Tarzawa	19,0±0,85

L'étude effectué par Babahani **[18]** a montré que les variétés des dattes Deglet nour et Deglet Baida atteignent respectivement une teneur en eau de 22,76% et 11,34% au stade de maturation. Des valeurs qui se différent légèrement avec les nôtres concernant les deux variétés, ceci pourrait être expliqué par la différence des conditions climatiques, dont Babahani **[18]** a prouvé dans son étude que la température a un effet sur l'évolution du poids, des dimensions et de la teneur en eau des dattes.

Les teneurs élevés en eau rendent les variétés qui ont un caractère mou susceptibles à la colonisation microbienne, ceci est confirmé par les analyses microbiologiques réalisé par notre équipe de recherche **[19],** dont la colonisation de la flore fongique est très importante.

2.3.5 LA TENEUR EN SUCRES TOTAUX

De nombreux auteurs, dont **[20], [21]** ayant travaillé sur plusieurs variétés des dattes affirment que les sucres des dattes varieraient en fonction de la variété, du pollen, du stade de maturation et du climat. La nature des sucres varie aussi, en fonction de la consistance de la datte.

Le tableau 9 présente les teneurs en sucres totaux des treize variétés des dattes étudiées.

Tableau 9. Teneurs en sucres totaux des dattes

Variétés de Dattes	Sucres totaux (%)
Abourar	71,0±0,78
Boufeggous	83,3±0,26
Bouskri	69,0±0,20
Bouslikhene	74,0±0,53
Degletbaida	58,0±2,76
Degletnour	73,0±0,12
Jihel	71,0±1,00
Khalt	76,0±0,35
Klane	74,0±0,50
Lulu	69,0±1,00
Mejhoul	81,0±1,14
Rassltmer	71,0±0,20
Tarzawa	72,2±0,72

Les résultats des teneurs en sucres totaux s'étalent entre 58% ± 2,76, valeur correspondante à la variété Deglet baida et 83% ± 0,26, valeur correspondante à la variété Boufeggous.

Pour étudier le profil des sucres chez les dattes étudiées, nous avons réalisé une analyse de la variance (ANOVA1). Les résultats montrent une différence significative à un seuil de probabilité de 5% entre les teneurs en sucres totaux des variétés de dattes étudiées (tableau 10).

Tableau 10. Analyse de la variance (ANOVA1)

	F value	**Probabilité (5%)**	**F critique**
Teneur en sucres totaux	**110, 9**	**3,67610-19**	**2,14792623**

L'étude effectuée par l'auteur **[10]** a révélé une valeur de 65% en sucre totaux pour la variété Deglet Baida et 50% pour la variété Deglet Nour, lors de notre étude, nous avons trouvé une valeur de 58% pour la variété Deglet baida et 73% pour la variété Deglet Nour.

L'auteur **[11]** révèle une valeur de 69,83% pour la variété Boufeggous, alors que nous avons trouvé une teneur de 83,3% pour la variété Boufeggous d'origine marocaine. Cette différence enregistrée en ce qui concerne les teneurs en sucres pourrait être dû aux différenciations génotypiques entre les variétés des dattes.

Les variétés à consistance demi molle renferment des teneurs en sucres totaux plus élevée en comparaison aux dattes sèches. En général, les résultats rapportés par différents auteurs dépendent en partie de la méthode utilisée. Néanmoins, tous s'accordent à dire que les teneurs en sucres totaux des dattes sont de l'ordre de 60 à 80% de la pulpe.

2.3.6 LA CONSISTANCE DES DATTES ETUDIEES

L'indice de qualité r (rapport sucres totaux /teneur en eau), permet de déterminer la consistance de la datte, et qui permet la classification des dattes en dattes sèches, demi-molle et molle **[20], [22].**

Les variétés étudiés ont la plupart une consistance demi molle à l'exception de la variété Tarzawa, Deglet baida et Rassltmer qui ont un caractère de texture sèche. Le tableau 11 présente l'indice de qualité de chaque variété de dattes, ainsi leur consistance

Tableau 11. Consistance des dattes

Variétés des dattes	**Indice de qualité r**	**Consistance des dattes**
Abourar	2,70	demi - molles
Boufeggous	3,10	demi - molles
Bouskri	2,80	demi - molles
Bouslikhène	2,76	demi - molles
Deglet baida	3,90	sèches
Deglet nour	3,00	demi – molles
Jihel	3,00	demi – molles
Khalt	2,90	demi – molles
Klane	3,10	demi – molles
Lulu	3,01	demi – molles
Mejhoul	2,70	demi – molles
Rassltmer	3,60	Sèches
Tarzawa	3,80	Sèches

Des études ont été effectué dans ce cadre, les résultats ont montré que la variété Deglet Nour a une consistance demi-mole ainsi que la variété Deglet baida se caractérise par une consistance sèche, des résultats concordent avec les nôtres **[23].** Pour la variété Mejhoul, l'auteur **[24]** confirme le caractère demi-mole de cette variété typiquement Marocaine.

3 CONCLUSION

L'étude des caractéristiques morpho-métriques et biochimiques des treize variétés des dattes étudiées révèle une différence variétale significative. Plusieurs facteurs physico-chimiques voir biochimiques ont un effet important dans la caractérisation du fruit. Les sucres jouent un rôle important dans la détermination de la consistance des dattes.

En effet, l'évaluation de la couleur a révélé que les variétés des dattes marocaines ont en générale une couleur marron, cependant, l'étude effectuée par l'auteur **[2]** a montré que la couleur préféré chez le consommateur marocain est la couleur miel doré.

Les critères de qualité étudiés ont fait ressortir que les variétés marocaines Mejhoul et Jihel ont une meilleure qualité. En effet, la variété Mejhoul a un poids moyen de 14g, ce qu'il a permis de se regrouper en tant que le plus grand fruit par rapport aux autres variétés étudiées et a un rapport pulpe/datte le plus élevé de 93,7%

Finalement, l'étude de la teneur en eau et la teneur en sucre, nous a permis de savoir la consistance de chaque variété et les classés en dattes demi-molle et sèche, dont le saccharose caractérise les dattes sèches et leur donne une couleur claire, une texture dure et un aspect farineux ; contrairement aux sucres réducteurs qui caractérisent les dattes avec une consistance demi-molles, de couleur foncée et de texture tendre.

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Etude des facteurs influençant le revenu des unités de production de poterie dans la cité d'El Oulja au Maroc

[Study of the factors that influence the pottery productions units' revenue in El Oulja in Morocco]

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ABSTRACT: The craft sector in Morocco, being the second largest jobs' creator after agriculture, reflects the cultural wealth and expertise of master craftsmen. Pottery, especially, is one of the oldest crafts in the world, this activity employs a large number of artisans, and contributes greatly to the growth of the craft sector. This report, resulting from a survey regarding potters in El Oulja, is the study of the influence of the surface of the production unit, the number of people employed and the different types of products manufactured by the production units, compared to the turnover achieved by the latter. Statistical analysis of all variables shows that the number of employees is the only factor to significantly influence the turnover.

KEYWORDS: Turnover, Surface in m², employees, types of products, Salé.

RESUME: Le secteur de l'artisanat au Maroc, étant le deuxième secteur créateur d'emplois après l'Agriculture, reflète la richesse culturelle millénaire et le savoir-faire des maîtres artisans. La poterie, plus spécialement, est l'une des activités artisanales les plus anciennes au monde, c'est une activité qui emploi un nombre important d'artisans, et contribue largement à la croissance du secteur de l'artisanat. Le présent rapport, fruit de l'enquête menée auprès des potiers d'El Oulja, nous permet d'étudier l'influence de la superficie du local de production, le nombre de personnes employées, et le nombre de types de produits fabriqués par les unités de production, sur le chiffre d'affaire réalisé par ces dernières. L'analyse statistique de l'ensemble des variables montre que le nombre d'employés est le seul facteur influençant d'une manière significative le chiffre d'affaire.

MOTS-CLEFS: Chiffre d'affaire, Surface en m², employés, types de produits, Salé.

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1 INTRODUCTION

La notion de *Système Productif Localisé* (*SPL*) stipule l'organisation spécifique et la spécialisation d'entreprises autour d'un produit ou d'un métier. Ceci peut être envisagé comme une structure dynamique, capable d'anticiper les évolutions, et de réinventer le développement économique d'un territoire à partir de ses ressources [1].

Selon M. Abdessamad Kayouh (2013), ex ministre de l'artisanat, ce secteur est considéré comme le deuxième employeur national après l'Agriculture. En effet, ce secteur est l'un des secteurs vitaux ayant un potentiel de développement économique et social du Maroc, vu l'importance quantitative de la population qu'il emploie et qui a atteint 2,3 millions d'artisans en 2013, soit 20% de la population active du Maroc, dont 1.1 millions d'artisans exerçant dans l'artisanat d'art et de production, et répartis sur plus de 150 métiers [2].

La Cité d'El Oulja se caractérise par la concentration de plusieurs unités de production opérant dans le secteur de l'artisanat, notamment la poterie. Afin d'assurer l'évolution d'unités peu structurées et traditionnelles à des petites entreprises organisées et répondre, ensemble, aux défis de la mondialisation, et aux changements technologiques constants, nous nous sommes proposés de vérifier la constitution d'un SPL autour de ce métier. L'objectif de ce travail est d'étudier l'impact des facteurs de la superficie des unités, le nombre d'employés et le nombre de types de produits fabriqués sur le chiffre d'affaire.

2 MATÉRIEL ET MÉTHODES

Situé à quelques kilomètres de Rabat, le quartier d'El Oulja, selon la direction régionale de l'artisanat, a été créé dans le cadre du plan quinquennal 1973-1977 et financé par le Fonds spécial de développement régional, sur une superficie de près de 10 ha, étendue à 13 ha. Parle. Les artisans installés dans cette cité sont répartis entre les métiers de la poterie, la vannerie, le bois et le fer.

L'enquête, de type prospectif transversal, menée entre le mois de juin et le mois d'octobre 2013, a porté sur les 48 unités de production actives implantées dans les 2 complexes d'El Oulja. Nous avons visé les propriétaires (Maallam) de chaque unité de production, vu son rôle de superviseur de toutes les fonctions de l'unité productive, pouvant répondre à tout type de questions.

Le questionnaire de l'enquête, demande outre les informations relatives aux unités de production et leurs situations économiques, les données individuelles propres à chaque interviewé (âge, sexe, etc.). Les données recueillies sont saisies sur un support EXCEL, et analysées via le logiciel d'analyse statistique SPSS (*Statistical Package for the Social Sciences*).

3 RÉSULTATS

Dès son réaménagement en 1980, la zone d'El Oulja connait un succès important auprès de clients locaux et internationaux, et devient un centre d'attraction de touristes nationaux et internationaux [3] connue principalement pour la production du tajine Slaoui. Selon la direction de l'artisanat de Salé (2014), le nombre d'unités de poterie installées dans cette zone n'a cessé d'augmenter, passant de 18 unités (au moment de la création) à 93 unité aujourd'hui, auxquelles ont été rajoutées par la suite 24 autres unités de vannerie, jadis, éparpillées entre Rabat et Salé. Il est à noter que la Cité d'El Oulja emploie aujourd'hui près de 9600 artisans [4].

Ces unités de production subissent l'influence de plusieurs facteurs dont certains ont un impact important sur le revenu et les conditions de travail. Dans ce sens, nous proposons un certain nombre d'analyses qui nous permettent de comprendre au mieux l'influence directe ou indirecte de ces facteurs sur l'évolution du chiffre d'affaire annuel de ces unités.

3.1 ANALYSE SÉPARÉE DE L'ENSEMBLE DES VARIABLES ÉTUDIÉES

Cette première partie des résultats nous permet de comprendre l'importance de chaque variable étudiée : la superficie, le chiffre d'affaire, le nombre d'employés, et le nombre de types de produits fabriqué (exprimé par « score produit »).

Tableau I : Analyse descriptive des variables étudiées

	COM	N	MOYENNE	±ES	FISHER	p	MIN	MAX	ASY	CV(%)
Superficie (m²)	1	15	871,33	±174,2545	24,63*	<0,001	350	2500	1,55	77%
	2	33	267,58	±17,352			125	500	1,059	35%
Chiffre d'affaire (Dh)	1	9	251111,11	±69830,04	0,467	0,5	50000	600000	0,595	83%
	2	19	200926,32	±38409,149			9600	500000	0,912	83%
Nbre. employés	1	15	8,47	±1,352	0,006	0,937	2	16	0,122	62%
	2	33	8,36	±0,639			4	20	1,278	44%
Score produit	1	15	2	±0,258	0,606	0,441	1	4	0,495	50%
	2	33	1,76	±0,174			1	4	1,121	57%

** Différence hautement significative à 5% d'erreur ; VAR : variable ; COM : complexe ; N : effectif ; MOYENNE ± ES : moyenne plus au moins l'erreur standard ; p : signification ; MIN : minimum ; Max : maximum ; ASY : asymétrie ; CV : coefficient de variation.*

Le tableau ci-dessus nous permet de comparer les deux complexes étudiés d'El Oulja en termes de superficie des unités de production de poterie, de chiffre d'affaire annuel réalisé par ces unités de production, le nombre de personnes employées dans ces unités de production, et le nombre de types de produits fabriqués au sein de ces dernières. Il est à noter que les deux complexes ont montré une distribution normale (gaussienne).

Nous observons que le coefficient de variation dans le premier complexe (77%, avec une superficie minimale de 350m² et une superficie maximale de 2500m²) est beaucoup plus élevé que dans le deuxième complexe (35%, avec une superficie minimale de 125m² et une superficie 500m²), ce qui implique que les unités de production dans le premier complexe sont hautement hétérogènes en termes de superficie. En effet, la majorité des unités de production dans le deuxième complexe disposent d'une surface moyenne de 267.58 ± 174.2545.

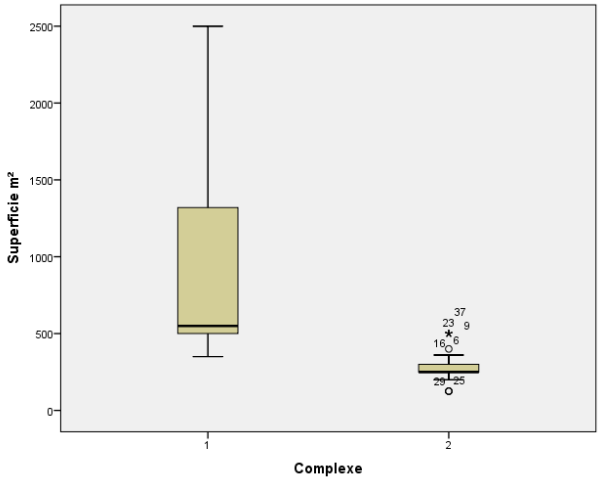


Figure (1) : Représentation en box-plot de la répartition des superficies (m²) dans les deux complexes

Aussi, nous notons que l'écart interquartile de la boîte à moustaches (Fig. 1) du deuxième complexe est très réduit comparé au premier complexe. L'analyse de variance à un seul critère de classification « effet complexe » montre une différence hautement significative entre les deux complexes [*F (47 ;2) = 24.63 ; p<0.001*].

De même, l'analyse de variance « effet complexe » sur le chiffre d'affaire ne montre aucune différence significative (*p=0.5*). En effet, la moyenne du chiffre d'affaire des deux complexes est à peu près la même malgré l'inégalité en termes de nombre d'unité de production dans chaque complexe (15 dans le premier contre 33 dans le deuxième), avec un coefficient de variation de 83%.

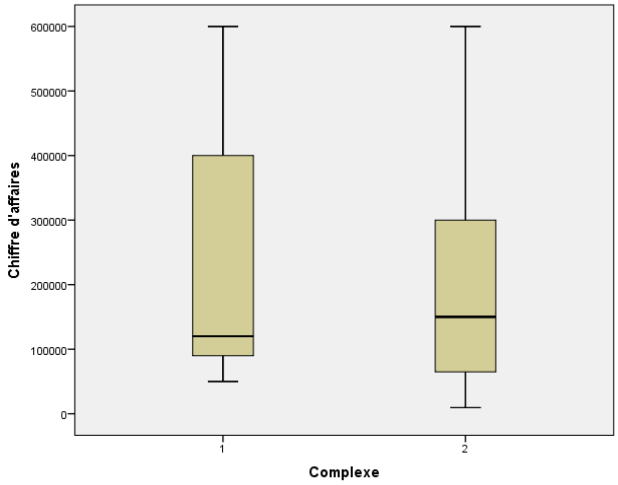


Figure (2): Représentation en box-plot de la répartition du chiffre d'affaire (Dirham) dans les deux complexes

La figure ci-dessus (Fig. 2) montre que 50% des unités de production ont un chiffre d'affaire compris entre 75000 et 440000Dh pour le premier complexe, et entre 50000 et 300000Dh pour le deuxième complexe. En outre, le premier complexe reste celui qui génère le plus de revenus, malgré le petit nombre d'unités qui y sont implantées.

Par ailleurs, la moyenne d'employés par unité de production est de 8, avec un minimum de 2 employés et un maximum de 16 dans le premier complexe, contre un minimum de 4 et un maximum de 20 dans le deuxième. Toutefois, nous constatons que le coefficient de variation dans le premier complexe est plus élevé que dans le deuxième complexe, ce qui implique une plus grande dispersion du nombre d'mployés dans le premier complexe, où 50% des unités emploient entre 4 et 14 personnes, que dans le deuxième, où 50% des unités emploient entre 6 et 11 personnes (Fig.3).

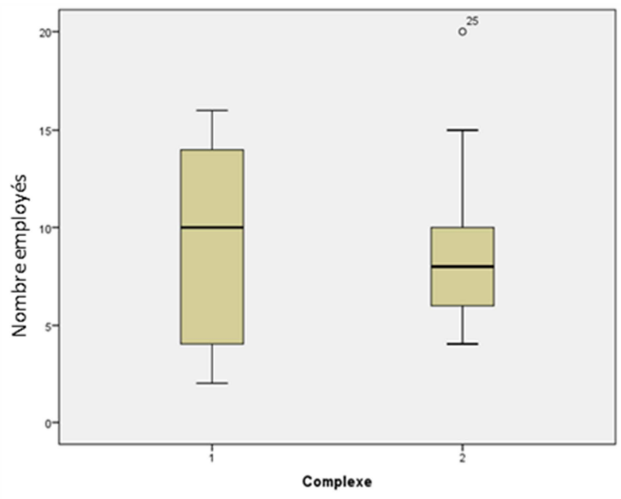


Figure (3) : Représentation en box-plot de la répartition des employés dans les deux complexes

Nous constatons que 50% des unités de production dans le deuxième complexe produisent entre 1 et 2 produits, alors que 50% en produisent entre 1 et 3. Et seulement 25% en produisent plus de 3 produits dans le premier complexe contre 25% qui en produisent plus de 2 dans le deuxième (Fig.4)

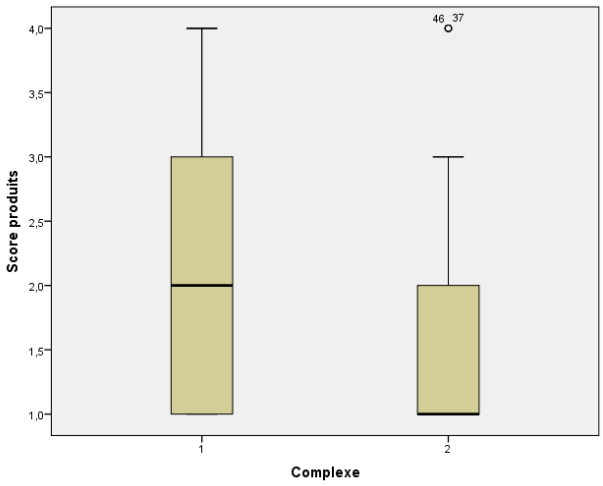


Figure (4) : Représentation en box-plot de la répartition du nombre de types de produits fabriqués dans les deux complexes

3.2 ANALYSE GLOBALE DE L'ENSEMBLE DES VARIABLES ÉTUDIÉES

Cette partie se divise ne deux analyses importantes. La première analyse (ACP) nous permet de définir les éléments déterminant nos axes de travail, qui orienteront la projection des unités de production, afin de définir les forces et faiblesses du métier de la poterie. Ensuite, l'analyse de régression, qui permet de relever l'influence qu'exercent certains facteurs sur d'autres.

3.2.1 ANALYSE EN COMPOSANTES PRINCIPALES

Pour déterminer la liaison entre les différentes variables (la superficie, le nombre d'employés, le nombre de types de produits), et leur influence sur le chiffre d'affaire, nous avons procédé à une analyse multiple par la régression linéaire multiple, et l'analyse en composantes principales (ACP).

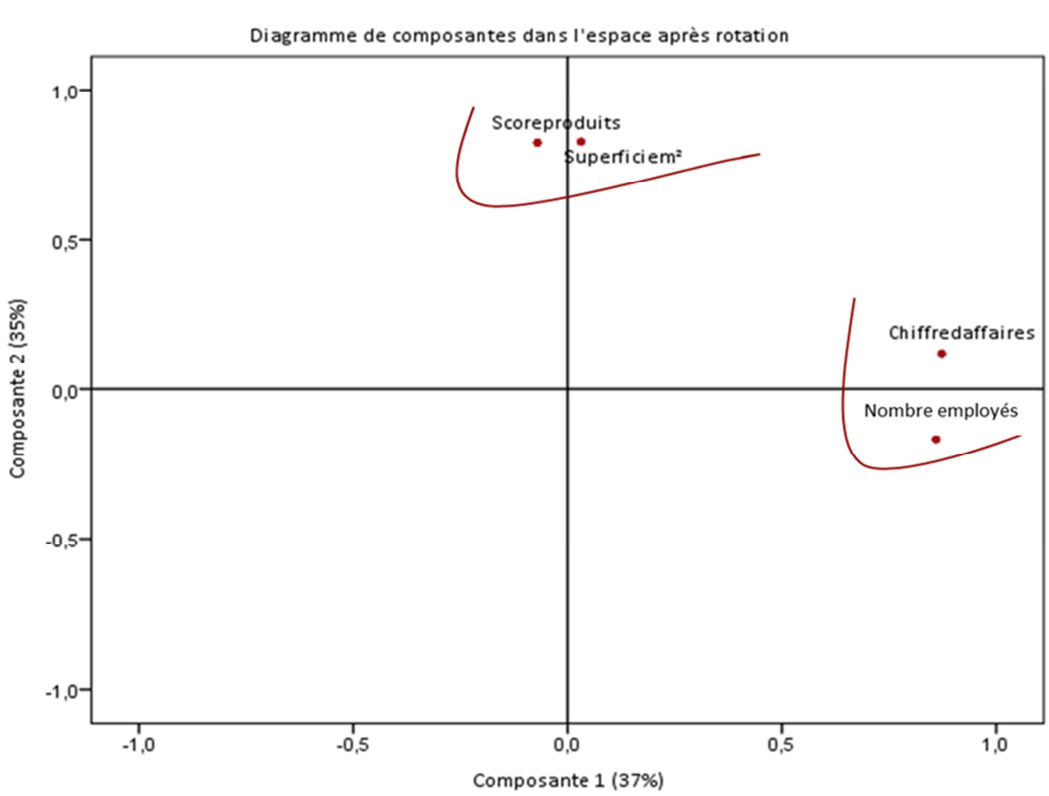


Figure (5) : Représentation en ACP de l'ensemble des variables selon les axes 1 et 2

L'analyse en composantes principales montre que les deux axes 1 et 2 absorbent à eux seuls 72% de la variation totale. Toutefois, l'axe 1 est fortement corrélé au chiffre d'affaire (r=0,87) et au nombre d'employés (r=0,86); alors que l'axe 2 est défini par les variables de superficie (r=0,83) et nombre de types de produits (score produits) (r=0,82) (Fig.5). La projection des points moyens de l'ensemble des unités de production en fonction du complexe montre que généralement, les unités du complexe 1 génèrent un chiffre d'affaire important et emploient un plus grand nombre d'employés comparé au complexe 2 selon l'axe1. Même chose selon l'axe2 (la majorité des unités n'ont pas une grande superficie et un score produits élevé).

Aussi nous constatons que les deux variables score produits et superficie sont corrélées entre elles (r= 0,451 ; p< 0.05), c'est à dire qu'elles évoluent dans le même sens, et sont hautement dépendantes l'une de l'autre. De même, nous remarquons une corrélation entre les deux variables chiffre d'affaire et nombre d'employés (r=0.504 ; p<0.05) (Fig.6).

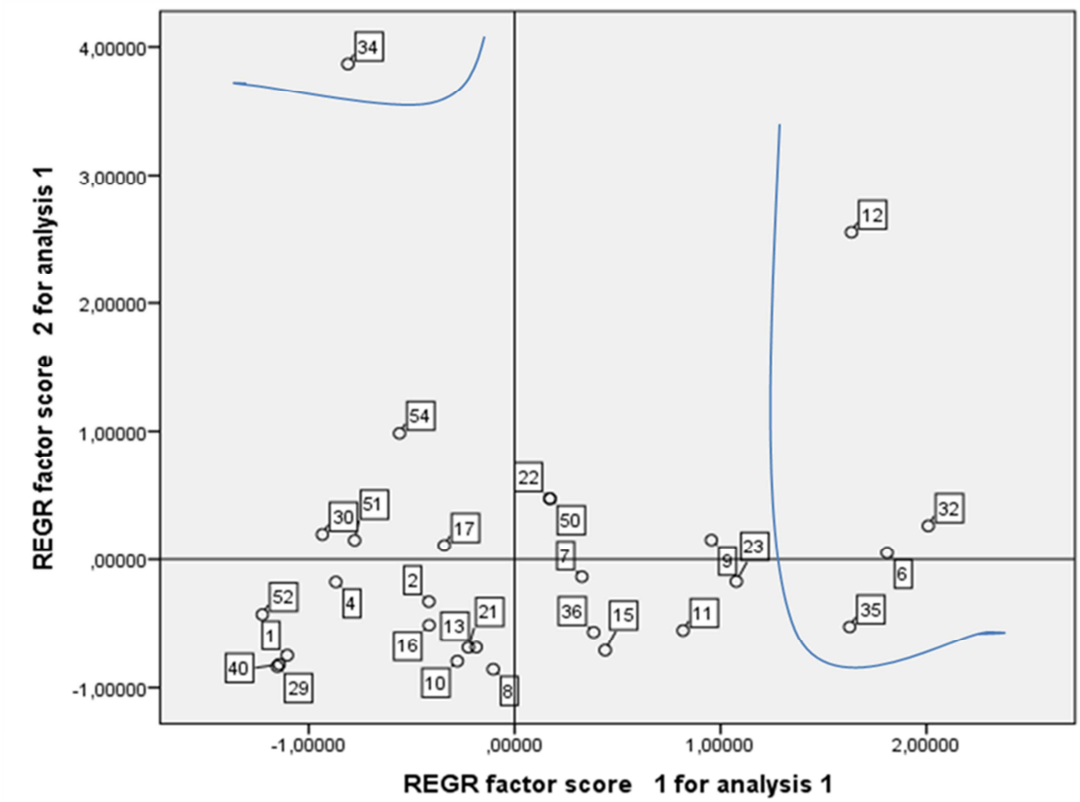


Figure (6) : Projection des unités de production selon les axes 1 et 2

Nous remarquons dans le graphe ci-dessous, une concentration des unités de production du côté négatif de l'axe2 (Fig.6), la majorité donc de ces unités de production disposent de petites superficies, et n'ont pas tendance à diversifier leur production (type de produit). Toutefois, deux unités de production se trouvent très en avance par rapport aux autres unités, produisant un grand nombre de type de produits, et disposant d'une plus grande superficie que les autres unités d'El Oulja.

Concernant le chiffre d'affaire réalisé par les unités de production, et le nombre d'employés, nous constatons une concentration des unités de production du côté négatif de l'axe 1 (Fig.6). Ces dernières emploient, dans leur majorité, un petit nombre d'employés et réalisent un chiffre d'affaires moins important.

3.2.2 RÉGRESSION LINÉAIRE MULTIPLE

Afin de vérifier les facteurs influant sur le chiffre d'affaire (variable dépendante), nous avons procédé à l'analyse de régression linéaire multiple, outil statistique permettant d'expliquer la variation d'une variable dépendante par l'action de plusieurs variables explicatives (Borcard).

Tableau I : Analyse de la régression multiple de la variable dépendante Chiffre d'affaires

Variable	Coefficients non standardisés		t	Sig.	r
	Asymétrie	Erreur standard			
(Constante)	-1249,685	99697,275	-0,013	0,99	
Superficie m²	-5,734	69,364	-0,083	0,935	0.505
Nbre. employés	23959,086	8421,66	2,845	0,009	
Score produits	8322,326	37226,375	0,224	0,825	

t= Valeur Student ; Sig. : Signification

L'analyse de la régression multiple en introduisant toutes les variables a permis d'éliminer la superficie et le score produits comme variables expliquant la variation totale. Seul le nombre d'employés, dont la signification est inférieure à la valeur 0.05, permet d'expliquer 50% de la variation totale de la variable prédite (chiffre d'affaire). Ainsi, l'équation modèle se présente comme suit :

$$Y_{\text{Chiffre d'affaire}} = -1249.685 + (-5.734x_{\text{superficie}}) + 23959.086x_{\text{nbre. employés}} + 8322.326x_{\text{score produits}}$$

L'estimation du chiffre d'affaire pour le nombre maximum d'employés de 20 selon l'équation modèle pour une superficie moyenne de 569.455 et un nombre de types de produits moyen de 2 est de 491311 Dh. Ce chiffre reste deux fois plus important que le chiffre d'affaire moyen (226018.715) :

Y= -1249.685- 5.734 * 569.455 + 23959.086 * 20 + 8322.326 * 2 = 491311.433Dh

4 DISCUSSION

Dans la ville de Salé, la poterie se présente comme le deuxième secteur en importance après celui du tapis, notamment grâce au potentiel en matière d'emploi et de production, dont une part non négligeable est destinée au marché intérieur. La poterie a connu un développement important depuis la construction d'El Oulja, et a pu, grâce à la spécificité de ses produits, attirer un grand nombre de touristes [5].

Les perses, les chinois, les chaldéens, les assyriens, les romains, les grecs, et les arabes utilisèrent la céramique pour architecture et décor interne. La civilisation islamique a produit ensuite une céramique très raffinée qui a vite évolué dans tous les pays musulmans. Inspirée de l'art iranien et chinois, la poterie islamique devient un art unique profondément original [4].

A part les faïences d'origine andalouse et persane, la poterie a toujours été une tradition locale. Tout en se rattachant historiquement à l'art musulman, la céramique marocaine est une création spécifique. Fortement lié à son milieu de naissance, l'art de la poterie au Maroc varie selon ses centres de production : Fès, Salé, Marrakech, Safi [4].

L'analyse des données recueillies a pu ressortir qu'en moyenne, les unités de production installées dans les deux complexes produisent 2 types de produits. Nous constatons alors que les artisans potiers de la Cité d'El Oulja exposent une offre limitée de produits, ce qui peut engendrer une baisse de la demande, et affaiblir la situation de ces potiers par rapport aux concurrents dans d'autres villes ou d'autres pays. En effet, les potiers continuent à produire les mêmes articles qu'ils ont toujours fabriqués, et qui connaissent une demande élevée, c'est le cas des pots, vases, vaisselle et luminaires.

D'ailleurs, dans le secteur du cuir à Fès, les produits souffrent de la difficulté de se procurer, sur le marché local, un certain nombre de composants qui répondent aux besoins de proposition de produits nouveaux. Des cellules de crise destinées à définir des politiques stratégiques de gammes de produits, de prix, de segments de marché, ont été mises en place, dans le but de proposer une ou des collections homogènes et identitaires en termes d'entreprise [6].

L'analyse de la régression multiple montre que le nombre d'employés est le seul facteur influant sur le chiffre d'affaire. Les prévisions projetées sur un nombre moyen de 20 employés tout en respectant les superficies allouées aux unités de production d'El Oulja, affichent un chiffre d'affaire correct. Un tel résultat conduit au fait que, plus l'entreprise emploie de personne, plus elle produit, et surtout, elle a plus de savoir et d'expertise, ce qui l'aide à produire des articles de qualité, et innovateurs, et produit des quantités importantes.

Cependant, le professionnalisme traditionnel des unités de production est en dépréciation par manque de moyens, et la situation ne pourra que s'aggraver si les organismes intéressés ne coordonnent leurs efforts afin d'adopter les mesures appropriées pour remédier aux insuffisances du secteur [7].

En effet, l'une des principales difficultés que connaît ce secteur se résume au manque de main d'œuvre. Les jeunes s'intéressent de moins en moins à ce secteur en raison de la détérioration des conditions de travail (aucune couverture sociale). Toutefois, les conditions de travail ardues et les difficultés de commercialisation des produits ne sont pas les seuls soucis des potiers. Ces derniers ne bénéficient d'aucune couverture sociale [8]. En outre, l'accès des artisans au financement ou à la couverture médicale n'est pas simple, cela nécessite une mobilisation de tous les intervenants, notamment des bénéficiaires eux-mêmes. En 2011, une convention de partenariat avait été signée entre le ministère et trois institutions bancaires pour mettre en place des produits de financement spécifiques au profit des artisans, projet ayant rencontré plusieurs obstacles, mais qui se trouve toujours au centre d'intérêt des responsables [9].

5 CONCLUSION

L'activité de la poterie contribue fortement à la croissance de l'artisanat dans la région de Salé, notamment grâce à la concentration des artisans en son sein, d'où l'intérêt de cette étude qui nous a permis de relever un des facteurs pouvant avoir un impact non négligeable sur le revenu des potiers, qui est le nombre d'employés employés par les unités de production.

A la lumière de ces résultats, nous recommandons les efforts entrepris entre les intervenants du secteur (ministère, délégation, chambre d'artisanat, institutions de formation, etc.) malgré lesquels le secteur souffre encore de plusieurs faiblesses, qui devraient faire l'objet d'études plus approfondies.

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A *Probable Meteor* Multi-Ring Impact Craters in the North-eastern Morocco: Evidence Petrographic and Morphologic

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ABSTRACT: The north-eastern Morocco, is a peculiar area which is suspected to be a large impact site. It has a conspicuous ring structure with an apparent diameter of about 200 km of which half is in the sea. Jurassic mountains Taourirt-Oujda-Tlemcen showing an arc form correspond to the outer ring. Mesozoic and Palaeozoic bedrock units are locally brecciated and cut by pseudotachylite breccia dykes. Kebdana mounts with its intense and unusual deformation, form probably the central uplift of a complex crater. A wide variety of breccias is located inside and outside of the crater, many of which contain fragments exhibiting shock metamorphic features. The age of the impact is estimated to be toward the late of Messinian.

KEYWORDS: Pseudotachylite, Suevite, Impactite, breccia, Kebdana, Beni Snassen, Messinian.

1 INTRODUCTION

The largest impact structures are multi-ring craters. They are characterized by several structural rings surrounding a topographic crater form. On earth, three large multi-ring basins have been recognized. One of them is the Chicxulub structure in Mexico, of 180-300 km diameter [1], [2].

In the North Eastern Moroccan a circular structure of 200 km of diameter, is visible on the Google Earth image (Fig.1). Half of this circular structure is conspicuous in the Mediterranean Sea. The Shock metamorphic effects present in samples of all sector, [3] suggest that circular region is a meteor impact structure.

In this paper, we announce the existence of a circular structure, and we describe briefly some shocked products from different locality of crater.



Fig. 1 Satellite image large oval structure which half is drawn by the reliefs of mountains ranging from Alhoceima, Taourit, Jerada to Tlemcen. The other half is visible in the Mediterranean Sea.

2 FORM AND GENERAL GEOLOGY

North-Eastern Morocco is a system of plains, plateaus and mountain ranges extending on the eastern parts of the eastern Meseta and Rif domains (Fig. 3). It is represented by the Beni Snassen and Kebdana mounts, the Taourirt-Oujda basin, the Taourirt-Oujda mount named “Pays des Horsts” and a crustal block without notable alpine deformation, which constitutes the High Plateaus. [4]

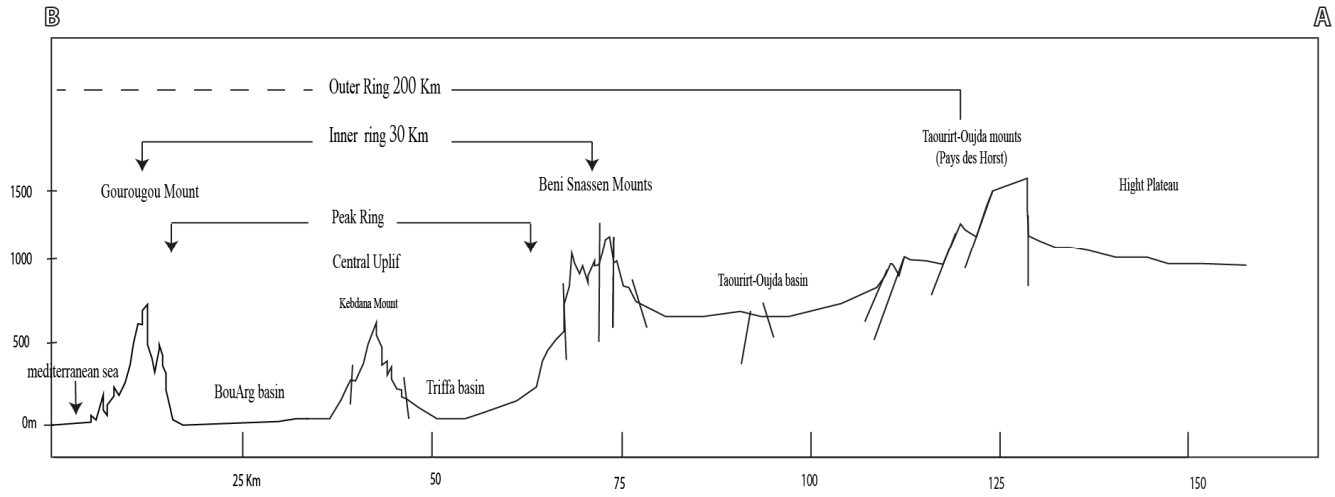


Fig. 2 NW-SE topographic profile of Complex Crater of north-eastern Morocco along the AB transect shown in Fig. 1.

The Kebdana chain located in the center area of the circular structure could be the central uplift of this complex crater. It is ringed by the plains (Triffa Sebra and BouErg) that form a ring of 30 km. Beni Snassen Mountains around the previous plains could be considered as the inner ring (terrestrial part). The Taourirt-Oujda-Tlemcen mounts (Pays des Horst) which show sub-horizontal Jurassic sediments affected by fault systems mounts would correspond to the outer ring. (Fig. 2 and 3)

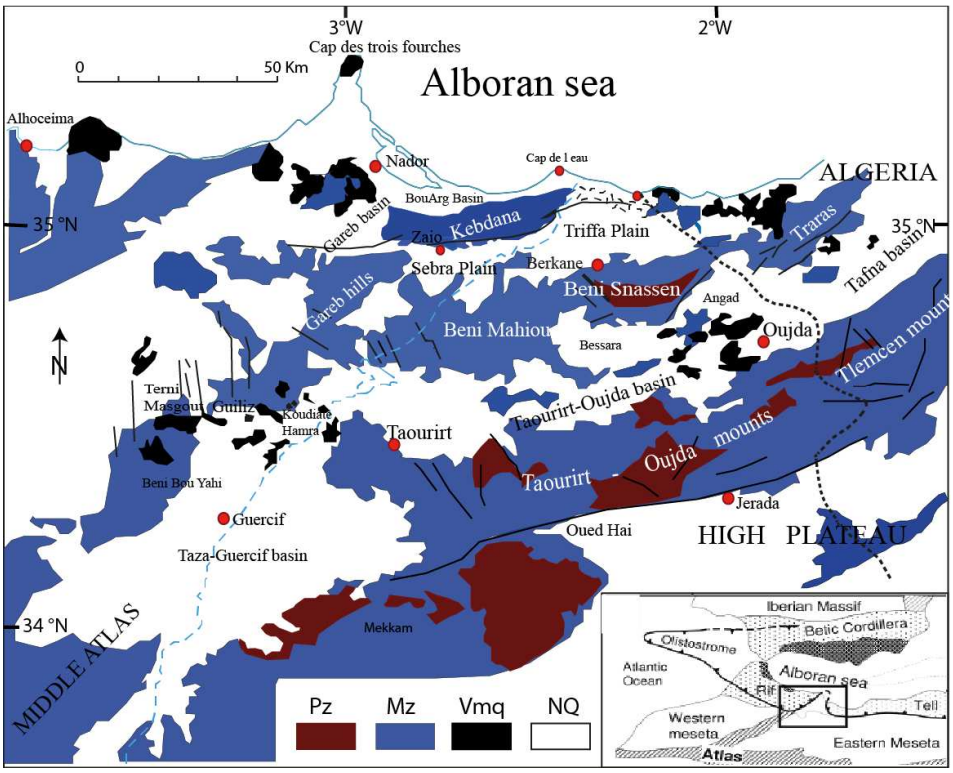


Fig. 3 General location and simplified geologic map of the north-eastern Morocco. [After El Hammichi 4] modified. Pz: Palaeozoic, Mz: Mesozoic, Vmq: Late Miocene to Quaternary volcanics, NQ: Neogene to Quaternary sediments. (Noted that Tertiary magmatism is located inside of the outer ring)

3 KEBDANA DEFORMATION

Several effects of metamorphism choc can be noted in Kebdana mounts. Such as breccia, quartzite with chocked quartz or like the dikes of pseudotachylite.

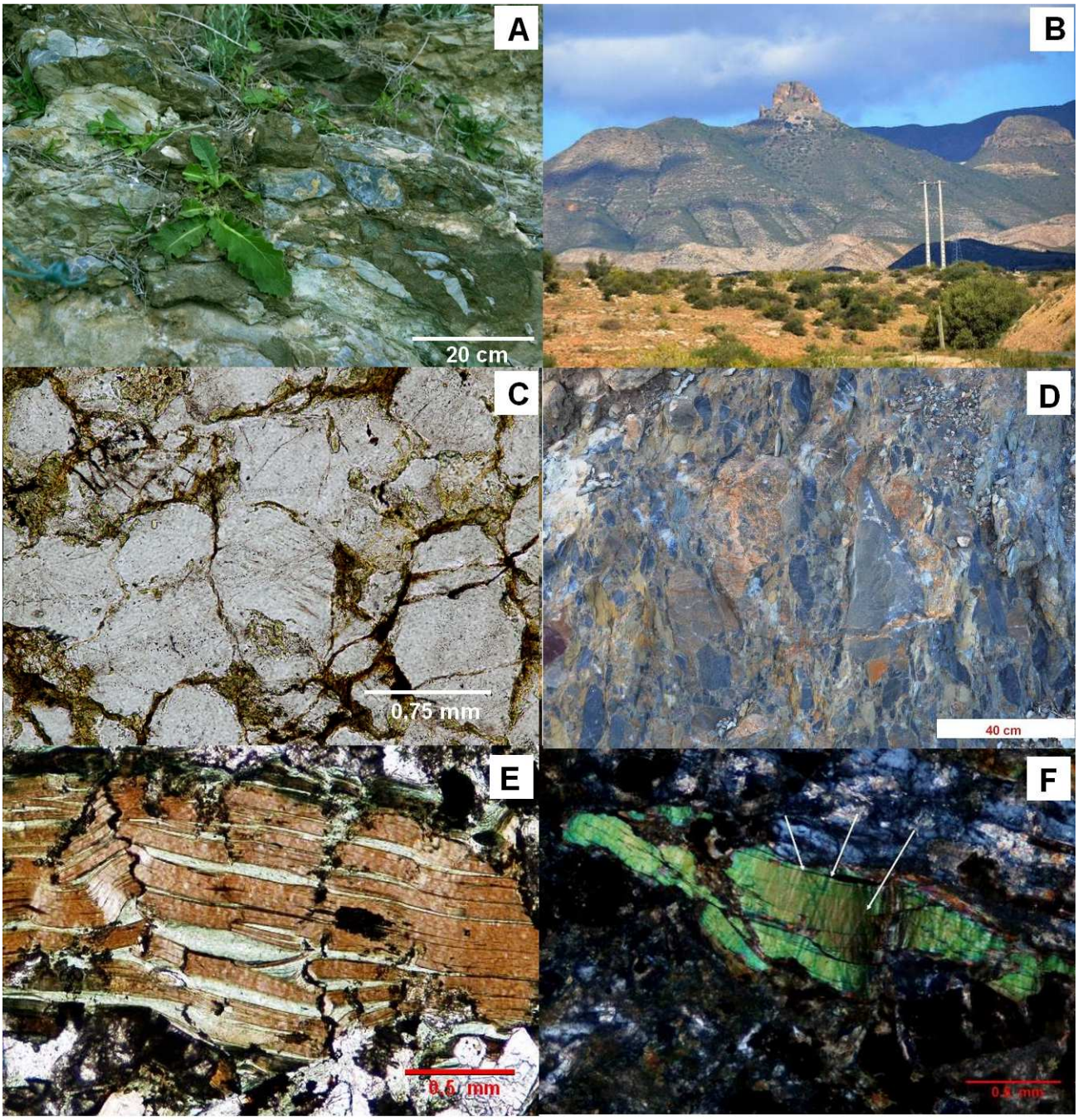


Fig. 4 (A). Dark green pseudotachylite breccia in the Kebdana Mountain. (B) A peaks of limestone blocks raised vertically in Kebdana. (C) The interstitial altered glass and choked quartz in quartzite from Kebdana. (D) Plastically deformed Breccia in Zaio area (Kebdana). (E) Complex kink bands and fractured deformation in biotite from Kebdana Pseudotachylite. (F) Biotite showing three main sets of PDFs. The arrow indicates the preferential direction of the PDFs in the biotite from Pseudotachylite of Kebdana

3.1 PSEUDOTACHYLITIC IN KEBDANA

Pseudotachylite occurs in the par-autochthonous rocks of large impact structures. It's most developed at two large, ancient impact structures: Vredefort (South Africa) and Sudbury (Canada). They occur like as abundant dikes or bodies that contain numerous large and small rounded inclusions of target rock set in a dense, aphanitic or crystalline matrix that is generally black to green in color [5].

The petrographic study of pseudotachylite (Fig. 4A) from Kebdana, has revealed the presence of the deformed biotite, the brown melanite (titanian garnet), curved apatite and titanite set in a matrix that contain considerable amounts of hydrothermal phases (chlorite, sulfides and carbonates).

The kink-bands are the most frequent micro-deformation in biotite and, more rarely, planar deformation elements (Fig.4E) and the borders are often curved or broken. In contrast to the kink-bands, planar elements display an appearance of very fine lamellae (Fig. 4F), arranged in parallel sets and closely spaced, analogous to those described by Schneider [6]. Along the fine lamellae, the birefringence is intensely reduced.

3.2 QUARTZITE

A wide block of quartzite (10 m) located at east of Kebdana corresponding to an intensely deformed rock, the shock has given the melt in interstices. The majority of quartz grains are shocked (2 to 3 sets planes PDFs) and show rounded shape by resorption (Fig. 4C). The same mineralogical characteristics were noted in the thin section of Miocene cobbles at Aknoul area (Fig. 6D).

3.3 BRECCIA

Several types of breccias have been observed at the Kebdana mount, we note the presence of mega-bloks and the plastically deformed breccia where both clasts and matrix are intensely affected (Fig. 4D). The quartzite clasts show many fracture and the shocked quartz.

The summits of Kebdana are decorated with peaks (Fig. 4B), which correspond to limestone blocks. These blocks are raised vertically, fractured, brecciated and in some times transformed partially to marble

4 BENI SNASSEN DEFORMATION

The deformation is recorded differently depending on the nature of the target rocks. The Jurassic limestone is deformed as monomicte breccias at the Aghbal valley or as conical structures (Fig. 5C and 5D) that are visible on the tops of Foughal and Ain Almou. Some Palaeozoic quartzite have been warmed and partially melted as attests it the presence of resorbed quartz and melt in interstices in thin section. The pseudotachylite occurs as altered magmatic dikes (20 cm to10 m of thick) cross-cutting the Palaeozoic formations.

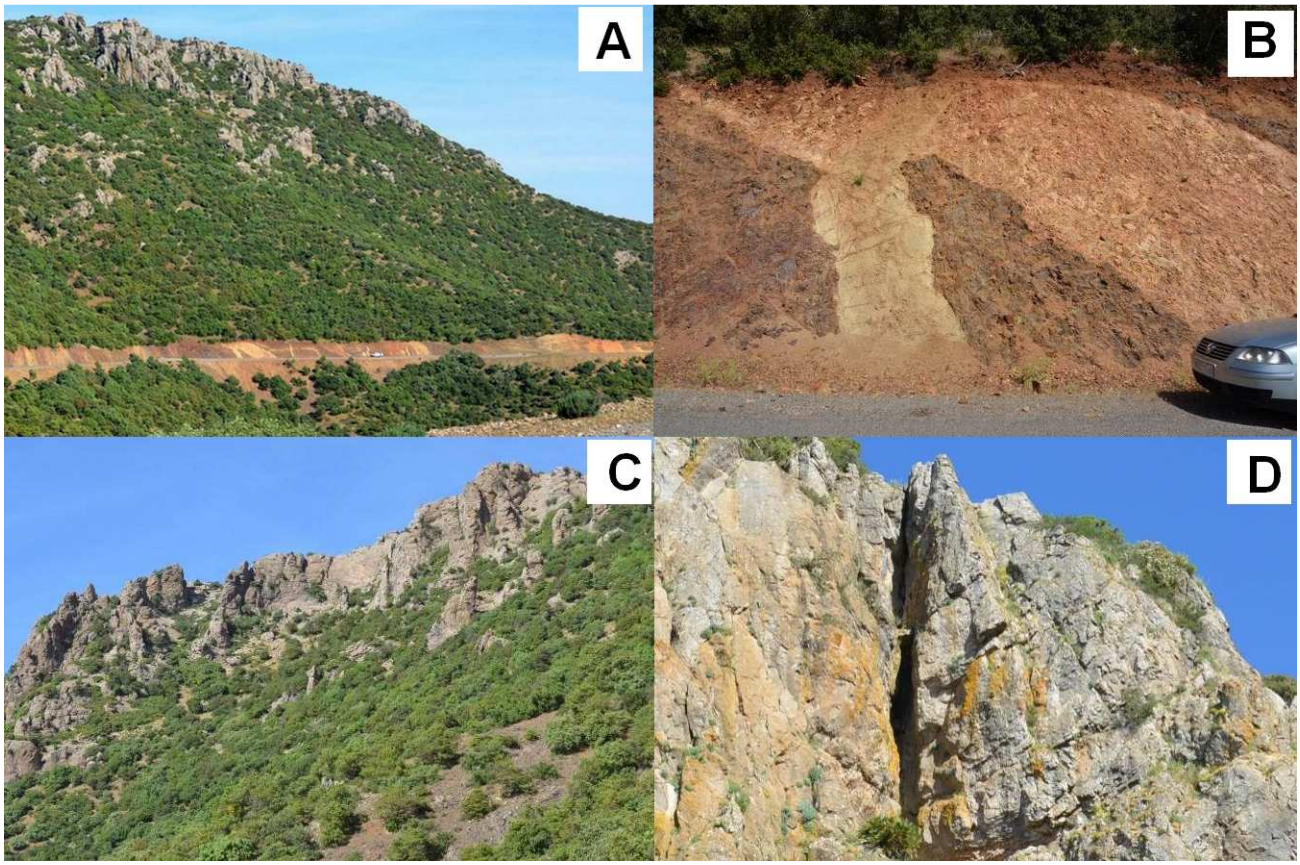


Fig. 5. (A) The pseudotachylite dyke cutting throough Palaeozoic formations which are overlain by the Jurassic fractured limestone. (B) A closer view of the pseudotachylite dyke crossed by a later green one. (C) Several blocks showing a conical structure in the Jurassic limestone summit of Foughal. (D) Closer view of the conical structure

4.1 PSEUDOTACHYLITE

Systems of dikes and sill (Fig. 5 A and B), sharply cutting through their host Palaeozoic rock are a prominent structure in the Beni Snassen Mounts. Their aphanitic matrix are much altered into friable rocks, only a few dikes show the intact rounded fragments. All phases appear to be altered. The microlites, indicating devitrification, appear to be chloritized. The rounded Quartz clasts in the pseudotachylite were more resistant to melting than other minerals of the host rock.

("Pseudotachylite" is used here as a descriptive term for tachylite-like, aphanitic inclusion-bearing dike and irregularly shaped bodies that may have glassy, tiny-grained, igneous or clastic matrices.)

5 CARBONATE-RICH SUEVITE

The superficial formations in the north-eastern Morocco occupy vast areas and form deposits and crusts considered Plio-quaternary (Fig. 6 A, B and C). These are tabular structures formed by a limestone crust, then a conglomerate encrusted and finally a low gravel terrace encrusted [7]. These formations are located in different basins of the region: Oued Hai Basin (Jerada), Taourit-Oujda Basin (Aioune and Taourirt) and Triffa Basin. [8], [9], [10].

The carbonates have often been neglected in studies of impactites. However, carbonates are common at the surface of the earth and, therefore, in target rocks. Several impactites must contain solid and melted carbonate phase. In the Triffa case like Chicxulub [11], where the target rock is Jurassic limestone, the contribution of carbonates to the produced melts was very important. In this case it's difficult to distinguish a carbonate impactite (Fig. 6 A and B) from the sedimentary breccia.

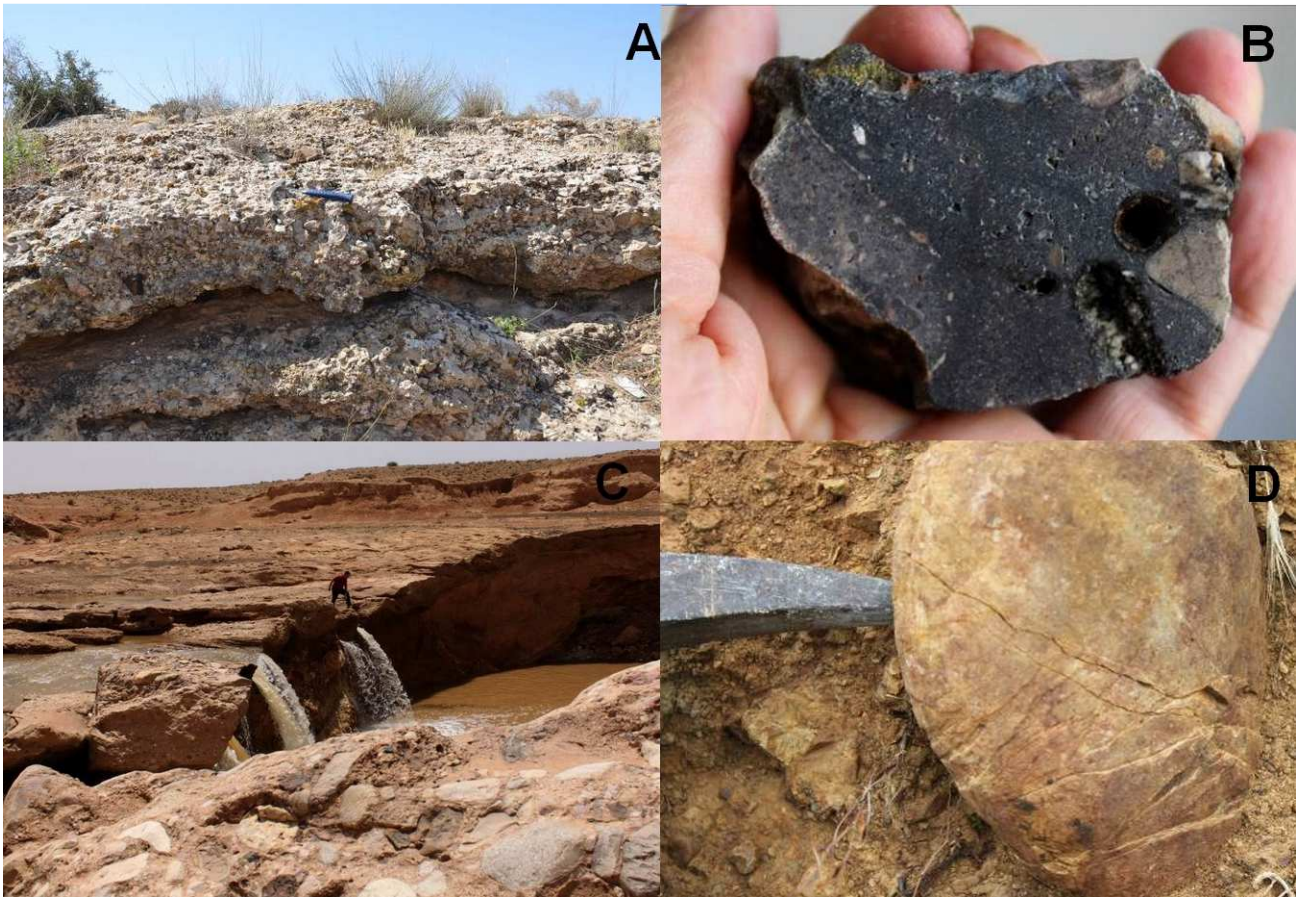


Fig. 6 (A) Suevite corresponding to blanket of encrusted conglomerate in Taourirt area. Fig. (B) Suevite with resorbed clasts in annealed fine-grained matrix from Taourirt. (C) A blanket of the Suevite with rounded clasts in Oued Hai. (D) Strongly deformed cobbles in Miocene outcrop (Aknoul) showing fracturing.

The breccia is mainly composed of carbonate clasts rounded or subangular and a few feldspar and quartz fragments. Clasts composed of clay minerals are also present. Many of the quartz grains are resorbed and rarely where it contains shock-induced planar deformation features (PDFs). The presence of melt and shocked quartz in these rocks allows us to consider, these Quaternary conglomerates present in northeastern Morocco, as the ejecta suevite formed by the fusion of limestone by this impact.

6 AGE

The fractured cobble and the shocked quartz in Miocene conglomerate allow us to suggest that the impact had occurred in the Miocene. However, considering the suevite plio-quaternaire corresponding to extended blanket conglomerate, the age of impact will be different.

The Neogene-Quaternary Taza-Guercif Basin is a neighboring of the crater, this basin position is particularly interesting from the biostratigraphy point of view, such as it records the deposit of the ejecta material in basin sediments. The basin fill of the Guercif Basin, starts with a Tortonian marine marl overlain unconformably by the Messinian marly [12], [13] which is in turn unconformably (Fig. 7A) overlain by the Pliocene continental unit (conglomerate and lacustrine limestone). This unit shows a level formed of carbonate melt (scoria) in the sediment (Fig. 7 B and C) and of conglomerate with shocked quartz. Noted sediment disruptions at the end of Messinian could be induced by the falling of impactite ejecta. So the boundary Messinian-Pliocene would correspond to the age of this impact.

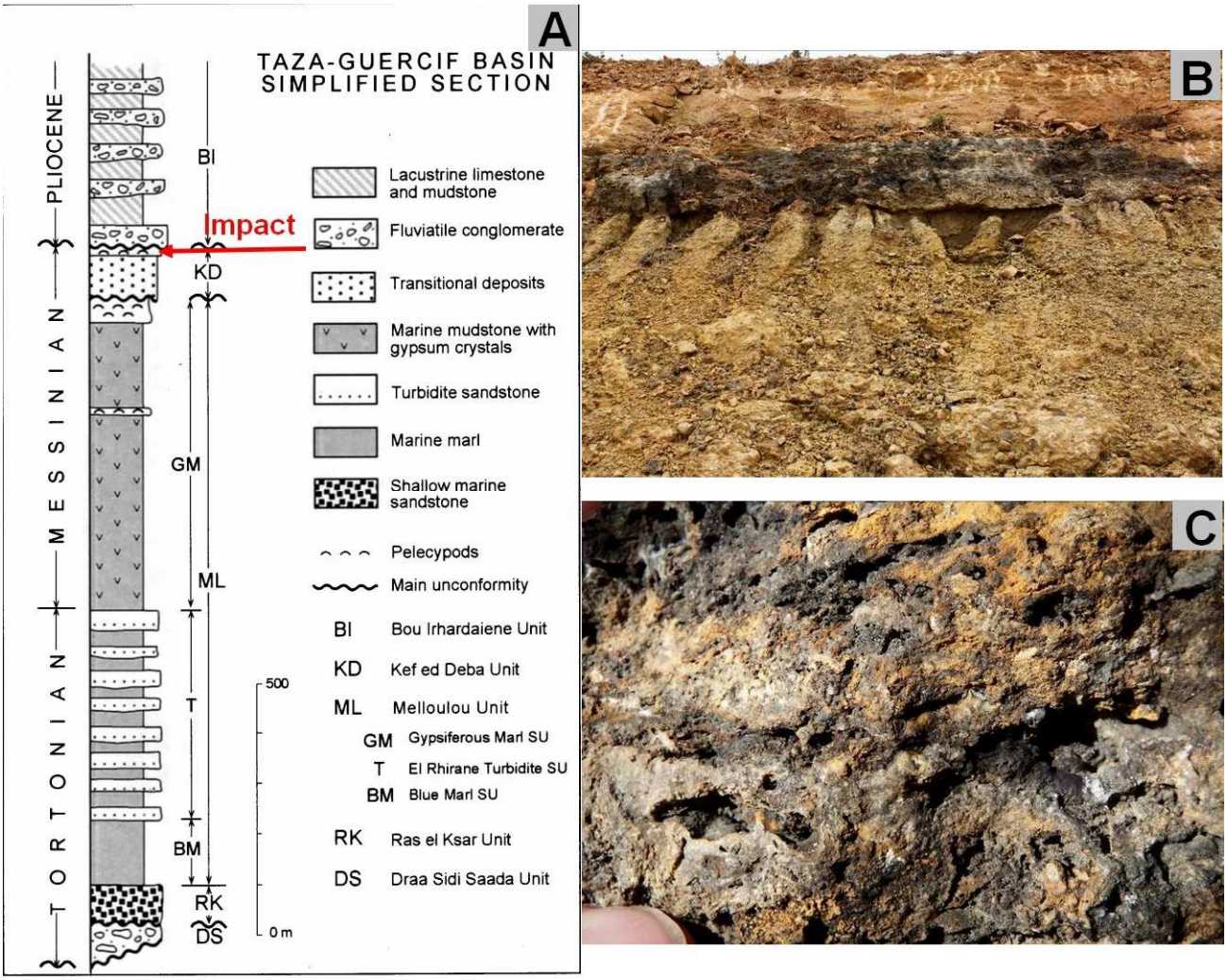


Fig. 7 (A) Schematic stratigraphic column of the Neogene Taza-Guercif basin. The arrow shows a probable impact age at the boundary Messinian-Pliocene. [In Bernini 12]. (B) A black level of carbonate scoria set in the sediment of Taza-Guercif Basin. (C) Close view of Carbonate scoria from black level in 7B.

7 CONCLUSION

Many indices of shock metamorphism are present in the north-eastern of Morocco. Pseudotachylite and monomict breccia are only present in the peak ring (Kebdana and Beni Snassen) but the carbonate suevite is spread from the center to outside ring of the crater.

The blanket conglomerates (Plio-Quaternary) present in the basins in northeastern of Morocco (Triffa, Taourirt, Aioune and Oued Hai (Jerada) would be a suevite with a carbonate matrix. All these suevites contain shocked quartz grains. The target carbonated rock (limestone Jurassic) pulverized and vaporized at impact shock formed a carbonate breccia and suevite.

Based on these criterions we suggest the existence of a wide multi-ring crater in the northeastern morocco. Kebdana Mountains intensely deformed form probably the central uplift of a complex crater. The Beni Snassen mounts could be considered as the inner ring and the Taourirt-Oujda-Tlemcen mounts would correspond to the outer ring.

Further investigations are needed to clarify the structure of this wide crater. New petrographic facies (sueviete and pseudotachylite) briefly described in this work deserve more advanced studies.

The presence of the Mio-Pliocene volcanism inside the outer ring of the crater, deserves some new reflection about the origin of this magmatism, taking into account the existence of this wide impact crater.

Also the Messinian age of the impact allows us to ask the following question: Is there a link between this event and the mass extinction known at the end of the Messinian?

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Outils SIG et caractérisation physiographique et climatique du bassin versant du barrage Sidi Chahed (NE de Meknès, Maroc)

[GIS tools and physiographic and climatic characterization Watershed Dam Sidi Chahed (NE Meknes, Morocco)]

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ABSTRACT: The Dam Sidi Chahed is located downstream of the Mikkes and Lmaleh rivers. It's located about 30 km at the NE of Meknes city and about 30 km at the NW of Fez city on the main road between Fez and Sidi Kacem. It was commissioned in 1997 and has a capacity of 170 million m3. It crosses three different structural units with the Middle Atlas to the south, the basin know the center and south-north Rif wrinkles. The use of ArcGIS and Global Mapper has been used to characterize the edge of the dam and its retention Sidi Chahed from ASTER images making several thematic maps which are: the map contours, the DTM, the map slopes and their exposure, thematic map of sub-basins, the thematic map of the river system and its classification, the superposition of the structural and drainage networks, thematic map of rainfall and late distribution maps of physico-chemical parameters. From thematic maps produced for the watershed studied, several geometric calculations were performed to characterize the watersheds under long view, width, equivalent rectangle, area, perimeter and compactness index. These parameters indicate that sub tanks are elongated favoring low flow rates, a greater flow of water and a total amount of time of considerable precipitation harvested. Rainfall results, which were obtained from the isohyets maps are divided into 7 classes with lower values since the Middle Atlas at the south (850 mm) to the Sidi Chahed dam at the north (450 mm).

KEYWORDS: Dam Sidi Chahed, Oued Mikkes, Geology, ASTER images, DEM, Watershed, Drainage, GIS.

RESUME: Le barrage de Sidi Chahed est situé en aval des oueds Mikkès et Lmaleh. Il est situé à 32 km au NE de Meknès et à 32 km au NW de Fès sur la route principale reliant Fès et Sidi Kacem. Il a été mis en service en 1997 et doté d'une capacité de 170 Mm3. Il traverse trois ensembles structuraux différents : le Moyen Atlas au Sud, le bassin de Saîs au centre et les rides sud-rifaines au Nord. L'utilisation des logiciels SIG a permis de caractériser la zone du barrage Sidi Chahed et sa retenue à partir des images ASTER en réalisant plusieurs cartes thématiques dont on peut citer : la carte hypsométrique, la carte des pentes et de leurs exposition, la carte des sous-bassins versant, la carte thématique du réseau hydrographique et sa classification, la superposition des réseaux hydrographique et structural, la carte géologique et en fin la carte thématique de la pluviométrie. A partir des cartes thématiques réalisées pour le bassin versant étudié, plusieurs calculs géométriques ont été effectués pour caractériser les sous bassins versant de point de vue longueur, largeur, rectangle équivalent, surface, périmètre et indice de compacité. Ces paramètres indiquent des sous bassins de forme allongée favorisant les faibles débits, un temps d'acheminement des eaux plus important et une quantité totale récoltée de précipitations considérable. Les

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résultats pluviométriques mettent en évidence des isohyètes reparties suivant 7 classes avec diminution des valeurs depuis le Moyen Atlas au Sud (850 mm) jusqu'au barrage Sidi Chahed au Nord (450 mm).

MOTS-CLEFS: Barrage Sidi Chahed, Oued Mikkes, Géologie, Images ASTER, MNT, Bassin versant, Réseau hydrographique, SIG.

1 INTRODUCTION

L'eau est indispensable à toute vie humaine et végétale. Elle joue un rôle très important dans le développement socio-économique aussi bien au niveau local, régional que national. Dans un pays semi-aride comme le Maroc, l'eau a une fonction fondamentale dans les activités socio-économiques. De ce fait et dans le cadre de la politique de rationaliser l'eau de pluie, de surface et l'eau souterraine, le Maroc a aménagé de nombreux dispositifs permettant de maitriser cette ressource précieuse et de favoriser le développement économique. L'un des principaux dispositifs est la réalisation des barrages pour conserver l'eau de pluie. Parmi les barrages du Maroc, le barrage de Sidi Chahed se situe entre la ville de Meknès et Fès (Fig. 1). Il est alimenté principalement par Oued Mikkès et Oued Lmaleh. Il avait pour but le renforcement à moyen et à long terme de l'approvisionnement en eau potable de la ville de Meknès et l'irrigation de 1200 ha [1].

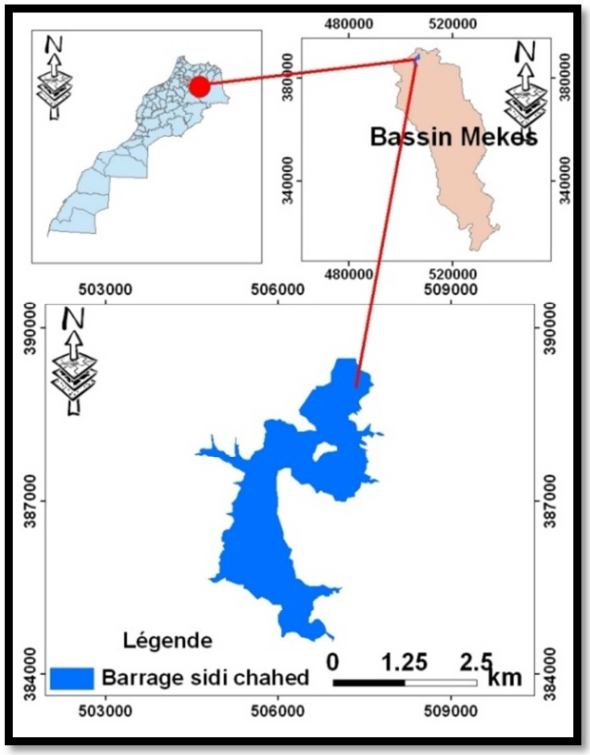


Fig. 1. Situation géographique du barrage Sidi Chahed.

Le barrage de Sidi Chahed et son bassin versant ont été le siège de plusieurs travaux antérieurs [2], [3], [4], [5], [6], etc. Le présent travail, consiste à réaliser des cartes thématiques à l'aide des logiciels utilisés dans les Systèmes d'Information Géographique (SIG), pour étudier les caractéristiques topographiques (MNT, TIN, carte hypsométrique, cartes des pentes de leurs expositions), hydrographiques (carte du réseau hydrographique avec sa classification), structurale (superposition des réseaux hydrographique et structural) et climatiques (cartes des isohyètes) du bassin versant du barrage Sidi Chahed.

2 CONTEXTE GÉOGRAPHIQUE ET CLIMATIQUE

Le barrage Sidi Chahed a été mis en service en 1997. Il a une capacité de 170 Mm^3 et une hauteur de 60 m au dessus des fondations. Il est situé à environ 32km au NE de la ville de Meknès et à 32km au NW de la ville de Fès, sur la route principale n° 3 reliant cette dernière et Sidi Kacem. Les eaux de l'Oued Mikkés, affluent de l'Oued Sebou, sont régularisées par celles du barrage de Sidi Chahed (Fig. 1).

Le bassin versant de l'Oued Mikkès est drainé par quatre affluents: l'Oued N'ja et l'Oued Atchane en rive droite et l'Oued Tizguit et l'Oued Akkous en rive gauche. Les deux premiers drainent la plaine du Sais et les deux derniers drainent le plateau de Meknès et le causse d'El Hajeb–Ifrane.

En allant du sud vers le nord du bassin versant, l'altitude diminue en parallèle avec les précipitations alors que les températures deviennent plus importantes. Le maximum des hauteurs de pluie est enregistré au niveau du causse et précisément à la station d'Ifrane (Altitude 1600 m), alors que le minimum de pluie est observé à l'aval du bassin au niveau de la station de Sidi Chahed (Altitude 190 m). La détermination de la hauteur pluviométrique moyenne interannuelle dans le bassin versant de l'Oued Mikkès durant la période 1968–2005 est très approximative étant donnée le peu de stations de mesure et les variations du relief. La lame d'eau moyenne calculée par la méthode des isohyètes est de l'ordre de 484 mm [1]. L'indice d'aridité I de la région, de 18 mm/°C (De Martonne 1942), correspond à un climat semi-aride avec $10 < I < 20$ [2].

3 CONTEXTE GÉOLOGIQUE

De point de vue géologique, le BV de l'Oued Mikkès comporte trois ensembles structuraux différents. Le causse d'El Hajeb–Ifrane, caractérisé par une forte fracturation, occupe la partie sud où prédominent les formations carbonatées représentées par les calcaires et dolomies du Lias inférieur et moyen. Le bassin de Sais, situé au centre, est constitué par les calcaires lacustres et les sables fauves du Pliocène ainsi que les marnes du Miocène. Dans la partie nord, au niveau du pré-rif, affleurent essentiellement les argiles du Trias et les marnes du Miocène supérieur (Fig. 2) [2].

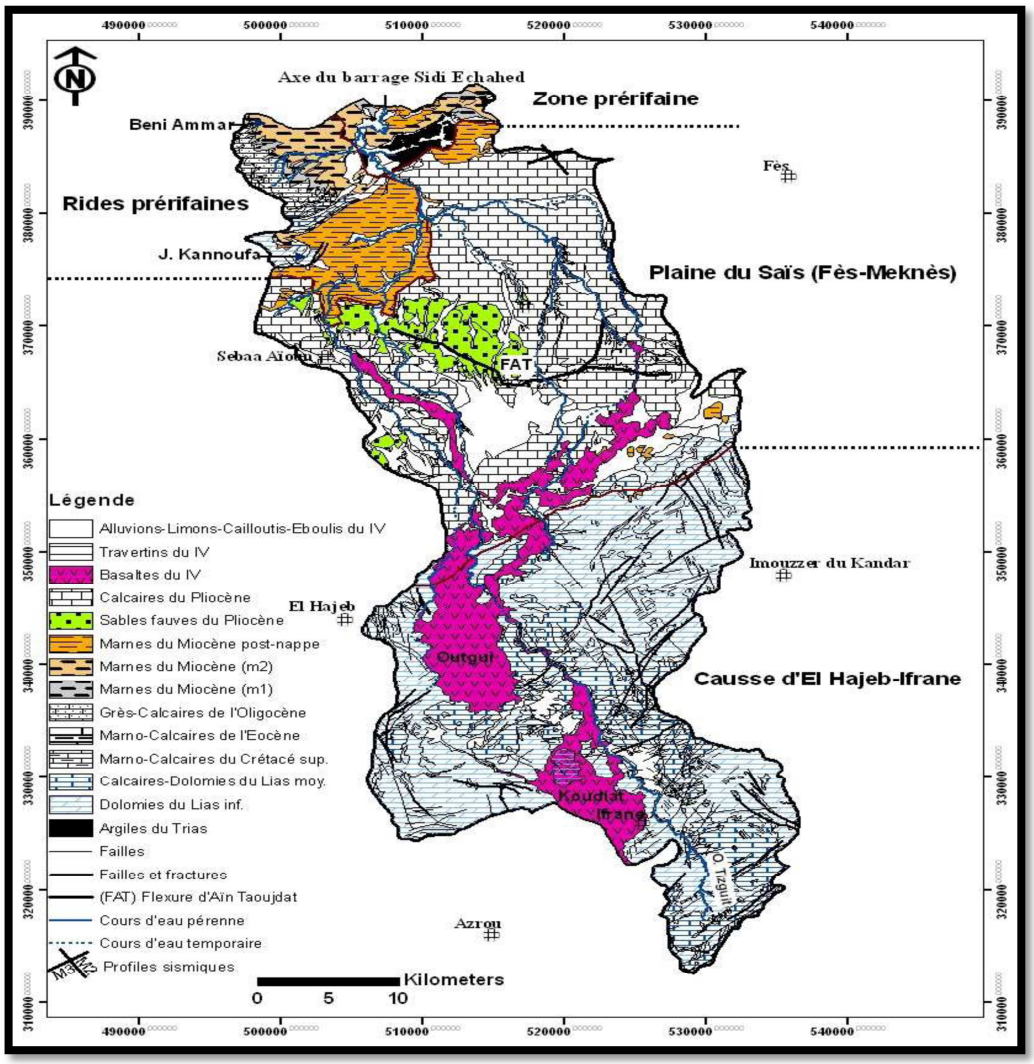


Fig. 2. Carte géologique du bassin versant de l'oued Mikkes [2].

La partie centrale du bassin d'Oued Mikkès fait partie du bassin du Sais. Ce dernier constitue lui aussi la partie centrale du sillon sud-Rifain. Les études antérieures ([7], [8], [9] et [10]) montrent que l'origine de ce bassin serait liée à la dislocation du substratum liasique, qui s'ennoie sous la couverture néogène. Il forme ainsi un large graben qui s'étend depuis le causse Moyen Atlasique au sud jusqu'au domaine pré-Rifain au nord selon une direction nord- sud [2] (Fig. 2).

4 MATÉRIELS ET MÉTHODES

Le système d'information géographique (SIG) peut être défini comme un outil informatique qui permet d'interroger, de localiser, d'analyser et de représenter des données ayant une référence spatiale. Le principe de travail est basé sur une succession des étapes permettant l'élaboration de cartes thématiques. Dans ce cadre les logiciels SIG ont été utilisés pour intégrer, gérer et diffuser des données à référence spatiale. Une des applications principales de ces logiciels est la représentation cartographique de territoires et le stockage des géométries des objets et leurs attributs graphiques en plus des attributs descriptifs.

Le présent travail a fait appel aux différentes cartes topographiques, géologiques, structurales et surtout aux images SRTM et de la zone d'étude.

5 RÉSULTATS ET DISCUSSION

L'utilisation de l'outil SIG et de l'image ASTER ont permis d'avoir une autre source d'information pour bien comprendre les aspects de l'endroit étudié. Le MNT a permis d'extraire des informations avec l'édition de cartes thématiques relatives à l'altitude, aux pentes et leur exposition, à la délimitation des sous-bassins et aux réseaux hydrographique et structural. Les autres données ont été utilisées pour créer des cartes thématiques relatives à la pluviométrie.

5.1 CARTE GÉOLOGIQUE SIMPLIFIÉE

La carte géologique simplifiée a été obtenue par digitalisation à partir de la carte géologique de Bni Ammar au 1/100000ème [11]. Elle montre la grande prédominance des terrains marneux du Miocène très vulnérables à l'érosion hydrique et aux glissements de terrain surtout en présence d'un relief montagneux accidenté. Dans la partie Est le long de l'oued Lmaleh, prédominent surtout les terrains du Trias qui menacent la retenue du barrage par l'impact des apports salifères en plus du phénomène d'envasement par les argiles. Vers le Sud affleurent surtout les calcaires lacustres de Saïss (Fig. 3).

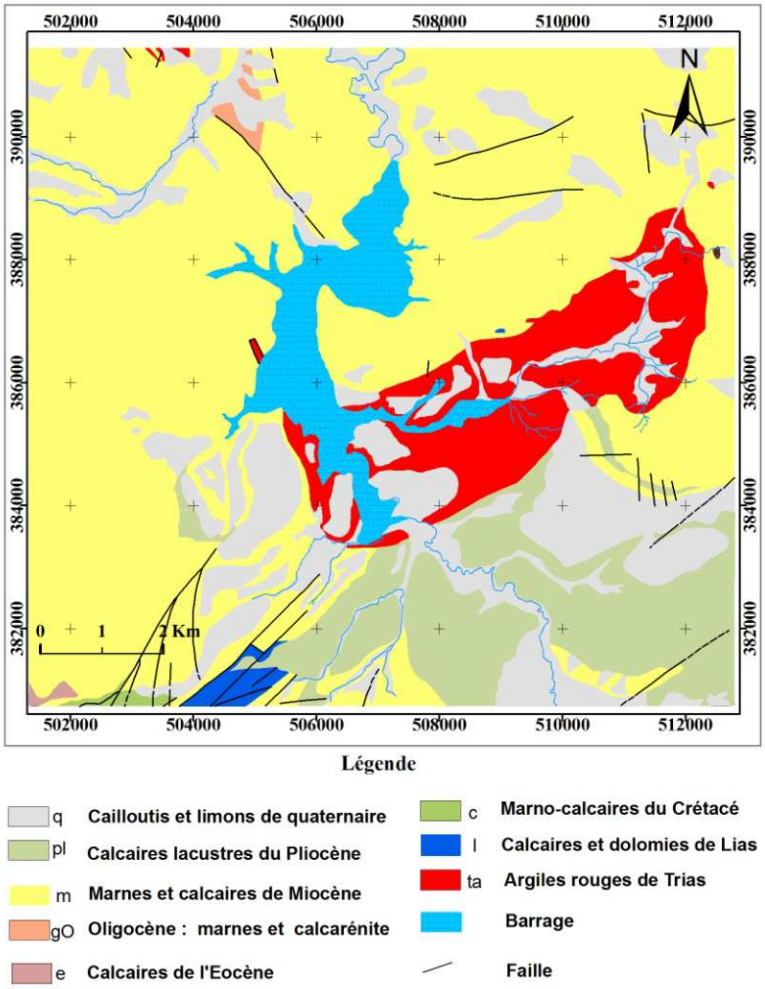


Fig. 3. Carte géologique simplifiée du bassin versant du barrage Sidi Chahed. Extraite de la carte géologique de Beni Ammar 1/50000 [11].

5.2 EXTRACTION DES COURBES DE NIVEAUX

Les courbes de niveaux ont été extraites à partir des images ASTER. Au niveau de la partie centrale de la carte, les courbes de niveaux, très espacées, indiquent le bassin de la retenue du barrage Sidi Chahed. Au tour de la retenue, les courbes, serrées, reflètent les reliefs du bassin versant proche formé par les rides sud-rifaines (Fig. 4).

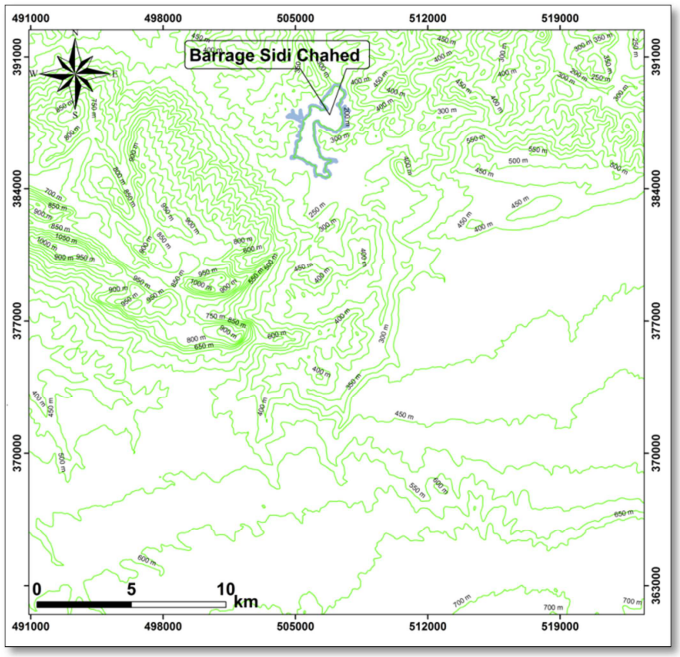


Fig. 4. Carte des courbes de niveaux.

5.3 CARTE HYPSOMÉTRIQUE ET TIN DE LA ZONE D'ÉTUDE

La carte hypsométrique et la carte TIN, obtenues à partir du Modèle Numérique du Terrain (MNT), montrent l'existence des altitudes essentiellement faibles d'environ 100 m au niveau du barrage et du réseau hydrographique. Au fur et à mesure qu'on s'éloigne de la retenue du barrage, les altitudes deviennent de plus en plus élevées (Fig. 5).

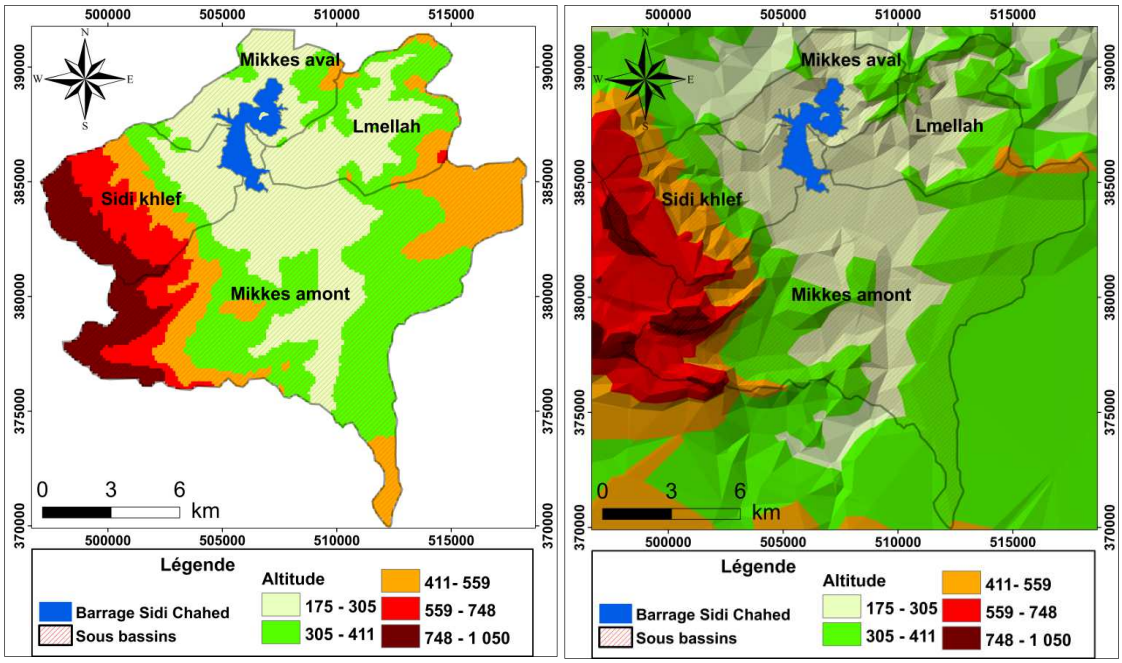


Fig. 5. Carte hypsométrique à partir du MNT à gauche et Carte des altitudes TIN à droite de la région étudiée

5.4 CARTE DES PENTES

La carte des pentes donne la topographie générale de la région. La plus grande partie de la carte est occupée par des pentes fortes relatives aux rides sud-rifaines. Au niveau du barrage et du réseau hydrographique, les pentes deviennent très faibles avec un relief plat (Fig. 6).

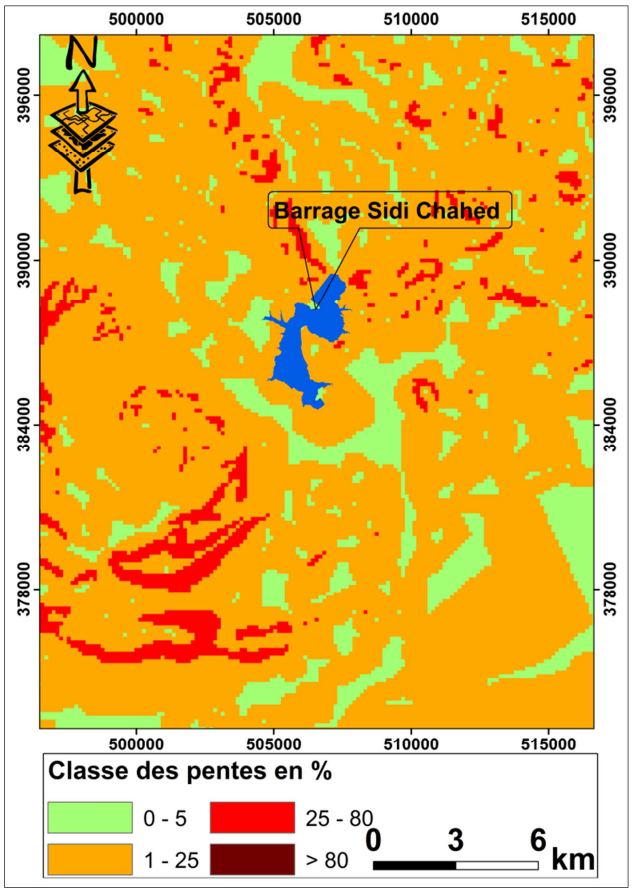


Fig. 6. Carte des pentes en pourcentage.

5.5 CARTE D'EXPOSITION DES PENTES

La carte d'exposition des pentes permet de déterminer l'orientation des pentes avec leurs pourcentages. Ainsi, l'exposition des pentes est dominée principalement par l'orientation NW (Fig. 7 et Tab. 1).

Tableau 1. Exposition des pentes en pourcent.

Exposition	Nord	Nord Est	Est	Sud Est	Sud	Sud Ouest	Ouest	Nord Ouest
Pourcentage	15,84	13,03	11,69	10,25	9,84	8,98	9,61	20,76

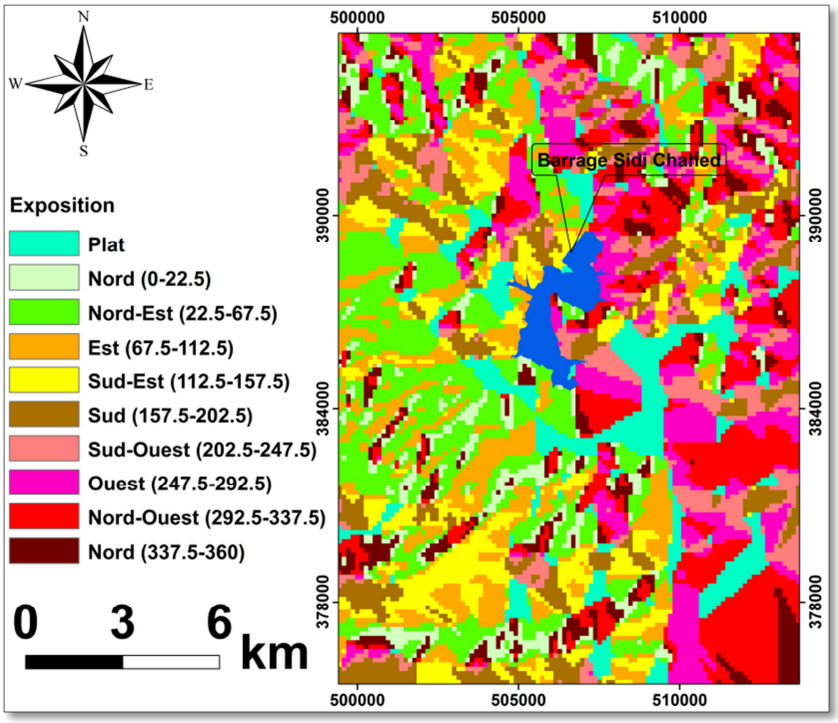


Fig. 7. Carte d'exposition des pentes.

5.6 RÉSEAU HYDROGRAPHIQUE

La carte du réseau hydrographique montre le chevelu hydrographique de la région d'étude permettant l'identification des cours d'eau. A sa lecture, apparaissent trois types de réseaux qui alimentent le barrage avec des oueds principaux à savoir Mikkes au Sud et Lmaleh à l'Est avec 15,56%, des oueds secondaires avec 25,82% et des chaabats avec 58,62% de l'ensemble du réseau hydrographique (Fig. 8, Tab. 2).

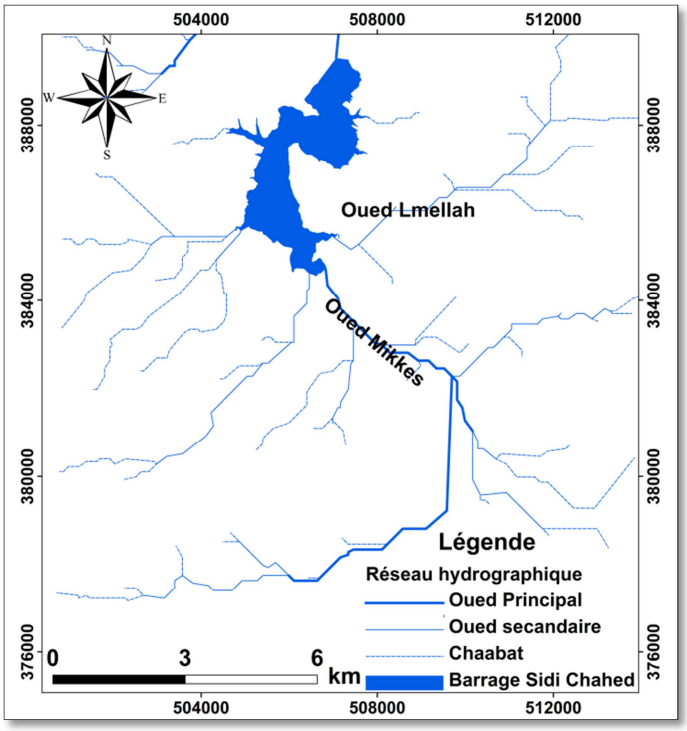


Fig. 8. Classification du réseau hydrographique.

Tableau 2. Caractéristiques du réseau hydrographique

Type de réseau	Longueur (km)	Pourcentage (%)
Oued principal	28,81	15,56
Oued secondaire	47,82	25,82
Chaabat	108,53	58,62

5.7 SUPERPOSITION DES RÉSEAUX HYDROGRAPHIQUE ET STRUCTURAL

Le réseau structural à été digitalisé à partir de la carte géologique de Beni Ammar [11]. La superposition des réseaux hydrographique et structural montre une bonne corrélation entre le réseau des failles et le réseau hydrographique avec plusieurs alignements de même direction. En effet, dans la partie SW, le parallélisme entre les deux réseaux permet de conclure que le réseau hydrographique semble bien guidé par le réseau de fractures préexistantes (Fig. 9).

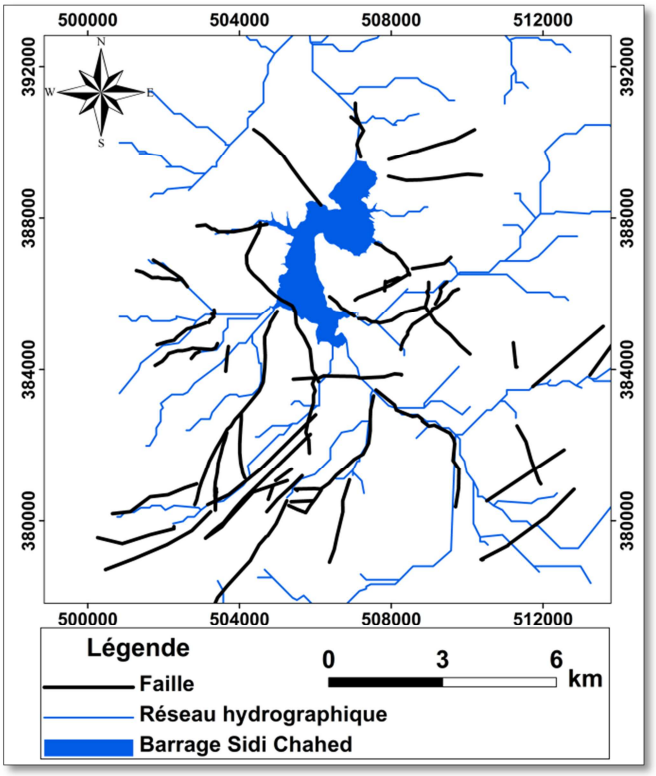


Fig. 9. Superposition des réseaux hydrographique et structural.

Le réseau structural est affecté par un réseau d'accidents de directions hercyniennes NE–SW et NW–SE et d'autres typiquement alpines EW et NS (Fig. 9). Il favorise l'infiltration des eaux au niveau du causse d'El Hajeb–Ifrane en amont du bassin versant et le drainage superficiel des eaux par des rivières au centre et au nord (Oued Tizguit, Oued Atchane, Oued Jdida, Oued Akkous et Oued N'ja) (Fig. 2).

5.8 DÉTERMINATION DES SOUS BASSINS VERSANTS

Le barrage de Sidi Chahed appartient au bassin versant de l'oued Mikkes. A la périphérie du barrage, quatre sous bassins ont été distingués (Fig. 10). Le sous bassin de Mikkes est situé vers le Sud dans la partie amont du barrage avec 36,46% de la surface du bassin versant. Le sous bassin de l'oued Lmaleh se trouve au NE et participe avec une surface de 9,54%. Le sous bassin de Sidi Khlef occupe la partie ouest avec une surface de 6,63%, alors que le sous bassin de Mikkes aval se trouve au Nord avec une surface de 10,9% (Fig. 10 et Tab. 3).

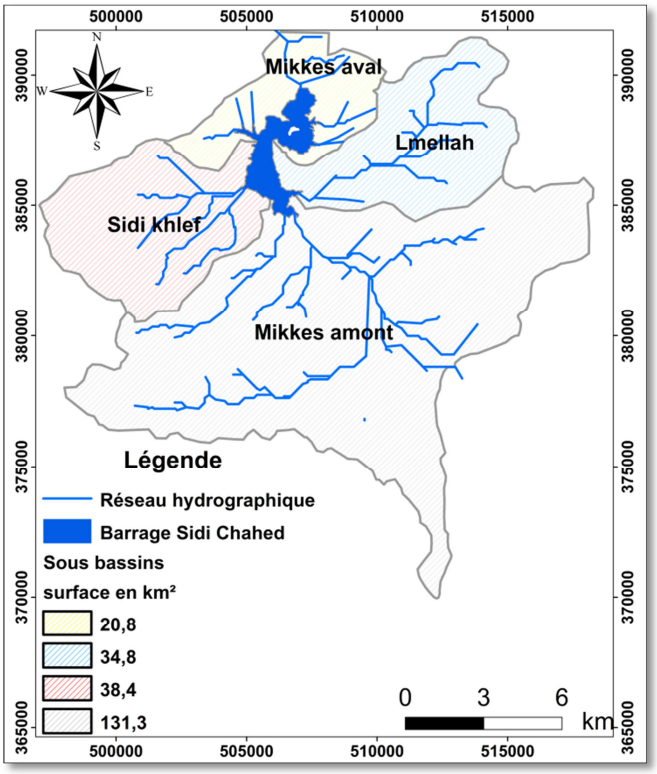


Fig. 10. Carte des sous bassins versants

Tableau 3. Caractéristiques des quatre sous bassins versant (SBV) et de leurs rectangles équivalents

Sous bassins	Surface (m^2)	%	Périmètre (m)	Largeur (km)	Longueur (km)
Sidi khlef	38 ,4	6,63	28,28	5	7,6
Lmaleh	34,16	9,54	36,54	5,6	9,25
Mikkes aval	20,15	10 ,9	38,08	2	13
Mikkes amont	131,32	36,46	70,38	21	18,8

5.9 CARTES ET COURBES HYPSOMÉTRIQUES DES SOUS BASSINS VERSANTS

Le relief est un facteur essentiel. Il détermine en grande partie l'aptitude au ruissellement des terrains, l'infiltration et l'évaporation. C'est un élément capital dans le comportement hydrologique d'un bassin versant.

Les cartes hypsométriques montrent la répartition spatiale des différentes classes d'altitudes avec leur fréquence leur abondance à l'échelle de chaque sous bassins versants (Fig. 11). Dans le SBV de Mikkes amont prédominent respectivement la classe des altitudes les plus faibles 200 – 356m avec environ 45% et une surface de 59km^2 et la classe des altitudes les plus élevées 710 – 1050m avec 38,73% et une surface de 50,79km^2. Le SBV de Mikkes aval montre la prédominance de la classe des altitudes les plus faibles 184 – 257m avec environ 48% et une surface de 10km^2. Le SBV de Lmellah est caractérisé par la prédominance de deux classes de faibles altitudes à savoir la classe 200 – 282m avec 36,88% et une surface de 13,25 km^2 et la classe 282 – 352m avec 34,73% et une surface de 12,48%. Dans le SBV de Sidi Khlef, les classes d'altitudes sont relativement équivalentes avec une légère importance de la classe des altitudes les plus faibles 200 – 376m qui représentent 30,13% et occupent une surface de 11,59 km^2.

Les altitudes les plus basses s'étendent sur la partie avale du SBV de Sidi Khlef et sur les parties médianes et avales des SBV de Lmellah et de Mikkes amont et aval. Les altitudes les plus élevées, au niveau du SBV de Mikkes amont jusqu'à 1050m et du SBV de Sidi Khlef jusqu'à 950m, reflètent le caractère relativement montagneux de ces deux SBV.

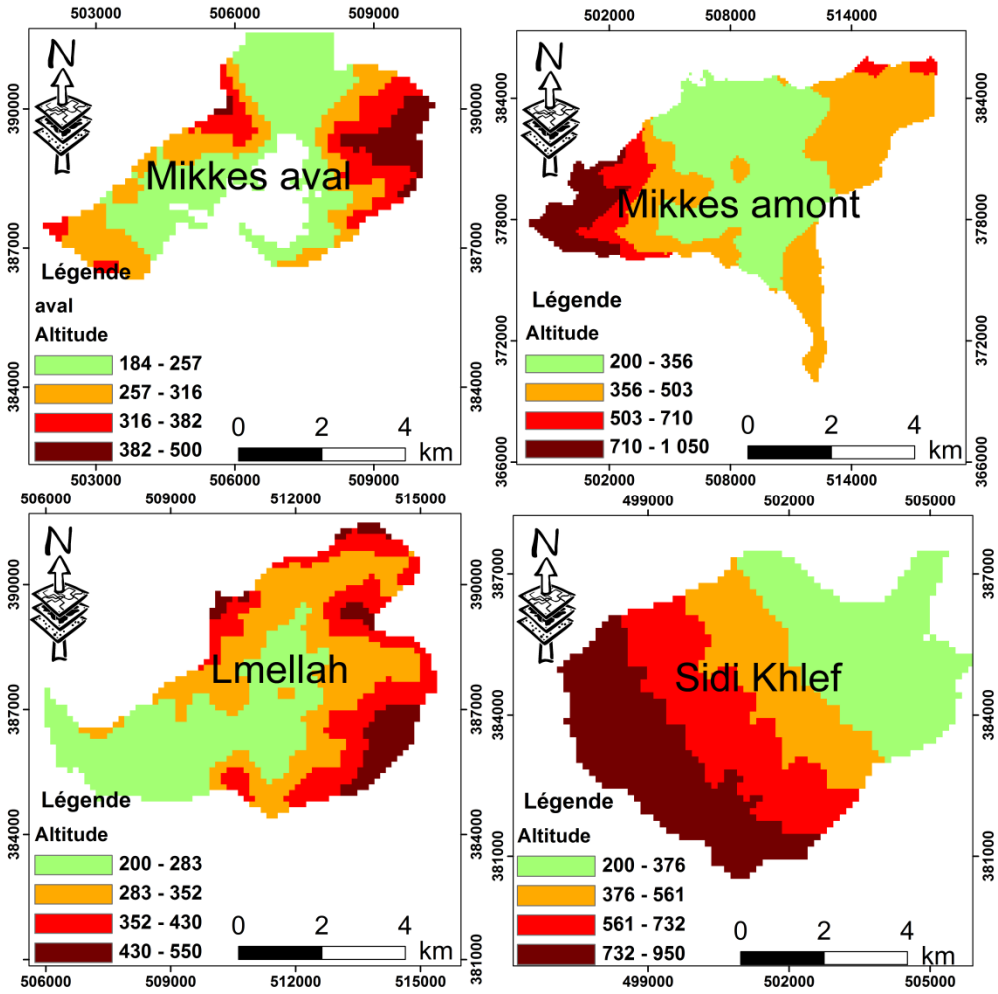
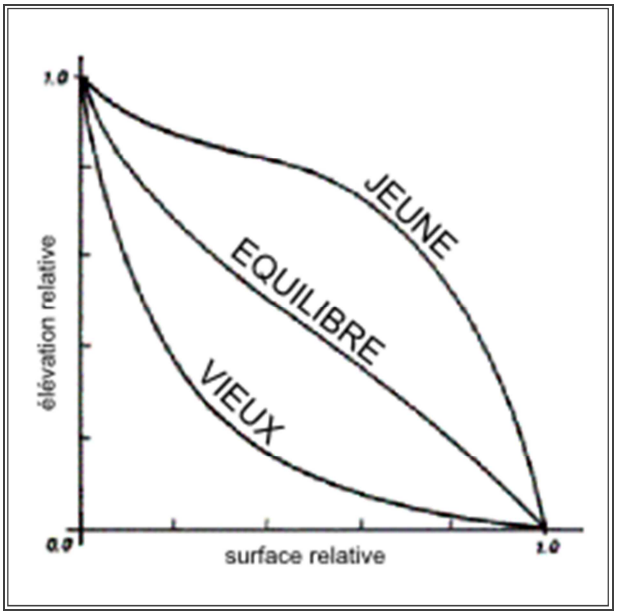


Fig. 11. Cartes hypsométriques des quatre sous bassins versants

A partir de la répartition par tranches d'altitudes des quatre sous bassins versants définis auparavant, les courbes hypsométriques ont été établies (Fig. 12). Ainsi, La forme de la courbe hypsométrique est caractéristique de l'état de maturité du relief (Jeune, en équilibre et vieux) ainsi que de sa capacité érosive. Selon Strahler [12], l'allure de la courbe hypsométrique caractérise le cycle d'érosion du relief actuel étudié (Fig. 12a). En effet, une courbe convexe est caractéristique d'un relief où l'érosion est encore intense (relief immature), tandis-qu'une forme concave reflétera une stabilisation des processus d'érosion (relief évolué) [13] et [14].

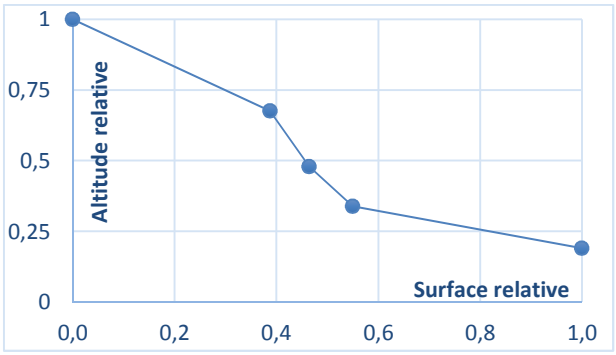
Les différentes courbes hypsométriques ont été tracées à partir des élévations et surfaces relatives calculées pour chaque sous bassin versant (Fig. 12 b, c, d et e). Elles montrent une légère concavité vers le bas, avec une pente assez élevée vers les hautes altitudes. Vers les basses altitudes, la pente devient faible.

L'allure de la courbe hypsométrique du sous bassin de Sidi khlef montre que le relief est plus ou moins en état d'équilibre (Fig. 12e). Par contre Les courbes hypsométriques des sous-bassins Mikkes aval, Mikkes amont et Lmaleh révèlent une morphologie qui tend vers un déséquilibre dans le relief qui pourrait être lié à la nature des formations géologiques, induisant une forte incision par les forces érosives hydriques. Ce facteur, favorisant l'érosion hydrique, est à tenir compte surtout pour les sous bassins se trouvant en amont du barrage Sidi Chahed afin d'atténuer son envasement.



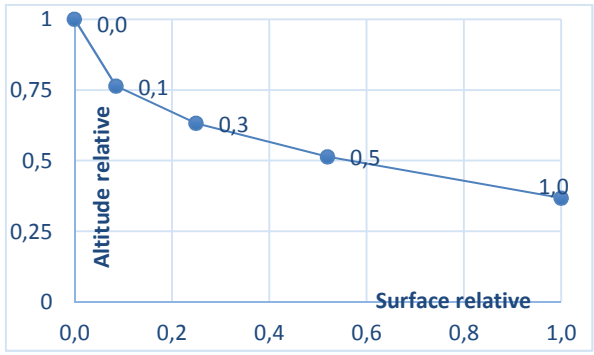
(a)

Forme de la courbe hypsométrique et état de maturité du relief des bassins versants



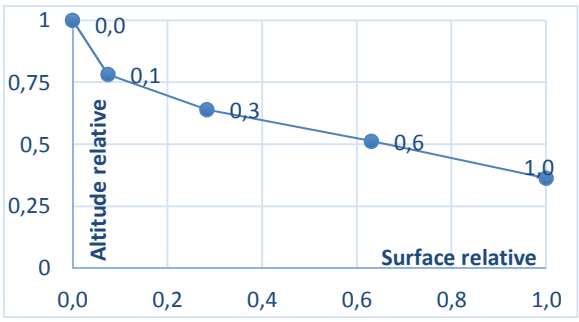
(b)

Mikkes Amont



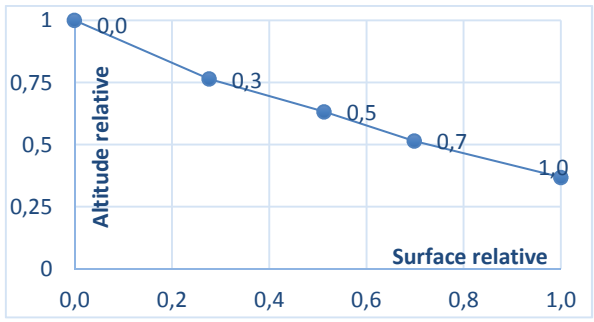
(c)

Mikkes Aval



(d)

Lmellah



(e)

Sous bassin versant Sidi Khlef

Fig. 12. Etat de maturité du relief de BV (a) et courbes hypsométriques des quatre sous bassins versants : SBV Mikkes Amont (b), SBV Mikkes Aval (C), SBV Lmellah (d) et SBV Sidi Khlef (e).

5.10 INDICE DE COMPACITÉ OU COEFFICIENT DE GRAVELIUS

Le coefficient de Gravelius Kc caractérise la compacité et permet d'identifier la forme du bassin versant : $Kc = \frac{p}{2\sqrt{\pi s}}$

Plus ce coefficient se rapproche de la valeur de 1, plus la forme du bassin versant devient circulaire alors que les valeurs élevées supérieures à 1 indiquent un bassin allongé. Dont ce travail l'indice de compacité permet de montrer que les quatre sous bassins sont allongés avec Kc >1 (Tab. 4).

Tableau 4. Indice de compacité des quatre SBV déterminés

Sous bassins versants	KC : coefficient de Gravelius
Sidi khlef	1,70
Lmaleh	1,62
Mikkes aval	1,30
Mikkes amont	2,05

5.11 LE RECTANGLE ÉQUIVALENT

Le rectangle équivalent est une représentation géométrique du bassin versant ayant le même périmètre et la même surface.

$L = \frac{Kc\sqrt{s}}{1,12}\ (1 + \sqrt{1 - (\frac{1,12}{kC})\text{^}2}$

$l = \frac{Kc\sqrt{S}}{1,12}\ (1 - \sqrt{1 - (\frac{1,12}{Kc})\text{^}2}$

A partir des calculs réalisés, tous les sous bassins versants ont une forme allongée. Mikkes amont est le plus grand sous bassin de la zone d'étude. Avec ces caractéristiques, il favorise donc les faibles débits, un temps d'acheminement plus importants et une quantité totale de précipitation récoltée considérable (Tab. 5).

Tableau 5. Caractéristiques des rectangles équivalents

Sous bassins versants	Longueur du rectangle Equivalent (km)	Largeur du rectangle Equivalent (km)	Périmètre du Rectangle équivalent (km)	Surface du Rectangle Equivalent (km2)
Sidi khlef	14,05	1,73	31,56	24,30
Lmaleh	16,25	2 ,16	36,82	35,12
Mikkes aval	14,47	2,68	34,3	23,78
Mikkes amont	43,47	3,08	93,1	133,88

5.12 CARTES DES ISOHYÈTES

Les cartes des isohyètes obtenues en 2002 et 2010 permettent d'avoir des résultats sur la pluviométrie moyenne [1] :

$P = \frac{\sum Si.Pi}{SBV}$.

Les deux cartes des isohyètes montrent une augmentation des précipitations du Nord vers le Sud (Fig. 13 et 14).

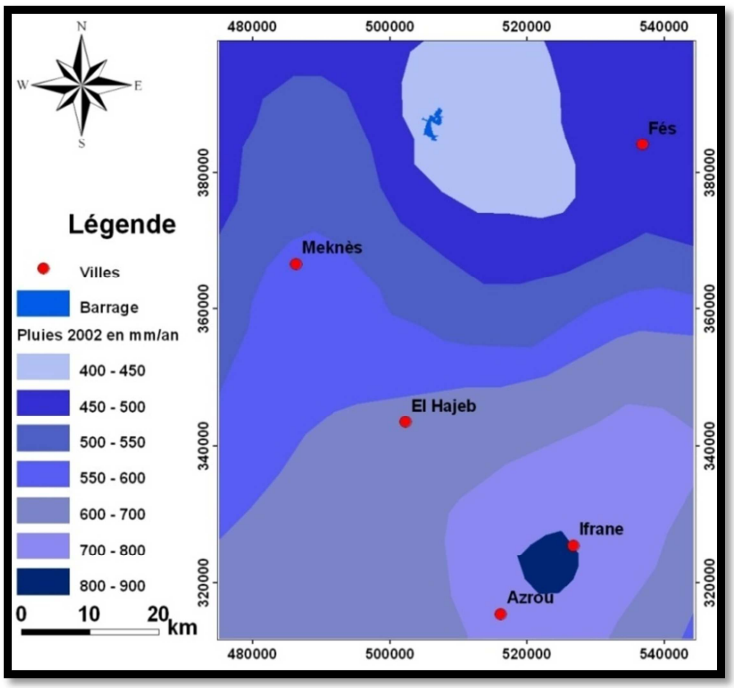


Fig. 13. Carte des isohyètes en 2002.

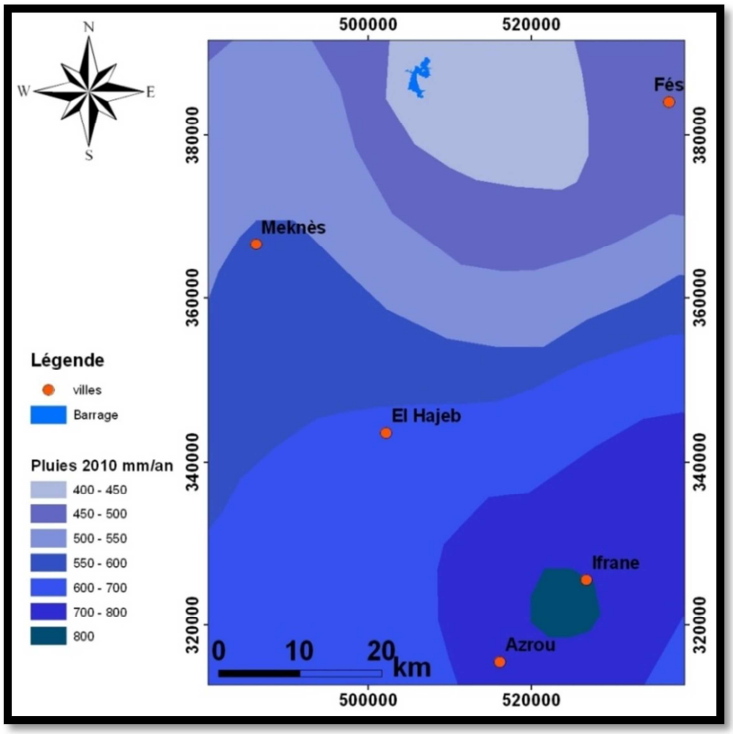


Fig. 14. Carte des isohyètes en 2010.

La comparaison temporelle des cartes des isohyètes indique une similitude de la pluviométrie moyenne entre les années 2002 et 2010 (Fig. 12 et 13 et Tab. 6). En effet, les résultats pluviométriques, tirés des cartes des isohyètes, ne montrent pas de changement climatique entre les années 2002 et 2010 avec une moyenne pluviométrique annuelle de 579,315 mm pour le bassin versant de l'oued Mikkes. Ces précipitations récoltées seront emmagasinées dans la retenue du barrage Sidi Chahed.

Tableau 6. Pluviométrie moyenne (en mm) des années 2002 et 2010 [1]

Intervalle d'isohyètes en mm	(Pi+Pi+1) /2 En mm	Surfaces limitées (2002) en km^2	Pluviométrie (2002)	Surfaces limitées (2010) en Km^2	Pluviométrie (2010)
400-450	425	581,61	38,38	580,25	38,40
450-500	475	1313,66	96,88	1331 ,02	98,45
500-550	525	977,59	79,68	995,57	81,39
550-600	575	940,19	83,93	920,96	82,40
600-700	650	1683,53	169,89	1646,33	166,64
700-800	750	886,34	103,20	889,01	103,83
800-900	850	58,24	7,69	59,43	7,87

6 CONCLUSION

La caractérisation topographique, morphologique, hydrographique et climatique du bassin versant du barrage Sidi chahed (NE de Meknès, Maroc) a été effectuée en faisant appel aux Systèmes d'Information Géographiques (SIG) et à l'aide de plusieurs logiciels spécialisés dans le domaine. Les données de base se résument aux images SRTM et aux données topographiques, géologiques, structurales et pluviométriques. Leur traitement a permis la réalisation de nombreuse cartes thématiques et leur interprétation.

La carte géologique souligne la vulnérabilité de la retenue du barrage due aux problèmes de la salinité et d'envasement liés directement aux phénomènes d'érosion et de glissement des terrains argilo-salifères qui entourent le barrage Sidi Chahed. Les cartes du MNT et du TIN montrent des altitudes élevées de 865 à 1050 m au SW de la zone d'étude et des altitudes faibles de 125 à 310 m au centre et en aval du bassin versant. Les pentes les plus fortes > 20% se trouvent aux pourtours du barrage alors que les plus faibles se situent au niveau du barrage et du réseau hydrographique. Les quatre sous bassins versants, de forme allongée, favorisent les faibles débits, un temps d'acheminement plus importants et une quantité totale de précipitation récoltée considérable. Le réseau hydrographique semble bien guider par le réseau structural avec prédominance de la direction NE-SW des failles.

Les résultats pluviométriques, tirés des cartes des isohyètes, ne montrent pas de changement climatique entre les années 2002 et 2010 avec une moyenne pluviométrique annuelle de 579,315 mm pour le bassin versant étudié. Ces précipitations récoltées seront emmagasinées dans la retenue du barrage Sidi Chahed.

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Les acacias: des plantes fixatrices d'azote prometteuses pour le développement durable des zones arides et semi-arides

[Acacia: Promising Nitrogen fixing trees for sustainable development in arid and semi-arid areas]

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ABSTRACT: Acacias are spectacular angiosperms grouping single canopy species to those of tropical forests. Easy growth, hardiness and drought resistance of these Australian Wattle trees give them variable and great economic importance. Indeed, among other they produce, wood, edible seeds, gums and provide a valuable source of high quality fodder, rich in protein for subsistence and commercial production of livestock because they provide foliage during dry periods in the absence of herbaceous species. In addition, they contribute to the warmer climate of arid and semi-arid areas by reducing evaporation and creating a shadow that slows the soil drying and provide the setting and coastal sand dunes with their lateral root system that promotes better maintenance of the sand particles cohesion. Moreover, their ability to develop a dual symbiosis with Rhizobium bacteria and mycorrhizal fungi confers ecological importance. Indeed, they provide soil enrichment and improvement of soil fertility due to their ability to fix atmospheric nitrogen and to explore deep horizons of the soil by their roots. All these factors make it an economic resource of a great environmental and social importance, especially in arid and semi-arid areas, and an excellent candidate for reforestation of Mediterranean areas.

KEYWORDS: Acacias, ecological and economical interests, desertification, Rhizobium, nitrogen fixation, endomycorhizae.

RESUME: Les acacias sont des Angiospermes spectaculaires, regroupant des espèces de simple couvert végétal à celles des forêts tropicales. La croissance facile, la rusticité et la résistance à la sécheresse de ces plantes originaires d'Australie leur confèrent une importance économique très grande et variable. En effet, elles produisent entre autres, du bois, des graines comestibles, des gommes de valeur et constituent une source de fourrage de haute qualité, riche en protéines pour la subsistance et la production commerciale du bétail puisqu'elles fournissent un feuillage pendant les périodes sèches en absence d'espèces herbacées. De plus, elles contribuent à l'adoucissement du climat des zones arides et semi-arides en diminuant l'évapotranspiration et en créant une ombre qui ralentie le desséchement du sol ; et assurent la fixation des dunes sableuses et côtières grâce à leur système racinaire latéral qui favorise un meilleur maintien de la cohésion des particules sableuses. Par ailleurs, leur capacité de développer une double association symbiotique, avec les bactéries du genre Rhizobium d'une part et les champignons mycorhiziens d'autre part, leur confère une importance écologique. En effet, elles assurent l'enrichissement du sol et l'amélioration de sa fertilité grâce à leurs capacités de fixer l'azote atmosphérique et de prospecter des horizons profonds du sol. Ce qui en fait une ressource économique, environnementale et sociale très

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prometteuse surtout en zones arides et semi-arides, ainsi qu'un excellent candidat pour la reforestation en zones méditerranéennes.

MOTS-CLEFS: Acacias, intérêt écologique, économique, désertification, Rhizobium, fixation d'azote, endomycorhizes.

1 INTRODUCTION

Les acacias sont des légumineuses arborescentes, originaires de l'Australie, qui se développent dans différentes régions climatiques et qui sont bien adaptées à des conditions écologiques défavorables, notamment celles des zones arides et semi-arides. Elles résistent au froid, à la faible pluviométrie, à la sécheresse, à la salinité… Ainsi, les espèces à feuilles entières sont résistantes au froid et supportent des températures de -5°C à -8°C, celles à feuilles composées résistent à -8 ou -10°C. De plus, les espèces des zones tropicales arides dont *A. ampliceps*, *A. maconochieana* et *A. stenophylla* tolèrent des sols très alcalins, salins et s'adaptent bien même aux sols acides riches en humus comme ceux du Pakistan [1].

Les acacias australiens sont considérés, comme plantes exotiques et recouvrent approximativement 2 millions d'hectares dans plus de 70 pays [2]. Elles ont été utilisées par les aborigènes australiens comme une source de nourriture, d'outils et d'armes ainsi qu'en médecine traditionnelle.

Leur grande biodiversité et leur capacité à développer une double association symbiotique avec les bactéries *Rhizobium* fixatrices d'azote d'une part et avec les champignons endomycorhizogènes d'autre part, leur confère une importance au niveau socio-économique et écologique. En effet, les *Rhizobium* dominent l'introduction et la répartition de l'azote dans la biosphère et tendent à compenser les pertes d'azote par dénitrification grâce à leur capacité de fixer l'azote atmosphérique et le transformer en une forme directement assimilable par la plante. Elles assurent la fixation de la plus grande partie d'azote fixé par les associations symbiotiques, estimée à 175 millions tonnes N/an [3]. Ce qui permet aux plantes hôtes de s'affranchir des contraintes de la fertilisation azotée à la fois coûteuse et polluante de l'environnement. En outre, les champignons endomycorhizogènes arbusculaires se retrouvant chez plus de 90% des espèces végétales ont un effet favorable, notamment sur l'absorption de l'eau et des éléments nutritifs, chez les plantes hôtes. D'où leur rôle important dans le fonctionnement et la stabilité de n'importe quel écosystème, surtout celui à faible niveau de dégradation dans lequel elles permettent non seulement l'acquisition des éléments nutritifs par l'hôte, mais aussi une redistribution des nutriments entre plusieurs plantes hôtes et entre les plantes hôtes et le sol hôte [4]. Ce qui aide les plantes mycorhizées à résister notamment aux conditions désertiques et contribue considérablement à la productivité et la longévité d'écosystèmes aménagés. Ainsi, les acacias peuvent être utilisés dans les programmes de reforestation et de lutte contre la désertification.

L'objectif de cette revue bibliographique est d'illustrer les rôles socio-économique, médicinal et écologique de ces arbres et arbustes ; puis, de mettre le point sur l'intérêt de la double association symbiotique.

2 GÉNÉRALITÉS SUR LES ACACIAS

2.1 TAXONOMIE

Le genre Acacia relève de la famille des Légumineuses, sous-famille des Mimosoideae. Il semble avoir d'abord été diversifié dans les régions tropicales qui représentent les restes actuels du Gondwana occidental [5]. La classification des espèces actuelles se heurte au caractère continu de la variation des caractères au sein de ce genre. On distingue néanmoins trois sous-genres présentant plusieurs sections [5]:

- s. g. Aculeiferum (fortes épines, semences sans albumen) ;
- s. g. Heterophyllum (feuilles bipennées ou phyllodes, semences avec traces d'albumen, absence d'arille) ;
- s. g. Acacia (stipules épineux, caractères cytologiques spécialisés).

2.2 HABITAT

Le genre *Acacia* a un habitat très vaste qui s'étend des régions côtières aux régions sub-alpines et des régions de forte pluviométrie aux zones arides ; recouvrant ainsi l'Afrique, l'Australie, l'Amérique du Sud et d'autres régions tempérées dans le monde.

Il est caractérisé par une grande diversité représentée par plus de 1350 espèces dont environ 1000 répertoriées en Australie [6]. Ces espèces d'acacias se développent, en fonction de la variété, en arbustes à faible croissance (à port dressé ou parfois buissonnant) ou en arbres d'ombre (pouvant atteindre une dizaine de mètres de hauteur). Il existe même des espèces qui constituent d'excellentes plantes de serre froide ou de véranda. Le sous genre *Heterophyllum* est principalement représenté en Australie et les deux sous genres *Aculiferum* et *Acacia* ont une plus large distribution.

Au Maroc, les acacias sahariens recouvrent une superficie de 1.128.000 ha de forêts naturelles. On rencontre *Acacia mearnsii* dans la région de la Mâamora (Plaine Atlantique), *A. gummifera* et *Acacia* spp. Dans la Meseta atlantique et orientale (Moyen Atlas), *A. gummifera, A. raddiana, A. seyal et A. albida* dans le présahara (région du Souss) ainsi qu'*A. raddiana* et *A. seyal* dans le Sahara [7]. Une superficie de plus de 27.000 ha a été reboisée par des acacias durant la campagne de 1980-1990.

3 INTÉRÊTS ÉCONOMIQUE, ÉCOLOGIQUE ET MÉDICINAL DES *ACACIA*

3.1 INTÉRÊT ÉCONOMIQUE DES ACACIAS

3.1.1 BOIS DE CHAUFFAGE (CHARBON DE BOIS)

Les Acacias sont reconnus pour leur potentiel élevé de production de la biomasse et leur bois est généralement considéré comme un bon combustible avec une haute valeur calorifique. En effet, certaines espèces d'*Acacia* fournissent un charbon de bois de très bonne qualité, surtout *A. nilotica*, *A. polyacantha* (subsp. *Campylancantha*), *A. tortilis* (subsp. *Raddiana*) et *A. senegal* [8]. Ayant un pouvoir calorifique de 4500 kcal / kg, *A. nilotica* a été utilisée dans les locomotives, les bateaux à vapeur et les petites industries. Cependant, la combustion du charbon émet des étincelles. *Acacia ehrenbergiana* produit également du bois avec un haut pouvoir calorifique mais sans fumée ni étincelles [9]. De plus, *A. ampliceps*, *A. maconochieana* et *A. stenophylla* sont utilisées avec succès comme une source de bois de chauffage en zones tropicales arides [1].

Acacia auriculiformis est largement plantée dans la région pacifique de l'Asie ; et des plantations d'*A. nilotica* sont gérées sur une rotation de 15-20 ans, en Inde et au Pakistan, pour le bois et le bois de feu (http ://www.worldagroforestrycentre.org).

3.1.2 BOIS D'ŒUVRE ET DE SERVICE

Le bois issu des plantations naturelles d'acacias sert à différents usages (Tableau I).

Tableau I : Principales utilisations du bois de quelques espèces d'acacias

Principales utilisations du bois des acacias	Exemples d'espèces
Production de matériaux de construction (poteaux, bois de traverse, perches, cadres de portes, etc.) :	*A. nilotica*, *A. tortilis* (subsp. *raddiana*) et *A. seyal* au Sahel ; *A. melanoxylon, A. celsa* et *A. mearnsii* en Australie ; *A. auriculiformis* et A. *crassicarpa* en Asie
Menuiserie et fabrication de mobilier	*A. mangium*, *A. melanoxylon, A. celsa.*
Industrie du papier	*A. mangium* et *A. mearnsii* en Australie ; A. *crassicarpa et A. peregiensis* en Asie pacifique
Instruments de musique et divers objets d'art	ex. *A. nilotica*
Réalisation d'outils agricoles, piquets, etc…	*A. polyacantha ; A. gourmaensis*
poteaux de clôture et des grillages de jardin	*A. aneura*, *A. acuminata*…
Produits d'intérêt industriel (cellulose, adhésifs et agents anticorrosifs)	*A. mearnsii*
Ustensiles de cuisine (plaques à découper, plaques de Pizza…).	*Acacia sp.*

Ainsi, de vastes plantations *d'A. mangium* ont été établies en Indonésie, Malaisie et en Australie [10] ainsi qu'en Inde et dans les provinces du Sud en Chine [11] afin de produire du bois pour l'industrie du papier grâce à la qualité de ses fibres. De même, des plantations commerciales d'*A. melanoxylon* ont été établies en Australie, durant les années 90, pour la production du bois de construction [12].

3.1.3 TANINS ET COMPOSÉS PHÉNOLIQUES

Communément appelés poly phénols, les tanins sont des composés phénoliques à usages multiples (adhésifs, teintures, tannage..). Certaines espèces d'*Acacia* sont très riches en tanins, dont *A. catechu*, *A. nilotica* (30-32% dans les gousses et 20% dans les écorces), *A. mearnsii* (30 à 54 % dans les écorces), *A. polyacantha* (subsp. *Campylancantha*), *A. saligna* (jusqu'à 30.3% dans les écorces) et *A. tortilis* (subsp. *Raddiana*). Ainsi, une teinture d'un brun rougeâtre produite à partir du bois d'*A. catechu* est utilisée pour le tannage des peaux et également, dans le passé, pour le *cachoutage* des voiles (imperméabilisation). Les tanins d'*A. pycnantha* et d'*A. mearnsii* sont également très utilisés dans l'industrie du cuir (tannage des peaux). Gouila et al (2012) ont isolé à partir des fleurs d'*A. saligna* des calcones et les ont utilisé comme produits de teintures naturels qui donnent des teintes brillantes et vives [13].

Par ailleurs, *A. mearnsii* est fondamentalement reconnue comme l'une des sources les plus productives de tannins condensés de haute qualité utilisés pour la production d'adhésifs imperméables dans les produits reconstitués du bois [14] ainsi que dans la protection des cordes, la teinture des tissus etc.. [15].

Récemment, une relation linéaire significative a été observée entre le potentiel antioxydant, l'activité antiradicaux et le contenu en composés phénoliques dans les écorces d'*A. mearnsii* [16] et d'*A. mangium* [11]. Les extraits aqueux des feuilles et bruts de l'écorce d'*A. confusa* riches en composés phénoliques ont également une excellente activité antioxydante [17, 18]. De plus, Olajuyigbe et Afolayan ont reporté que l'activité antimicrobienne des extraits de l'écorce d'*A. mearnsii* pourrait être expliquée par les propriétés astringentes propres associées avec son pourcentage élevé en tannins [19].

3.1.4 GOMMES

La gomme est un extrait sec obtenu à partir des tiges et des branches d'*Acacia senegal* (L) Willdenow ou *Acacia seyal* (Famille Leguminosae) [20]. C'est un polysaccharide hydro colloïdal, totalement atoxique (E 414), neutre, inodore, insipide, incolore, stable et de faible viscosité. Elle possède des propriétés émulsifiantes, stabilisantes et épaississantes la rendant très recherché dans différents domaines :

Agroalimentaire : comme additif alimentaire, stabilisant et émulsifiant industriel dans les produits laitiers, en confiserie, en pâtisserie etc.

Médicinal : anti-inflammatoire, diurétique, contre la dysenterie et les ulcérations. Elle est même recommandée dans les premiers stades des fièvres typhoïdes.

Elles peuvent être utilisées en pharmacotechnie comme stabilisant des suspensions, émulsifiant, agent d'encapsulation d'arômes par nébulisation ou encore additif pour la préparation des formes solides destinées à la prise par voie orale [15].

Industriel : pour l'impression et l'apprêt des étoffes.

Plusieurs espèces d'Acacia produisent de la gomme arabique : *A. senegal*, A*. ehrenbergiana*, *A. nilotica*, *A. sieberana*, *A. tortilis* (subsp. *Raddiana*) et *A. polyacantha* subsp. *Camplylacantha* [8].

3.1.5 MÉDECINE TRADITIONNELLE

Les préparations à base des feuilles, brindilles et écorces d'une trentaine des 950 espèces Australiennes sont utilisées à large étendu pour des besoins thérapeutiques par les indigènes [21]. Il en ait de même en médecine traditionnelle marocaine [22] que pour d'autres pharmacopées [23] (Tableau II).

Tableau II : Utilisations de quelques espèces d'Acacia en médecine traditionnelle

Espèces d'*Acacia*	Utilisations en médecine traditionnelle	Référence
A. raddiana savi.	Contre les affections oculaires, les diarrhées, la jaunisse, les maladies pulmonaires, la toux, l'asthme, la laryngite, les aphtes, l'ictère et pour la cicatrisation des plaies	Hmamouchi, 1999
A. gummifera	Antitussif et antirhumatismal.	Hmamouchi, 1999
A. seyal Delite Quant	Anti-ulcéreux, antirhumatismal et anti-inflammatoire des voies respiratoires.	Hmamouchi, 1999
A. albida Delite	Traitement des affections cutanées (tâches blanches)	Hmamouchi, 1999
A. arabica	Astringent et antiseptique puissant, pour resserrer et protéger les muqueuses. Antidiarrhéique.	(Encyclopédie des plantes médicinales, 1997).
A. mearnsii	Astringent et antiseptique puissant, et antidiarrhéique. Contre les maux de gorge et comme gargarisant (décoction d'écorces).	(Encyclopédie des plantes médicinales, 1997).
Acacia catechu	Astringent puissant qui favorise la coagulation, réduit l'excès des sécrétions nasales, intestinales et vaginales. Traitement de l'eczéma, des hémorragies légères, des diarrhées et de la dysenterie ou encore pour apaiser les maux de gorge	(Encyclopédie des plantes médicinales, 1997).
A. confusa (extrait foliaire aqueux)	Guérison des blessures et facilitation de la circulation sanguine (Taiwan)	(Kan, 1978).
Faidherbia albida (écorces)	Désinfectante (décoctions), fébrifuge et antitussive (infusions) et antidontolalgique	
A. senegal et *A. polyacantha* subsp. *campylacantha*	Contre les ulcères de l'estomac, les oedèmes et la dysenterie (écorces).	
A. ataxacantha	Anti-inflammatoire *(feuilles)*	
A. kamerunensis	Anti- dermatose et fébrifuge *(feuilles)*	
Acacia macrostachya	Les feuilles empêchent la propagation des venins de serpents	
Acacia mellifera (Vahl) Benth	Contre la pneumonie, la malaria, la syphilis (en Afrique); Activité antimicrobienne intense	Mutai et al., 2009
Acacia nilotica	Arrêt des saignements, cicatrisation des ulcères ou calme de la toux (gousses). Pouvoir antidontalgique surtout les racines de la sous espèce *adstringens* Anti-diarrhéique et anti-dysenteries infantiles (écorces). Contre les inflammations oculaires (feuilles)	(Vassal., 1998). (Guinko, 1998)

Grâce à leurs différentes propriétés, les différentes parties de plusieurs espèces d'acacias sont largement utilisés dans diverses formulations pour soigner plusieurs maladies.

Par ailleurs, les propriétés anti oxydantes et anti hyper glycémiques des extraits d'*A. nilotica* [24] et leur effet antiulcéreux [25] ont récemment été prouvé. Sultana et al (2007) avaient signalé qu'elle contient des molécules bioactives ayant des propriétés anti-hypertensive, antispasmodique, anti-inflammatoire, vasoconstricteur et anti- agglutinante des plaquettes [26].

De plus, l'activité antimicrobienne intense d'*Acacia mellifera* (Vahl) Benth est dû au lupan : principal constituant actif des extraits méthanoliques et méthane/dichlorométhane (1 :1) de l'écorce [27].

Dernièrement, les extraits aqueux des gousses d'*A. auriculiformis* ont été utilisés, comme agent réducteur et agent de coiffage, pour une synthèse des nanoparticules d'argent (Ag NPs) selon une méthode respectueuse de l'environnement. De

plus, ces nanoparticules synthétisées ont révélé une activité antibactérienne contre les bactéries Gram négative et Gram positive avec plus d'efficacité contre les Gram négatives [28].

3.1.6 GRAINES ET ALIMENTATION HUMAINE

Les graines d'environ 30 espèces d'acacia sont utilisées comme aliments bien qu'on pense généralement que leurs fruits et leurs graines sont non consommables et toxiques pour l'homme. En effet, les graines d'*Acacia* australiens sont très nutritives, ont un contenu énergétique élevé et un faible indice glycémique (Tableau III) ; ce qui est une propriété recherchée par plusieurs industries agro-alimentaires [29].

Tableau III : Composition chimique et contenu énergétique des graines d'acacia.

Constituants	Pourcentage	Observations
Protéines	22,8 ± 5,3 %	Ceci les rend très nutritives
Lipides	8,6 ± 5,4 %	Plus élevé que les autres légumineuses
Hydrates de carbone	55,8 ± 13,7 %	Ce taux est plus faible que celui des lentilles et plus élevé que celui du Soja
Fibres	32,3 ± 14,3 %.	
Contenu énergétique	1480 ± 270 Kj/100g	Ce contenu énergétique est élevé
Indice glycémique	faible	

Par ailleurs, les espèces d'acacia des zones semi-arides du sahel, dont *A. elachantha*, *A. thomsonii*, *A. tumida* et *A. colei* produisent des graines nutritives et savoureuses [30]. En effet, leur farine est incorporée dans plusieurs recettes locales et peut apporter une nourriture supplémentaire à plus de 25% dans cette région [31] (Photo 1). Les graines en germination d'*A. mangium* sont cuits et consommées comme légumes.



Photo 1 : Pain préparé des farines d'Acacia saligna et du Teff.

By Tony Rinaudo. http://www.worldwidewattle.com/infogallery/utilisation/sehel.php

En Inde, les graines d'*A. senegal* sont séchées et conservées pour la consommation humaine.

En plus, les graines d'*A. senegal* produisent une huile qui a des caractéristiques physicochimiques lui permettant d'être appliquée en industrie de revêtement et dans les processus de friture. En effet, sa composition en acides gras, acide oléique (43.62%) suivie par l'acide linoléique (30.66%) et l'acide palmitique (11.04%), montre sa fonctionnalité nutritionnelle désirable et lui permet d'être un substituant acceptable pour les huiles conventionnelles notamment celle du Maïs dans le régime alimentaire [32].

Rappelons enfin que les gommes des acacias sont également très nutritives et largement utilisées en industrie agro-alimentaire. Alors que leur miel est particulièrement riche en fructose et possède une saveur très douce ce qui le rend bien apprécié par les enfants et les personnes en régime hypoglycémiant.

3.1.7 ESPÈCES À VALEUR FOURRAGÈRE

Plusieurs espèces d'acacias sont couramment utilisées comme fourrage de réserve dans les zones arides. En effet, les gousses d'*A. farnesiana* et *A. cambagei*, les jeunes tiges et les feuilles d'*A. mangium* sont consommées respectivement par les moutons et le bétail. De même, A. *aneura*, *A. tortilis, F. albida* et *A. nilotica* sont souvent utilisées pour leur valeur fourragère. Toutefois, le taux des substances toxiques et antinutritives (tanins (4-7% ms) limite l'ingestion d'acacia, d'où la nécessité d'ajouter des sources d'azote supplémentaires (l'urée, l'ammoniaque) ou l'associer avec d'autres arbustes fourragers dont *Atriplex nummularia,* sous forme d'ensilage. Ainsi, les régimes à base d'*Acacia*, ajouté à *A. nummularia* et aux raquettes d'*Opuntia*, ont donné d'excellents résultats [33].

El Euch (1995) a reporté qu'*A. saligna*, communément répandue dans les milieux à climat aride, a une valeur fourragère importante (16% de protéines brutes, dont 12% de protéines digestibles) et constitue un aliment de complément pour le cheptel en Tunisie ; bien que relativement pauvre en énergie (0,40 UF/ kg de matière sèche en moyenne) [34].

Par ailleurs, les fleurs des *Acacia* produisent des taux modérés de pollen et de nectar [35]. Bien qu'ils ne soient pas considérés comme étant des producteurs majeurs, ils constituent ainsi une source importante de nutriments pour les espèces « nectivores ». Ainsi, les fleurs de certains acacias produisent un bon fourrage pour les abeilles, notamment *A. aneura, A. albida, Acacia erythrocalyx*, *A. gourmaensis*, *A. hockii*, *A. modesta*, *A. senegal, A. sieberiana* et *A. thomasii*. En plus, les fleurs d'*A. Koa* produisent du nectar et du pollen pour différents insectes dont les abeilles.

3.1.8 AUTRES UTILISATIONS

La période de floraison varie largement avec une grande majorité qui fleurie au printemps et en été et quelques espèces qui fleurissent pendant l'automne et l'hiver. Ainsi, une bonne connaissance des arbustes permet de sélectionner les variétés fleurissant aux différentes saisons et les choisir selon les besoins horticulturaux.

Plusieurs espèces ont des fleurs délicatement parfumées. Ainsi, certains parfums sont produits à partir des fleurs d'Acacia et sont caractérisés par leur odeur très douce. En effet, les fleurs d'*A. farnesiana* sont utilisées en parfumerie en Mexique. Les fleurs et le bois d'*A. redolens* ont un arôme vanille doux. La fleur, très fragile d'*A. dealbata*, donne une essence utilisée comme modificateur des accords floraux basés sur la rose et le jasmin.

Par ailleurs, *A. senegal* produit des arômes pour des sodas très populaires en Afrique.

Les graines d'*Acacia giraffae*, un arbuste des savanes africaines, ont été utilisés comme substituant du café. Alors que celles d'*Acacia niopo* sont utilisées pour la préparation du tabac (en mélange avec la chaux et cocculus) en Amazonie.

Les gousses d'*A. concuine* sont utilisées en Inde comme shampooing et leurs feuilles sont utilisées en cuisine pour leur acidité.

Actuellement, plusieurs industries cosmétologiques produisent des shampoings biologiques nourrissants, à base des fleurs d'Acacia, qui sont caractérisés par leur pH acide d'où leur bonne tolérance par le cuir chevelu.

Enfin, les extraits de vapeurs volatiles des racines d'*A. pulchella* inhibent la croissance de certains champignons pathogènes comme *Phytophtora cinnamomi* [36].

3.2 INTÉRÊT ÉCOLOGIQUE

Grâce à leur capacité de coloniser les zones dégradées, les Acacias protègent le sol contre l'érosion, la formation des dunes et la désertification.

Plusieurs espèces sont actuellement intégrées et largement utilisées dans les paysages désertiques, alors que d'autres sont encore en cours d'étude. Les espèces qui se sont révélées prometteuses sont : *A. caven* (native de l'Amérique du Sud), *A. eburnea* (native de l'Asie du Sud), *A. erioloba* (native du Sud d'Afrique), *A. karroo* (native d'Afrique), *A. occidentalis* (Mexique) et à moindre étendue *A. pendula* (Australie) [37]. De même, *A. colei* ms (native d'Australie) a montré un potentiel élevé de croissance et de résistance à la sécheresse [30].

3.2.1 PROTECTION CONTRE L'ÉROSION, LA DÉSERTIFICATION ET LA DÉFORESTATION

La destruction du couvert végétal, dans les régions arides et semi-arides, rend le sol vulnérable à l'érosion éolienne, favorise la formation des dunes de sable et provoque l'inhibition de la production vivrière et animale. De plus, le vent transporte des particules qui peuvent nuire au réseau d'irrigation, ou causer une évapotranspiration conduisant à la salinisation dans les régions irriguées. En outre, la susceptibilité du sol aux fortes intensités de précipitation et la destruction fréquente du couvert végétal causent des pertes considérables des terres par ruissellement dans les zones de captage des eaux.

La plantation des acacias sous forme de brise-vent et de rideaux – abris peut aider à stabiliser les sols de ces régions en limitant les dégâts de l'érosion éolienne et même hydrique grâce à leur système radiculaire pivotant et riche en racines latérales souterraines qui leur permet d'explorer des horizons plus profonds du sol ainsi que d'absorber le maximum d'eau de pluie, même si les précipitations sont faibles. Elles peuvent lutter contre l'érosion hydrique soit par une amélioration de la couverture du sol et son enrichissement en matière organique, surtout en zone montagnarde, où les sols sont sensibles à l'érosion par ravinement généralisé ; soit par une réduction du débit solide et une régularisation des écoulements ainsi qu'une amélioration de la productivité agricole ou forestière dans les bas-fonds (http://www.ma.auf.org/erosion).

Par ailleurs, le couvert aérien joue, lui aussi, un rôle dans la réduction de l'érosion éolienne et dans l'amélioration des micro-climats. Ainsi, l'effet d'ombrage favorise l'abaissement de la température ambiante, permet de réduire l'évaporation des sols et abaisse leur température de surface ce qui favorise l'apparition d'une couverture végétale plus mésophyte et plus nutritive. En revanche, en l'absence de tout ombrage, la température superficielle élevée des sols nus a un effet délétère, voire mortel, sur les semences dormantes ou en germination à la surface du sol, ce qui contrarie la repousse et favorise la désertification [38].

Des plantations intensives d'*A. nilotica,* subsp. *Indica, A. senegal, A. tortilis* et F. *albida* ont été alors effectuées pour fixer et stabiliser les dunes de sable et combattre l'érosion éolienne [38]. *A. mangium* est également plantée pour la reforestation et la réhabilitation des sols dégradés. Au Maroc, *A. saligna* (Photo 2) est largement utilisée dans la région du Souss pour lutter contre la désertification, fixer les dunes littorales et valoriser les sols salés, alors qu'*A. cyclops* est rencontrée à Mogador où elle sert à fixer les dunes côtières, *A. mearnsii* a été introduite dans la région de Sidi Yahia El-Gharb et dans la Maâmora pour le reboisement.



Photo 2 : Acacia saligna (www.wikipédia.org)

3.2.2 MAINTIEN ET RESTAURATION DE LA FERTILITÉ DES SOLS

Il est important de signaler que la production agricole dans les zones arides est souvent limitée par la faible fertilité des sols, généralement pauvres aussi bien en macroéléments (N, P) qu'en oligoéléments (Cu, Zn…), bien que l'eau soit considérée comme étant le facteur le plus limitant.

L'utilisation d'espèces adaptées et améliorantes, comme les acacias, peut donc être intéressante grâce à leurs capacités de puiser dans les ressources du sol par leur système racinaire développé d'une part, et d'améliorer la fertilité du sol, en assurant le recyclage et la redistribution de l'azote et des autres éléments minéraux à partir des couches profondes vers la surface du sol, lors de la décomposition de leur litière, d'autre part. D'où leur rôle dans l'amélioration des productions agricoles et forestières ; la lutte contre la dégradation de l'environnement, le maintien et la régénération de la fertilité des sols. De même, leur utilisation dans des systèmes de cultures en couloirs permet de limiter l'application abusive des engrais minéraux, d'éviter les monocultures et d'améliorer la fertilité du sol en évitant l'appauvrissement de ses éléments biologiques et/ou la dégradation de sa condition physique.

Ainsi, les acacias constituent un élément clé pour le développement durable car elles jouent un rôle important dans la stabilisation et la re-fertilisation des sols.

En effet, comme toutes les légumineuses fixatrices d'azote, les *Acacia* peuvent assurer :

- L'enrichissement du sol en azote organique par leur utilisation comme engrais verts : la décomposition de leurs racines et leurs différentes parties, dans la litière, libère de l'azote qui est restitué dans le sol et qui sera utilisé par les cultures suivantes [39]. *A. mearnsii* est un fixateur d'azote efficace qui produit 25 MT/ha/an de feuilles fraîches contenant 245-255 kg N.
- La dépollution azotée par leur utilisation comme substituant aux engrais chimiques. La litière de feuilles d'un peuplement moyen de 50 *Faidherbia albida* par hectare réintroduit chaque année dans le sol l'équivalent de 75 kg d'azote, 12 kg de phosphore, 13 kg de potassium, 20 kg de soufre, 25 kg de magnésium et 120 kg de calcium par hectare [40].
- La restauration écologique des sols pauvres grâce à leur aptitude de se développer en tant que plantes pionnières, indépendamment des composés azotés, grâce à leur potentiel fixateur d'azote. En effet, elles peuvent convertir l'azote atmosphérique en une forme pouvant être utilisée par les plantes dans les écosystèmes forestiers ; suite à la restitution dans le sol de leurs feuilles et racines dont l'humus résultant améliore la fertilité et les propriétés du sol. Tel est le cas de certaines espèces dont *A. tortilis* subsp. Raddiana et *Acacia salicina* qui améliorent la qualité et la fertilité des sols [41, 42].

3.2.3 AGROFORESTERIE

Les systèmes d'agroforesterie semblent permettre une régénération des sols plus rapide et plus durable que les systèmes de rotation culturale traditionnels utilisant les arbres et les arbustes. Ils se sont surtout développés dans les régions tropicales humides, où la croissance des arbres et la régénération des sols sont plus rapides.

Des tentatives d'utilisation d'*A. senegal* en agroforesterie au Soudan et d'*A. albida* au Tchad n'ont pas connu un grand succès à cause de la sécheresse, en plus d'une surexploitation de la jachère de la 1ère espèce et des conflits politiques au Tchad, alors qu'elle est bien adaptée aux systèmes d'agroforesterie dans les régions à forte pluviosité des zones semi-arides. Mais, dans les régions les plus sèches de l'Inde, *Acacia nilotica,* subsp. *Indica* a été largement utilisée en agroforesterie ; quoiqu'une croissance réduite des cultures sous couvert a été signalé [38]. En outre, *Acacia salicina* peut faciliter l'établissement et la croissance de la végétation du sous-étage, qui a atteint une diversité appréciable, 13 ans après plantation des arbres en zone méditerranéenne [42]. D'autres espèces : *A. seyal, A. nilotica, A. saligna, A. polyacantha et A. holoserica* sont utilisés en jachères de 5 – 14 ans en zone soudano-sahélienne et en Sud sahélien. Alors que *A. mangium et A. polyacantha* sont utilisées en zone soudano-guinéene [43].

Toutefois, pour être susceptible de lutter contre l'érosion, d'accroître la fixation d'azote et promouvoir un recyclage efficace des éléments nutritifs, un système agroforestier doit être approprié. D'où la nécessité de choisir une espèce rigoureuse, robuste et bien adaptée qui va enrichir le sol en azote fixé et améliorer la fertilité du sol d'une part et la productivité globale du système d'autre part, sans présenter de risque de devenir envahissante.

3.3 INTÉRÊT SYMBIOTIQUE DES ACACIAS

En plus de leur importance économique et écologique, les acacias, comme d'ailleurs toutes les légumineuses, représentent un système précieux permettant d'examiner les interactions plante – micro-organisme car leur système racinaire peut être colonisé au moins par deux micro-organismes importants du sol : les bactéries *Rhizobium* fixatrices d'azote et les champignons endomycorhiziens arbusculaires (CMA). Ces deux micro symbiotes améliorent la nutrition minérale de la plante hôte en échange des assimilas fournis par cette dernière.

En effet, l'enzyme nitrogénase de *Rhizobium* fixe l'azote atmosphérique dans les nodules racinaires et le transforment en une forme directement assimilable par la plante hôte. Alors que les hyphes fongiques des CMA facilitent l'absorption des ions, principalement le phosphore et améliorent l'alimentation hydrique. Dans la plupart des cas étudiés, en particulier lorsque l'N et le P sont des facteurs limitants, les CMA et les *Rhizobium* semblent agir de façon synergique : la double inoculation par les deux micro-organismes augmente la croissance et la reproduction de la plante plus que l'inoculation avec l'un d'eux et donne des degrés plus élevés de colonisation par les deux symbiotes [44, 45, 46]. Toutefois, certaines études ont montré un effet inhibiteur des symbiontes l'un sur l'autre ou sur la croissance de la plante [47] surtout lorsque l'un des microsymbiotes avait colonisé le système racinaire avant l'autre [48] car l'existence de plusieurs similitudes entre ces deux symbioses suggère des propriétés communes d'interaction avec les plantes.

IMPACT DES DEUX ASSOCIATIONS SYMBIOTIQUES SUR LES ACACIA

L'effet bénéfique de l'inoculation par des souches efficientes de bactéries fixatrices d'azote, sur la croissance des acacias au cours des stades jeunes (plantes en tubes ou en pépinières), et sur le taux de survie des jeunes plants après transplantation, a déjà été prouvé. Cet effet est en étroite relation avec la concentration d'inoculum, la répétition de l'inoculation et la population indigène. Ainsi, l'inoculation répétée des plantes d'*A. saligna*, par *Rhizobium*, augmente leur rendement en matière sèche, le nombre de nodules et leur poids sec, leur contenu en azote total et le taux d'azote fixé (%Ndfa) [49].

Donc, l'inoculation de ces plantes avec des *Rhizobium* convenables est un moyen protecteur de l'environnement pour améliorer leur croissance et leur rendement économique, particulièrement dans les sols dégradés. Martin-Laurent et al. (1999) ont montré que l'inoculation d'*A. mangium* améliore sa survie dans le champ de 10%, quelque soit la souche de Rhizobium sélectionnée [50]. Galiana et al (1998) ont revu plusieurs essais d'inoculation dans différents pays (côte d'ivoire et autres pays tropicaux) et ont montré des effets positifs sur la croissance d'*A. mangium*, quelque soit le type de sol et le pays, et l'augmentation était détectable 2 – 3 ans après transplantation [51]. Lal and Khanna (1996) ont également démontré une bonne réponse à l'inoculation au champ d'*A. nilotica* en Inde [52].

Sutherland et al. (2000) ont rapporté une amélioration significative de la croissance et la fixation d'azote chez 7 espèces d'acacias inoculées au Kenya et ont montré que dans certains cas l'inoculation par un mélange de souches était préférable à l'inoculation par une seule souche [53].

Toutefois, cet effet est très controversé après la première année sur le terrain à cause d'une variabilité génétique intraspécifique et interspécifique chez les acacias, qui d'ailleurs a été confirmé par nos études préalables, aussi bien pour le rendement, la nodulation que pour l'absorption minérale surtout azotée et phosphatée. Ce qui nécessite la prise en considération de la biodiversité et l'exploitation de la variabilité génétique des acacias lors des programmes d'aménagement et de lutte contre la dégradation de l'environnement.

Par ailleurs, la croissance des acacias est améliorée par la colonisation endomycorhizienne particulièrement en conditions de stress hydrique. Certaines espèces se sont même révélées être fortement dépendantes de la mycorhization pour atteindre leur développement optimal dans de telles conditions [54], principalement grâce à une absorption minérale nécessaire à la fois à la croissance de la plante et la fixation efficace de l'N2 [55].

Duponnois et al (2007) ont montré des effets positifs de l'inoculation par *G. intraradices* sur la croissance d'*A. holocericea* après 18 et 30 mois de transplantation [56].

Par ailleurs, Lesueur et Duponnois (2005) ont montré que la symbiose mycorhizienne améliore la croissance des acacias Australiens et le développement de leur symbiose avec Rhizobium [57].

4 CONCLUSION

Les acacias présentent un intérêt socio-économique direct grâce à la production du bois, de tanins (*A. mearnsii*), de gommes (*A. seyal, A. senegal* et *A. gummifera*), de charbon et d'outils. Plusieurs espèces sont aussi utilisées en alimentation humaine et d'autres ont une grande valeur fourragère. En effet, les phyllodes, les jeunes pousses, gousses et graines, frais ou secs, sont riches en protéines, sont non toxiques et acceptables pour les ovins et les caprins.

De plus, les acacias sont d'importantes plantes fixatrices d'azotes, qui constituent une source d'azote supplémentaire dans l'écosystème.

Mais, elles présentent une certaine dépendance vis-à-vis des Rhizobium pour la FBA et des mycorhizes pour l'absorption des éléments nutritifs en particulier le P, nécessaires pour la croissance. Plusieurs études ont montré que la performance des associations symbiotiques rhizobiennes et/ou mycorhiziennes contrôlées dans l'amélioration significative la croissance des acacias australiers. D'où l'intérêt de la double inoculation endomycorhizienne et par Rhizobium pour l'amélioration des programmes de reforestation des sols dégradés avec des légumineuses à croissance rapide, surtout en zones arides et semi-arides. Ainsi, leur inoculation, en pépinière sous conditions contrôlées, par des souches efficientes et compétitives de Rhizobium et des CMA pourrait également améliorer leur survie et augmenter leur performance dans les systèmes de reboisement. A moins de sélectionner des espèces promiscous capables de former des nodules et fixer l'azote même avec les populations indigènes de Rhizobium.

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ÉVALUATION DU RISQUE SANITAIRE LIE A LA PRÉSENCE D'OCHRATOXINE A DANS DES FARINES ALIMENTAIRES ET LES VINS COMMERCIALISÉES AU BÉNIN

[HEALTH RISK ASSESSMENT RELATED TO THE CONTAMINATION OF FLOUR FOOD AND WINE BY OCHRATOXIN IN BENIN]

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ABSTRACT: Bromatological toxicities frequencies and probabilities of toxicological levels for ochratoxin A in flour (wheat, corn) and Drinks With Alcohol, especially samples of wine brands (Baron de Valls, Don Simon Sangria, Le Pichet, Bonita, JP. Chenet) reveal a large public health risk for consumers in Cotonou and Porto-Novo. According to European Commission's Regulation 1881/2006, meal should not exceed 3 ng/mL or 3.10^{-6}g/l or3.10^{-3} mg/l or 3.10^{-3} ppm. Unfortunately, corn flour has the highest average content of ochratoxin A which is 4.716 ng/mL with a probability of 0.5%. Wheat flour, has the low average of 1.6287 ng / mL with a probability of 0.5 % . In the same regulation, wines must not exceed 2ng/mL of ochratoxin A. It follows that the average content of ochratoxin A in descending order can be found in " Le Pichet " (1.635 ng / mL with a probability of 26%) ; « Sangria » (1.1359 ng/mL with a probability of 1 %) ; Bonita (0.4059 ng/mL with a probability of 0.5 %). « Baron de Valls "and "JP Chenet" not hold ochratoxin A. Corn flour, wheat, and wines such as Sangria, Bonita, especially Pichet are unfit for human health and regulars measuresmust be taken to ensure people safety.

KEYWORDS: Bromatological toxicity; ochratoxin ; flour ; wine ; average grade.

RESUME: La fréquence de toxicité bromatologique et les probabilités de teneurs toxicologiques en ochratoxine A des farines (blé, maïs) et des BRAA (Boissons Raffraichissantes Avec Alcool), particulièrement des échantillons de marques de vins (Baron de Valls, Sangria Don Simon, Le Pichet, Bonita, JP. Chenet) exhibent une vulnérabilité pour la santé publique des consommateurs à Cotonou et Porto-Novo. Selon le règlement 1881/2006 de la Commission Européenne, les farines ne doivent pas excéder 3 ng/mL soit 3.10^{-6}g/L ou 3.10^{-3} mg/L ou 3.10^{-3} ppm d'ochratoxine A. Malheureusement, la farine de maïs détient la plus forte teneur moyenne en ochratoxine A qui est de 4,716 ng/mL avec une probabilité de 0,5 %. Quant à la farine de blé, elle a la plus faible teneur moyenne qui est de 1,6287 ng/mL avec une probabilité de 0,5 %. Selon ce même règlement, les vins doivent contenir au plus 2ng/mL d'ochratoxine A. Il ressort que la teneur moyenne en ochratoxine A dans l'ordre décroissant se retrouve dans « Le Pichet » (1,635 ng/mL avec une probabilité de 26 %) ; « Sangria » (1,1359 ng/mL avec une probabilité de 1 %) ; et Bonita (0,4059 ng/mL avec une probabilité de 0,5 %). Par contre Baron de Valls et JP Chenet ne détiennent pas d'ochratoxine A. En esquisse, les farines de maïs, de blé, et les vins tels que Sangria, Bonita, et particulièrement Pichet sont impropres pour la santé humaine et des mesures de contrôles réguliers doivent être prises pour l'assurance qualité des aliments et la sécurité sanitaire des consommateurs.

MOTS-CLEFS: Toxicité bromatologique ; ochratoxine A ; farine ; vin ; teneur moyenne.

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1 INTRODUCTION

L'ochratoxine A (OTA) est une mycotoxine synthétisée par des moisissures appartenant aux genres ***Penicillium*** **et** ***Aspergillus.*** Dans le sang, elle est la source d'intoxications aiguës parfois mortelles chez les animaux, et d'intoxications chroniques chez l'homme (Merwe et *al.*, 1965). Les risques qui résultent de cette exposition de l'homme aux mycotoxines par voie alimentaire sont considérés comme un problème majeur de santé publique (Krogh, 1987). Elles sont néphrotoxiques et demeurent la cause principale des néphropathies endémiques de Balkan. En dépit de cette néphrotoxicité, l'OTA est immunosuppressive, tératogène, génotoxique et cancérogène (Krogh et Elling, 1977).

Des dispositions légales et réglementaires sont actuellement prises au niveau international par le Codex Alimentarius et certains partenaires au développement pour le renforcement des exigences de sécurité alimentaire, en particulier au niveau de l'Union Européenne en vue de protéger les consommateurs des effets néfastes des contaminants chimiques et des mycotoxines, notamment de l'ochratoxine A (FAO, 2003 ; CE, 2005).

En vue d'une investigation des risques de contaminations à l'ochratoxine A dans les denrées alimentaires d'alerter les populations et les décideurs sur l'importance de ces risques face à la consommation incontrôlée d'aliments contaminés, est initiée la présente étude.

2 MATÉRIEL

Une gamme multi variée de matériel fait objet du présent travail. 131 échantillons de denrées alimentaires sont collectés pour l'expertise bromato-toxicologique. 76 échantillons de farines ont été prélevés et étiquetés sur les sites de Cotonou et Porto-Novo. Dans le lot se distinguent 39 échantillons de farine de blé et 37 échantillons de farine de maïs. 55 échantillons de vin sont collectés, dont 11 échantillons par marque (Baron de Valls, Sangria Don Simon, Le Pichet, Bonita, JP. Chenet) prélevés sur différents sites à Cotonou. Les réactifs utilisés sont constitués du kit ÉLISA (spécifique pour l'ochratoxine A), de l'eau distillée, de l'acide chlorhydrique (1 molaire), du di-chloro-méthane (1 molaire), et du bicarbonate de sodium (0,13 molaire). Quant à l'appareillage, il est constitué d'une chaine ÉLISA, d'une centrifugeuse, d'un vortex, et des accessoires (verrerie, etc.).

3 MÉTHODES

3.1 COLLECTE DES ÉCHANTILLONS

Différents sites à Cotonou et Porto-Novo (boulangeries, moulins et marchés) ont fait l'objet de lieu de prélèvements des échantillons. La technique d'échantillonnage est aléatoire stratifiée, cumulée à un choix raisonné suivant la marque et la traçabilité.

- 40 échantillons sont collectés à Porto-Novo : dont 20 échantillons de farine de blé prélevés au marché/boulangerie et 20 échantillons de farine de maïs prélevés au marché/moulin.
- 36 échantillons sont recueillis à Cotonou : dont 19 échantillons de farine de blé prélevés au marché, à la boulangerie et au Grand Moulin du Bénin (GMB) et 17 échantillons de farines de maïs prélevés au marché et au moulin.
- 55 échantillons de vin sont relevés à Cotonou (marchés et supermarchés), à raison de 11 échantillons par marque (Baron de Valls, Sangria Don Simon, Le Pichet, Bonita, JP. Chenet). Ces cinq marques ont été ciblées après une enquête préalablement menée sur le terrain.

3.2 ETIQUETAGES

Une fois au laboratoire, tous les échantillons sont codifiés pour les besoins d'analyses. Le mode opératoire utilisé pour la recherche et le dosage de l'ochratoxine A se résume en trois grandes étapes: la préparation des réactifs, la préparation des échantillons et le dosage.

3.3 PRÉPARATION DES RÉACTIFS

Les solutions d'acide chlorhydrique (1 molaire), de dichlorométhane (1 molaire), de bicarbonate de sodium (0,13 molaire), tampons (diluées au $1/10^{ième}$) et d'enzyme conjuguée (diluée au $1/200^{ième}$) sont préparées.

3.4 PRÉPARATION DES ÉCHANTILLONS

- Farine de maïs et farine de blé

1 g de l'échantillon est prélevé et mélangé à 20 mL de solution de bicarbonate de sodium. Après 1 minute d'agitation au vortex, il s'en suit la centrifugation à 1200 tours/min 15 minutes durant.

- Boissons Rafraîchissantes Avec Alcool (BRAA) : les vins

Les échantillons sont manipulés à la température du laboratoire (18 à 25 °C). On y ajoute dans l'ordre, 5 mL d'acide chlorhydrique à 5 mL de vin et 10 mL de dichlorométhane puis on agite lentement le mélange au vortex 15min durant. Il s'en suit une centrifugation à 2200 trs/min pendant 15min ; on prélève ensuite 5 mL de la phase inférieure pour y ajouter 2,5 mL de la solution de bicarbonate de sodium. A nouveau, on tourne l'ensemble au vortex 15min durant suivi d'une centrifugation à 2200trs/min pendant 15min. Enfin on prélève et on dilue (2x) le surnageant (la phase aqueuse) avec la solution de bicarbonate de sodium.

3.5 DOSAGES AU LABORATOIRE

Les étapes qui suivent sont idem pour toutes les matrices faisant objet du présent travail. Le kit ÉLISA utilisé est '*I'screen* OCHRA*; de code OR361'*. Sa limite de détection et de quantification est de 1 ppb (partie par billions) dans les céréales et le cacao et de 0,1 ppb dans le vin et les grappes de raisin.

Deux essais ont été réalisés par échantillon en vue de réduire les erreurs liées à la manipulation. Au terme, les valeurs obtenues multipliées par le facteur de dilution (20 pour les farines et 2 pour le vin) représentent les concentrations de chaque échantillon dosé.

Suite aux deux essais réalisés, les valeurs moyennes des concentrations sont déterminées.

3.6 ANALYSES STATISTIQUES

Sur la base des résultats issus des données d'analyses de laboratoire, a été procéder une série d'analyse statistique dans différents logiciels, dont Excel, et Minitab version 14. En prélude, une base de données est réalisée dans Excel, et a servi de guide aux tests statistiques dans Minitab 14. Les analyses statistiques les plus indexées sont constituées des fréquences de toxicités bromatologiques et de la probabilité de teneurs en Ochratoxine A des denrées alimentaires.

4 RÉSULTATS ET DISCUSSIONS

Des Fréquences de toxicité bromatologique et des probabilités de teneurs toxicologiques, présentées dans les figures qui suivent, il ressort que :

- Pour ce qui concerne les farines, le maïs détient la plus forte teneur moyenne qui est de 1,842 + 2,874 soit 4,716 ng/mL avec une probabilité de 0,5 %. Quant à la farine de blé, elle a la plus faible teneur moyenne qui est de 1,092 + 0,5367, soit 1,6287 ng/mL avec une probabilité de 0,5 %.
- Au niveau des vins, la teneur moyenne en ochratoxine dans l'ordre décroissant se retrouve dans 'Le Pichet' (1,225 + 0,419, soit 1,635 ng/mL avec une probabilité de 26 %) ; 'Sangria' (0,5691 + 0,5668, soit 1,1359 ng/mL avec une probabilité de 1 %) ;et Bonita (0,1364 + 0,2695 soit 0,4059 ng/mL avec une probabilité de 0,5 %). Par contre Baron de Valls et JP Chenet ne détiennent pas d'ochratoxine.

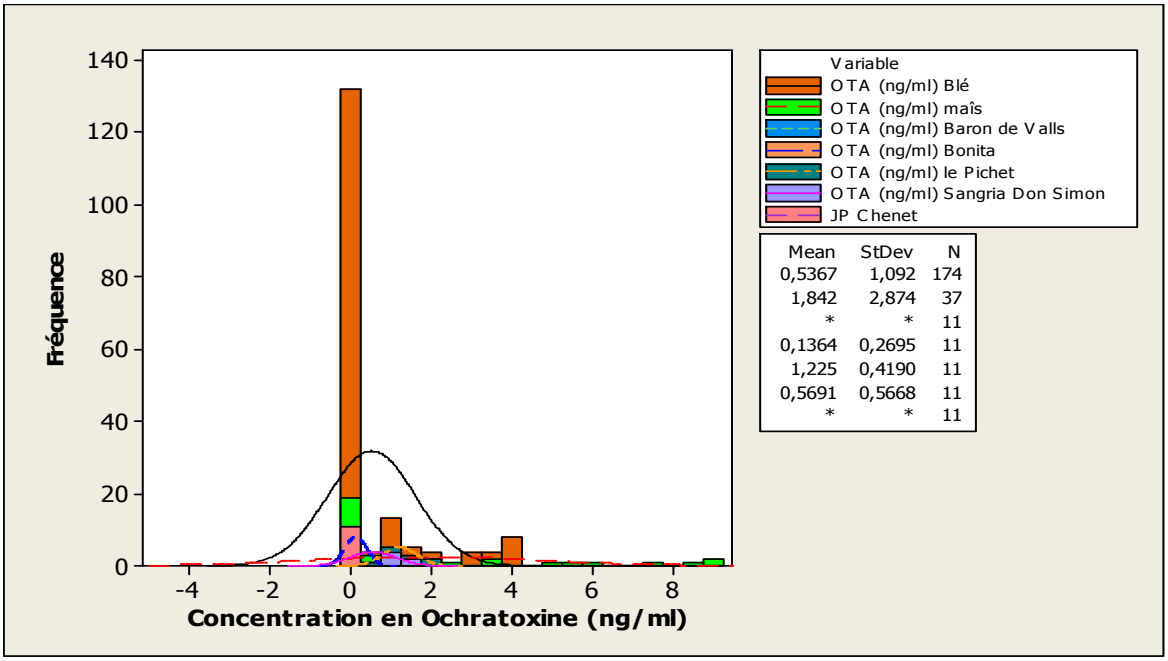


***Figure 1** : Fréquences de toxicité bromatologique en ochratoxine A des denrées alimentaires à Cotonou et à Porto-Novo*

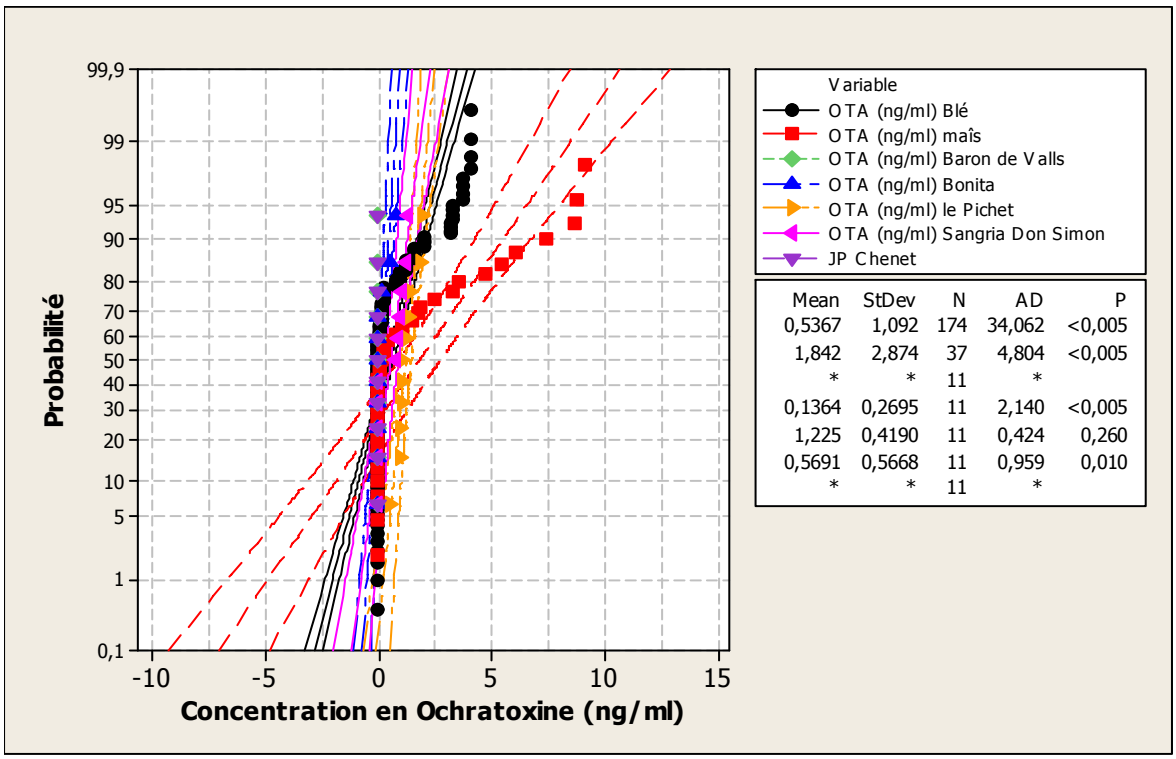


***Figure 2** : Probabilités de teneurs toxicologiques en ochratoxine A des denrées alimentaires à Cotonou et à Porto-Novo*

Selon le règlement 1881/2006 de la Commission Européenne, les farines ne doivent pas excéder 3 ng/mL soit 3.10^{-6}g/l ou3.10^{-3} mg/l ou 3.10^{-3} ppm. Il ressort que sur les 39 échantillons de farine de blé, 16 échantillons soit 41,03 % contiennent de l'OTA et que parmi ces derniers il y en a 4 (l'échantillon 26: 3,35 ng/mL ; l'échantillon 31: 3,79 ng/mL ; l'échantillon 37: 4,09 ng/mL et l'échantillon 39: 3,24 ng/mL) soit 10,24 % qui ont une concentration supérieure à la norme. Quant aux 37 échantillons de farine de maïs analysés, il y a présence de l'OTA dans 21échantillons soit 56,76 % et 09 soit 24,32 % ont une teneur en OTA qui dépasse la valeur seuil.

Sur les 11 échantillons de vin rouge 'Baron de Valls' traités, aucun échantillon ne contient de l'OTA. 03 échantillons de vin 'Bonita' sur les 11 analysés soit 27,27 %, contiennent de l'OTA. Il y a présence d'OTA dans les 11 échantillons de vin « Le Pichet » analysés soit 100 %, avec des concentrations variant de 0,49 à 1,95 ng/mL. 06 échantillons de vin 'Sangria Don Simon' sur les 11 traités soient 54,55 %, contiennent de l'OTA quand bien même que ces valeurs ne dépassent pas le seuil réglementaire. La concentration minimale est de 0,76 ng/mL et la maximale de 1,33 ng/mL.

En ce qui concerne les échantillons de «J.P. Chenet » analysés, aucun ne révèle la présence d'OTA dans les vins.

Sur les 11 échantillons de vin rouge « Baron de Valls » traités, aucun échantillon ne contient de l'OTA. 03 échantillons de vin « Bonita » sur les 11 analysés soit 27,27 %, contiennent de l'OTA. La concentration maximale étant de 0,79 ng.

Il y a présence d'OTA dans les 11 échantillons de vin « Le Pichet » analysés soit 100 %, avec des concentrations variant de 0,49 à 1,95 ng/mL.

06 échantillons de vin « Sangria Don Simon » sur les 11 traités soient 54,55 %, contiennent de l'OTA quand bien même les valeurs ne dépassent pas le seuil réglementaire, la concentration minimale est de 0,76 ng/mL et la maximale de 1,33 ng/mL.

Quant aux échantillons de « J.P. Chenet » analysés, aucun ne révèle la présence d'OTA.

La présence des différentes concentrations d'OTA obtenues dans les vins analysés confirme l'hypothèse du passage très important des moisissures dans le moût lors de la période de macération. Les conditions de développement des champignons étant réunies, il s'en suit la production d'ochratoxine A. D'où l'intérêt de la qualité du vendange pour l'assurance de la production.

Les résultats ainsi obtenus sur l'ochratoxine A dans les denrées alimentaires, étaient prévisibles pour raison d'absence des mesures de sûreté sanitaire des aliments au Bénin. Ceux-ci se conjuguent aux études réalisées dans l'Union Européenne sur les échantillons totaux de vins rouges et ceux contaminés en OTA.

Ces différents taux de contamination obtenus représentent un véritable danger du fait que l'OTA est une substance toxique difficile à éliminer dans les réseaux trophiques. Elle affecte la santé du consommateur même à faible taux et s'accumule dans l'organisme, causant ainsi des intoxications chroniques avec de graves risques pour la santé comme tels mentionnés en prélude à ce document.

5 CONCLUSIONS ET RECOMMANDATIONS

Les farines et vins à Cotonou et environs détiennent des teneurs considérables en ochratoxine A. Il se pose une réelle inquiétude de sureté sanitaire des aliments sur les espaces littoraux du Bénin. La santé des consommateurs est très menacée, et il urge des mesures juridiques et institutionnelles pour l'instauration d'une politique de surveillance qualité des aliments en zone portuaire du Bénin.

La société civile, et la presse sont fortement invitées à se doter des présents résultats d'analyses, pour une meilleure sensibilisation sur les risques.

L'Etat central doit assurer la santé des consommateurs, et se procurer de ce document pour une meilleure conception des mesures, qui d'ailleurs méritent une collaboration intrinsèque entre la société civile, les opérateurs économiques, et les laboratoires spécialisés.

Il urge des mesures préventives.

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Comparing efficiency of on-farm experiments relative to designed experiments in complete blocks

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ABSTRACT: The aim of this study was to estimate the relative efficiency (RE) of an On-Farm Experiment conducted in randomized complete block design (RCBD) compared with a completely randomized design (CRD). An on-farm experiment was carried out at Noralhuda, Gezira, Sudan during season 2010. A set of six varieties of sorghum were evaluated in this study and data was collected on flowering period (FP), number of plant (NP), plant height (PH, cm), head length (HL, cm)), 100 seed weight (SW, g), forage weight (FW, kg) and productivity (P, t/ha). Relative efficiency to RCBD, of on-farm experiment was about 91%, 2.04%, 1.22% , 0.91% , 0.88% , 0.99% and 0.89 for FP, NP, PH, HL, 100SW, FW, and P respectively. The coefficients of variation (CV), coefficient of determination (R2) and relative efficiency (RE) were 7.70%, 78% and 1.12% for RCBD respectively. The relative efficiency of on-farm trials show the same efficiency comparing to RCBD, as can be expected. It would have attained the same sensitivity as in RCBD or CRD with about approximately 100% of replication used. The use of completely randomized design was most suited on farms where blocks might be difficult to be formed and impractical to maintain, it was found that experimental design efficiency compared to RCBD is not too low on-farming experimental.

KEYWORDS: RCBD, On-farm trials, Relative efficiency.

1 INTRODUCTION

The statistical analysis of on-farming experimental to experimental design efficiency are generally characterized by low coefficient of determination, R2 and high coefficient of variation (CV), due to varying farmer management levels from one technology to another within a farmer Kashif et al. (2011). CV provides a measure of inherent variation in the field for given atrait and is expressed as a percentage, it is referred to as experimental error Bellon and Reeves eds (2002). A high CV make treatment differences less likely to be detected statistically significance with less number of replications, while with a low CV it is highly likely Johnston et al. (2003). Efficient experimental design is essential when planning research trials Asheber (2010). For a small number of treatments, the completely randomized design (CRD) and randomized complete block design (RCBD) are the most frequently applied, and , practically, the CRD is the simplest of all designs (Shelton et al., 2009). The randomized block experiment is inefficient for large number of treatments, due to of their failure to reduce the effect of soil heterogeneity Muhammad et al. (2008).

On-farm experiments are planned in the fields of representative farmers and examine a small number of experimental materials SSC (1998). Efficiency of on farm experiments an essential of well-studied statistical tools in design of experiments, and ANOVA can be incorporated in its framework Kashifa et al (2011). The purpose of each on farm experiment to study the effect of measurements taken before, during, and after the growing season in this case the efficiency is widely accepted relative precision as measure purported to evaluate the relative efficiency in terms of the ratio of error variances of both designs Ingrand et al. (2006).

There are several experimental-design procedures that are quite amenable to simulation experiment such as on- farm experiment Ingrand et al. (2000). These simulation experiments present unique opportunities not present in physical experiments Kelton (2000). The designing simulation experiments deserves the capitalize in modeling effort and unplanned, hit-or-miss course of experiments unlikely to yield much solid insight Parsad e et al. (2009).The assessment of on-farm trail is commonly based on measures of coefficient of variation (CV) coefficient of determination (R2) and experimental error due to varying farmer management levels Timothy et al. (1997). The aim of this study was to estimate the relative efficiency (ERE) of an On-Farming Experimental simulated to RCBD compared with a CRD.

2 ON-FARM RESEARCH

On-farm research is in fact that looks in combination with a scientific approach. An on-farm trial aims at testing a technology or a new idea in farmer's fields, under farmer's conditions and controlling the farmer's practice Pierre et al. (1999). On-farm research is a powerful decision-making tool for organic farmers. A lot of work goes into doing high-quality research, but the confidences one has in the results are worth it. Analyses of different farming practices may be generated by replication, randomization, and use of a control in designing an experiment because they help to separate out treatment effects from natural levels of background variation Sooby (2001). On-farm trials differ from classical on-station trials in various ways Nokoe (2003). The mostly commonly used method for analyzing on-farm trials is the conventional analysis of variance (ANOVA) for the relevant design of the trial John (2003). Some basic principles for on-farm research are:

- Address experiments problems that are important to farmers
- Limit your experiment to a comparison of two (or maximum three)
- Treatments
- Help to adopt entire new systems of production
- The results should not be turn out as you planned

On-Farm research helps in testing the technologies developed at the research stations by taking into account the realistic environment the on-farm trials can be classified into three categories(i), designed experiment and managed by researchers (ii) designed experiment by researcher and managed by farmers, and (iii) designed experiment and managed by farmers. Primarily on-farm research is suffering from lack of control on variability due to (a) variation in farmers' managerial skills and resources, (b) variation in plot etc. In this case resolvable block designs are quite helpful in On-Farm research to take care of variation due to management skills of the farmers or plot to plot variation (Meertens, 2008). The use of design of experiment (DOE) and data farming techniques is critical to effectively planning, and subsequently evaluating, tests of complex adaptive systems in a joint mission environment (Cheng et al., 2003). On-farm research is a problem-directing approach to agricultural research that begins by diagnosing the environmental conditions, practices and problems of farmer's users Tripp and Woolley (1989).

3 JUSTIFICATION OF THE STUDY

Most agricultural research was carried out on-station, where conditions can be controlled and single treatments applied. The scientists have replaced the RCBD on investigating experimental trails in many fields, however over location and seasons due to their understudying its layout and simplest statistical analyses. The on farm trails are widely used in plant breeding and variety testing around the world and are more efficient than RCBD. These designs are restricted to very limited number of treatments and the field layout is very CriticalKashifa et al. (2010).

4 MATERIAL AND METHODS

On farm experimental field was carried out at Noralhuda location, Gezira scheme experimentation using randomized complete block design (RCBD) layout, Wad Medani during season 2010-2011. a set of six verities of sorghum cultivars were use in this study on flowering period (FP), number of plant (NP), plant height (PH) (cm), head length (HL) (cm), 100 seed weight (g) (SW), forage weight (kg) (FW) and productivity(P), respectively. The mean square error from each analysis was used to estimate the relative efficiency of an (RCBD) compared with a CRD according to the relative efficiency equation. The results were statistically analyzed using Cropstat version7.2.

4.1 RELATIVE EFFICIENCY

Efficiencies are measures of goodness of the design Kuhfeld et al. (1994). Relative efficiency is often used to indicate how much saving in cost and land can be envisaged from a design. Efficiency measures and the relative precision are described in an attempt to provide some guidance in the choice of appropriate measure of effective blocking in RCBD. The results for the obtained by the proposed measures are presented Gwowen (2004).

$$\text{Efficiency of RCBD vs. CRD} = \frac{(b-1)\text{MS.B}+b(t-1)(\text{MS.E})}{(bt-1)\text{MS.E}}$$

Where

b and r are the number of blocks and treatments respectively
MS.B is the mean square of block /replication under RCBD
MS.E is the mean square of error under RCBD

Efficiency of RCBD relative to CRD can be interpreted as the number of times as many replicates would be needed for CRD to have the same precision of estimates of treatment means as in case of RCBD.

4.2 RELATIVE EFFICIENCY OF THE RCBD

RCBD and CRD may lead to different conclusions, how much more (less) efficient is the RCBD compared to a CRD?, The relative efficiency (R) of the RCBD with respect to the CRD is

$$R = \frac{(dfb+1)(dfr+3)}{(dfb+3)(dfr+1)} \cdot \frac{\sigma_r^2}{\sigma_b^2}$$

Where σ_r^2 is the CRD error variance, $\sigma_b^2$is the RCBD error variance dfr is the CRD error degree freedom and dfb is the RCBD error degree freedom.

R is the factor by which the number of replications of a CRD needs to be increased for a CRD to achieve the same precision as a RCBD. From Table 1, an estimated relative efficiency (ERE) less than 1 indicates that a CRD is a more efficient design, while value nearly equal to 1 suggests that the two designs yield similar results. Value greater than 1 suggests that RCB design is more efficient design than CRD. In this study, the efficiency of complete randomized designs (CRD) and randomized complete block design (RCBD) was compared in this research experiment conducted during season 2010 in a Gazira scheme, Wad Medani, Sudan.

5 RESULTS AND DISCUSSION

The results of this work are based on data collected from Gezira Scheme by sampling chosen at three times.

Table 1. Cultivation of 6 sorghum cultivars in Galoka Managil in Gezira scheme, Sudan

Variety	Flowering Period	No of Plant	Plant height (cm)	Head length (cm)	100 seed weight (g)	Forage weight (kg)	Productivity (t/ha)
Panar	73 ab	39000 ab	77 ab	33 a	3.45a	924 b	4.6 d
Alfa2	62 bc	41000 bc	86 ab	31 a	2.63 a	1118 b	8.1 b
W.Ahmed	77 a	41000 a	95 ab	28 ab	3.71 a	1235 b	5.8 c
Pac 501	56 c	46000 c	154 a	22 b	3.05 a	2464 a	11.6 a
Tabat	79 a	30077 a	98 b	28 ab	3.05 a	1274 b	3.5 e
Pac 537	61 bc	43000 bc	157 a	31 a	2.85 a	2512 a	5.8 c
SE±	2.83	2444.81	5.22	1.45	0.48	162.92	0.23
Sig	0.0003	0.0179	0.0001	0.0027	0.6541	<.0001	<.0001
Mean	68	40013	111	29	3.12	1588	6.57
CV% under CRD	7.2	10.5	8.1	8.7	26.8	18.1	5.9
CV% under RCBD	7.8	7.6	7.6	9.4	29.3	18.7	6.5

Means with the same letter are not significantly different; the means comparison was performed by Tukey's HSD (honest significant difference) test

Table 1 shows the yield and yield components on sorghum cultivars, there were statistical significant for all parameters, in this section statistical information is needed such as CV%, standard error of means and significant level to illustrated the means of relative efficiency, regarding the results show that there were not statistical difference between the coefficient of variation (CV %)of CRD and RCBD at (p>0.959). The overall CV% was 12.19 and 12.41 for CRD and RCBD respectively. It is evident that there was efficiency in experimental form trials. In general results of on- farm trials either simulated as CRD or RCBD, It's given highly efficiency due to the experimental management and farmers conditions, which accrued depend on accuracy of coefficient of variation.

Table 2.Results of Coefficient of variation (CV %) and Coefficient of determination (R2)for all parameters of CRD and RCBD

Parameters	CV %		R2	
	CRD	RCBD	CRD	RCBD
FD	7.2	7.8	0.832	0.826
NP	10.5	7.6	0.846	0.642
PH	8.1	7.6	0.964	0.952
HL	8.7	9.4	0.755	0.747
SW100	26.8	29.3	0.22	0.218
FW	18.1	18.7	0.893	0.881
PROD	5.9	6.5	0.986	0.986

Tables 1 and 2 shows the summary of analysis of variance for all parameters, which were analyzed as simulated RCBD. The results showed that there were highly statistical significant expect the 100 seed weight (SW) there were approximately equality of coefficient of variation and coefficient determination. The above result indicated, the CV% of CRD is slightly lower (10%) than RCBD.

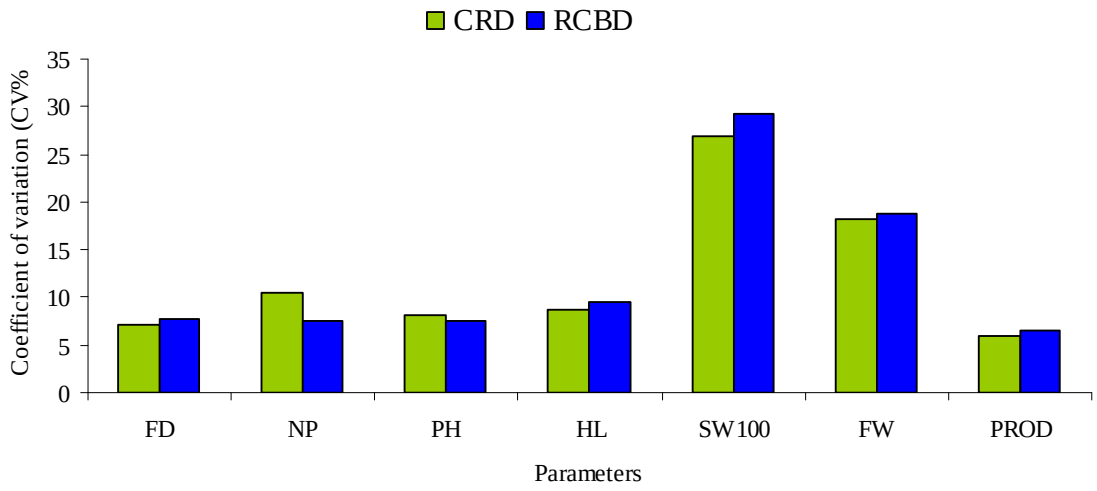


Figure 1. Comparison of estimated coefficients of variation (CV) between CRD and RCBD

The figure1 has shown no statistically significant for CV % and R2over all parameters at (p> 0.263) for all parameters of CRD and RCBD. The coefficient of variation (CV) calculated for all parameters to preliminary yield trials are (12.19 and 12.41) for CRD and RCB design respectively. The standard deviation (StDev) calculated for these simulated trials are (7.58 and 8.53) for CRD and RCB design.

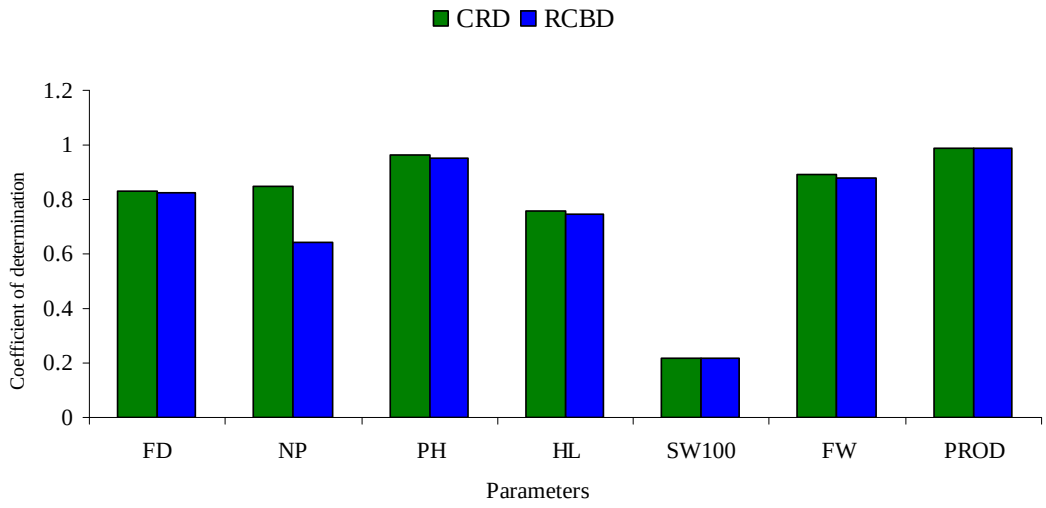


Figure 2. Comparison of estimated coefficients of determination (CV) between CRD and RCBD

The figure 2 show there were no statistical significant over all parameters (p>0.929). The coefficients of determination (R2) were calculated for all parameters to preliminary yield trials are (0.785 and 0.751) for CRD and RCB design respectively. The standard deviation (StDev) calculated for these simulated trials are 0.2615and 0.2627) for CRD and RCB design.

Table3. Expectation of mean squares (EMS) of complete randomized design (CRD) and randomized complete block design (RCBD)

Parameters	MSE of RCBD	MSB(Replication) of RCBD	MSE of CRD	Relative Efficiency
FD	27.87	4.67	24	91%
NP	9255556	6.106E7	17888889	2.04%
PH	70.9	135.50	81.7	1.22%
HL	7.37	1.17	6.3	0.91%
SW100	0.84	0.01	0.7	0.88%
FW	85222.22	50555.56	79444.4	0.99%
PROD	0.18	0.01	0.2	0.89%

Where MSE=Mean square error

Thus the CRD is the more efficient design in this case. It would have attained the same sensitivity as the RCBD with about 84% of the replications used. The results of the experiments show that there is small difference between error mean squares (EMS) under CRD and RCB design. The coefficient of variation (CV) of RCB design is comparatively low as compared to CRD. In study the on farm experiment indicated good index of reliability due to Low value of CV. The effectiveness of this design, relative to the more traditional design (RCBD). The results showed that, the RE of on-farm experimental about 91%, 2.04%, 1.22%, 0.91%, 0.88% , 0.99% and 0.89 for FP, NP, PH, HL, 100SW, FW, and P respectively . The overall coefficient of variation (CV) and relative efficiency (ER) are (7.70 and 13.6) for RCBD to CRB. The relative efficiency of on farm trials shows that was more efficient than RCBD. The value of relative efficiency (12.41 and 1.12%) indicates that the use of CRD or (RCBD) has the some precision, thus the RCBD is the more efficient design in this case. It would have attained the same sensitivity as the CRD with about 1.12% and approximately 100%. The error mean squares (EMS) under RCB design was smaller as compared to RCB design. It is also noted that the coefficient of variation (CV) RCB design was comparatively low as compared to CRD. Historically agronomists have relied heavily on the CV as a measure of trial's reliability. This increase in precision resulted in RCB design better detected significant differences than CRD. The value of relative efficiency greater than one for both the experiments shows that RCBD was clearly more efficient than CRD (table1). Relative efficiency indicates that the use of RCBD will increase experimental precision in general.

6 CONCLUSIONS

The results highlighted that, RCBD On-farm experiment appeared more efficiency than CRD. The relative efficiency of on-farm trials shows that was same efficiency to RCBD, as can be expected. It would have attained the same sensitivity as the RCBD or CRD with about approximately 100% of replication used. The use completely randomized design was most suited on farms where blocks might be difficult to form and impractical to maintain, it was found that experimental design efficiency compared to RCBD is not too low on-farming experimental. The use completely randomized design was most fundamental and useful in effectiveness and an appropriate measure of relative efficiency of on-farm experiment. The benefit of use on farm experiment will be in evaluating specific cultivars in share of environmental and economic condition with highly precisian to have parricidal in the provision of time and effort together. Investigation of efficiency of On-farm experiments as requirement of good experimental trials and precision of agricultural field research, because part of the farm is controlled and measured in order to make projections about how the whole farm will respond. Similarly, in making measurements it would take a prohibitively long time to the results of the study may be used in advising agricultural communities that sustainability of agro-ecosystem will ensure more efficient agricultural production.

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EFFECTS OF BUTTER AND ESTROGEN ON LIPID PROFILE AND HISTOTEXURE OF LIVER AND SKIN IN REFERENCE TO THE DEVELOPMENT OF OBESITY IN SWISS ALBINO MICE

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ABSTRACT: The study was performed in to investigate the effects of butter and estrogen on lipid profile and histo-texture of liver and skin in mice. 30 days old 60 (30 male and 30 female) Swiss Albino mice were divided into 6 equal groups of which (M, M_1, and M_2) were in male and (F, F_1, F_2) in female. Group M and F (Control) were fed with normal mice pellet. Mice in the group M_1 and F_1 (butter treated) were fed with 20% butter; group M_2 and F_2 (estrogen) were fed with estrogen @ of 10 µg/mice/day. The effect of butter and estrogen in the development of obesity in mice was evaluated based on weight gain, lipid profile, blood glucose and histopathology. In this study in case of male the highest body weight gain was detected in group M_1 ($P<0.001$) and in biochemical study, group M_1 showed the increase in total plasma cholesterol ($P<0.01$), LDL ($P<0.01$), TG ($P<0.001$), blood glucose ($P<0.05$) but increase in HDL ($P<0.001$) in M_2 group compared to control group. In female the highest body weight gain was detected in group F_1 ($p<0.001$) and in biochemical study, group F_1 showed the increase in total plasma cholesterol ($P<0.01$), LDL ($P<0.01$), TG ($P<0.001$), blood glucose ($P<0.05$) but increase in HDL ($P<0.001$) in F_2 group in compared to control group. In histopathological study fatty changes and endothelial desquamation were found in the liver of butter treated groups. Fatty changes, loss of elasticity, dermal thickness were found in the skin of butter treated mice. On the basis of the findings and observations of the present study, it can be concluded that 20% butter supplementation would be able to cause a change in lipid profile and would also produce degenerative changes in liver and skin of mice.

KEYWORDS: Obesity, Cholesterol, lipid, Estrogen, Cholesterolemia.

1 INTRODUCTION

Obesity is a medical condition in which excess body fat is accumulated to the extent that it may have an adverse effect on health, leading to reduced life expectancy and/or increased health problems. A person is obese when it is greater than 30 kg/m^2. Obesity is a major health problem worldwide. In United States, roughly 300,000 deaths per year are related to obesity. Obesity also increases the risk of developing several chronic diseases such as type-2 diabetes, insulin resistance, coronary heart disease (responsible for heart attacks), cerebrovascular disease (responsible for strokes), high blood pressure, gout, gallstones, colon cancer, sleep apnea, and a form of liver disease called nonalcoholic fatty liver disease (NAFLD). Clinical and epidemiological studies have led to the identification of the genetic, environmental, and inflammatory risk factors of these diseases like dyslipidemia, hypertension, diabetes, obesity, smoking, high-fat diet, fatty liver disease, and chronic inflammation [1].

Obesity is most commonly caused by a combination of excessive food energy intake, lack of physical activity, and genetic susceptibility, although a few cases are caused primarily by genes, endocrine disorders, medications or psychiatric illness. Evidence to support the view that some obese people eat little yet gain weight due to a slow metabolism is limited; on

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average obese people have a greater energy expenditure than their thin counterparts due to the energy required to maintain an increased body mass. The incidence and prevalence of obesity continues to reach pandemic proportions and is a leading force behind the also worrisome frequency of type 2 diabetes mellitus (DM2) and cardiovascular disease (CVD), causing significant morbidity, mortality and imposing a severe economic burden to health care systems in both industrialized and non-industrialized countries [2].

According to the National Health health care systems in and Nutrition Examination Survey (NHANES), between 1999 and 2010 the overall age-adjusted prevalence of obesity in the USA was 35.8% in adult men and 35.5% in adult women [3].

There are important sex-related differences in the prevalence of obesity, DM2, hypertension and CVD, with premenopausal women at less risk relative to age-matched men [4], [5].

It is now well established that obesity is an independent risk factor for the development of cardiovascular diseases. Cardiovascular disease (CVD) is a degenerative disease that most often occurs and becomes a major killer in industrialized countries .In developing countries, the incidence of cardiovascular disease is increasing alarmingly [6]. CVD is emerging as a serious health hazard in Bangladesh. Latest survey on cardiovascular diseases in Bangladesh showed prevalence of ischemic or coronary heart disease (CHD) in adult population about 10% (National Heart Foundation of Bangladesh, 2010). A major cardiovascular disease of the productive age is coronary heart disease (CHD), which is closely related to atherosclerosis [7].Compared to men, women suffer a disproportionate burden of disease attributable to overweight and obesity. Female Obesity is defined as an excessive amount of body fat, keeping in mind the Body Mass Index ratio, of the woman concerned.

Women with body weight measuring up to 30 percent more than that of the ideal are known as Obese. The body mass index (BMI), is the most popular and effective way of calculating female Obesity.

It is believed that Female Obesity has increased by 15 percent in the past decade and as a result, women have become prone to diseases like diabetes, high BP, etc. Women who have a hereditary problem of obesity need to be very careful about their food and exercise quotient. Often women find it difficult to shed post pregnancy weight which in turn leads to lifelong obesity for them. The occurrence of CVD can be reduced by decreasing the formation of atherosclerosis by lowering cholesterol levels in the blood and increase the concentration of high density lipoprotein [8].

Evidences from lipid lowering trials have clearly established that Nonalcoholic fatty liver disease (NAFLD) refers to a wide spectrum of liver diseases ranging from the most common, fatty liver (accumulation of fat in the liver, also known as steatosis), to Nonalcoholic steatohepatitis (NASH, fat in the liver causing liver inflammation), to cirrhosis (irreversible, advanced scarring of the liver as a result of chronic inflammation of the liver). All of the stages of Nonalcoholic fatty liver disease now believed to be due to insulin resistance, a condition closely associated with obesity. In fact, the BMI correlates with the degree of liver damage, that is, the greater the BMI, the greater the liver damage.

Generally, high-fat diets, high sucrose/fructose diets, diets high in saturated fats and restricted in certain essential nutrients, like choline and methionine, have been shown to cause obesity and fatty livers in a number of different strains and species of rodents [9]. High-fat/high-cholesterol western diets induce extreme hypercholesterolemia and also lead to concomitant features of the metabolic syndrome, such as weight gain, decreased HDL levels, obesity, hypertriglyceridemia hyperinsulinemia, and insulin resistance [10], [11]. In addition, these diets generate pathologies independent of atherosclerosis, such as changes in fur and skin integrity, changes in plasma lipids, and hepatic steatosis [12], [13]. This suggests that “overnutrition” might play a role in the genesis of obesity related fatty liver disease and other risk factors associated with metabolic syndrome . Dietary cholesterol has been shown to reduce fatty acid oxidation, which in turn increases the levels of hepatic and plasma triacylglycerols (TG) [14].

Evidences from lipid lowering trials have clearly established that reduction of total cholesterol or low density lipoprotein cholesterol (LDL-C) is associated with decreased risk of atherosclerosis and CHD [15], [16]. The ingestion of polyunsaturated fatty acids present in vegetable oils is inversely related to the incidence of heart diseases by decreasing the cholesterol and triacyglycerol plasmatic levels. Increased adiposity and insulin resistance contribute to the progression from NASH to fibrosis through the development of a profibrotic mileau in the liver, including increased hepatocellular death [17].

Commercial butter is about 80% butter fat and 15% water; traditionally made butter may have as little as 65% fat and 30% water containing high proportion of saturated fat. Saturated fat consists of triglycerides containing only saturated fatty acids having no double bonds between the individual carbon atoms of the fatty acid chain. That is, the chain of carbon atoms is fully "saturated" with hydrogen atoms. [18]. Chemically butterfat consists essentially of a mixture of triglycerides, particularly those derived from fatty acids, such as palmitic, oleic, myristic, and stearic acids. Fats rich in saturated fatty acids can result in the elevation of plasma total and lipoprotein cholesterol [19]. Changes in the diet in terms of fatty acid content

can have a marked effect on lipid profile of blood. The information regarding the effects of butter and estrogen with high fat diet on cardiovascular and hepatic disease is limited.

Therefore, the investigation was made by the application of high fat with estrogen to learn about any alteration in biochemical profile of blood and also in histo-texture liver and skin in mice. The whole work has been designed with the following objectives:

i. To investigate the effects of butter and estrogen on lipid profile of blood.
ii. To study any alteration in hepatic and cutaneous histo-texture following supplementation of butter and estrogen.

2 MATERIALS AND METHODS

The experiment was conducted in the Department of Physiology, Bangladesh Agricultural University, Mymensingh during a period of 3 months from 25 September to 25 December 2013. The details of the experimental approach and methodology are presented in this chapter.

2.1 EXPERIMENTAL DESIGN

One month old 60 (30 male and 30 female) Swiss Albino mice *(Mus musculus)* with an average body weight of 15-18g were used. The mice were randomly divided into 6 equal groups of which 3 groups (M, M_1, M_2) were of male and the remaining 3 groups (F, F_1, F_2) were into the female. Each group consisted of 10 mice (n=10). All groups were supplied with standard broiler pellet (5gm/mice/day) and fresh drinking water was given ad libitum throughout the experimental period of 90 days. Group M from male and group F from female were kept as control and animals were fed with normal broiler pellet. Mice of group M_1 and F_1 were fed with 20% butter with feed. Group M_2 and F_2 were fed with conjugated estrogen at a dose rate of 10 µg/mice/day with water. Body weight, biochemical profile, was measured and histopathological observation was made in the course of study (Figure 2.1).

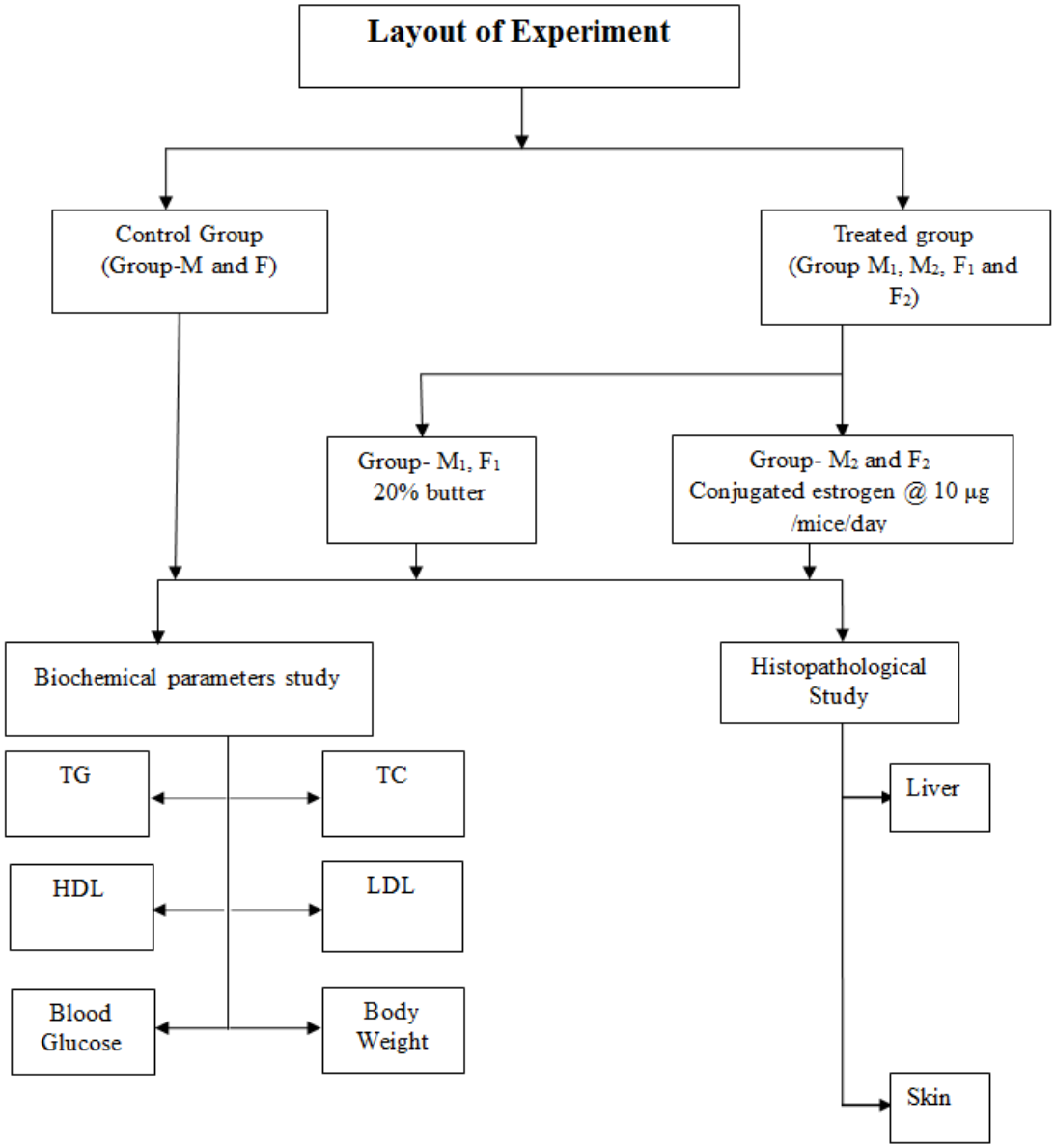


Figure 2.1: Layout of the experimental design

2.2 EXPERIMENTAL ANIMALS

The mice were purchased from ICDDR, B, Mohakhali, Dhaka. Before being used in the experiment, mice were adapted for 7 days in order to acclimatize in the environment. All groups were housed in a compartmentalized rectangular metallic cages (9× 11 ×7 cubic inches) wrapped with wire mesh. The cages were kept in well ventilated room at 28 $\pm 2^0$C and a relative humidity of 70-80% with natural day and light. The experimental laboratory was cleaned and washed at a regular interval.

2.3 EXPERIMENTAL DIET

Commercial Broiler pellet (HI-PRO-VITE feed) was collected from local feed market in Mymensingh.

Table 2.1: Composition of the HI-PRO-VITE feed (kg/100kg)

Ingredients	Amount (%)
Maize	56.70
Rice polish	16.92
Soybean meal	4.78
Fish meal	7.14
Limestone	0.50
Common salt	0.25
DCP	0.25
DL-methionine	0.06
Broiler premix	0.05
Crude protein (%)	18.40
Calcium (%)	0.09
Total phosphorus (%)	0.76
Lysine (%)	0.85
Methionine	0.38
Tryptophan (%)	0.27

Butter was collected from local market, Bangladesh Agricultural University (BAU), Mymensingh.

2.4 EXPERIMENTAL DRUGS

Tablet Estracon® (Conjugated Estrogen @0.625mg/tablet) from Renata were used to evaluate the role of high fat diet and Estrogen supplementation.

2.5 MANAGEMENT PRACTICES

The cages were kept in a well-ventilated room. In order to prevent spoilage feeds were kept in poly packed sac. The feed and fresh drinking water were supplied daily to the mice. Mice cages were cleaned regularly. Proper hygienic and sanitary measures were also taken during the experimental period. Feces were removed regularly.

2.6 COLLECTION OF BLOOD

On the 1st day (after acclimation) and at the end of the experiment, blood sample was collected by sacrificing the mice. After giving anaesthesia the mice were placed inside the air tight container one by one containing cotton soaked with chloroform. Then they were taken out of the container for blood collection. The abdominal cavity and thoracic cavity were opened surgically and blood was collected directly from the heart with the sterile syringe and needle. About 1ml of blood from the syringe was taken in the test tube containing anticoagulant (3.8% Na citrate solution) for hematological studies. The remaining amount of blood of syringe was used for collection of serum.

2.7 PREPARATION OF SERUM

2 ml of blood was collected in the sterile glass test tube. The blood containing tubes were placed in slanting position at room temperature for 1 hour. Then the clot was detached from the wall of the syringe carefully and allowed it to settle down and afterward serum was collected. Collected serum was centrifuged at 1500 rpm for 15 minutes to obtain clear serum and then stored at -20^{0}C temperature until being used.

2.8 BIOCHEMICAL STUDIES

The biochemical parameters of serum Total Cholesterol, Triglyceride, HDL, LDL, Blood glucose.

2.8.1 DETERMINATION OF TOTAL SERUM CHOLESTEROL

The cholesterol was determined using the procedure described by [20]; 10 µl ready serum sample was taken in each cuvette (1 cm light path) with the help of micropipette. Then 1000 µl reagent was taken to each cuvette and mixed thoroughly by shaking. The cuvettes were incubated at 37^0C for 5 minutes. After incubation, each mixture was placed in the Biochemistry Humalyzer-3000 (Human type, Germany) against the blank reagent at 500 nm, 546 nm wave length. Then result was recorded from display. The result was expressed in mg/dl.

2.8.2 DETERMINATION OF TRIGLYCERIDES

The triglycerides were determined after enzymatic hydrolysis with lipases. The indicator is a quiononeimine formed from hydrogen peroxide, 4- aminophenazone and 4-chlorophenol under the catalytic influence of peroxidase. The triglyceride of blood serum is determined by Biochemistry Humalyzer-3000 (Human type, Germany) according to the technique described by [20]. This procedure is similar to total serum cholesterol. The result was expressed in mg/dl.

2.8.3 DETERMINATION OF HDL CHOLESTEROL

Two hundred µl serum samples was mixed with 500 µl diluted precipitant in the test tube. Then the mixture was allowed to sit for 10 minutes at room temperature and then centrifuged for 10 minutes at 4000 rpm. 100 µl clear supernatant was separated within two hours in such way 20 supernatant was from 20 serum sample. 100µl supernatant was taken in the cuvette (1 cm light path) by micropipette. Then 1000 µl reagent (Cholesterol) was mixed with supernatant by shaking. After mixing the mixture was incubated in Reflectron ® Humalyzer 3000 (Human type, Germany) for 5 minutes at 37^0C. Then the mixture was placed in the Reflection ® against the blank reagent at a wave length of 500 nm. Then result was recorded in mg/dl which displayed in the Biochemistry Humalyzer-3000 (Human type, Germany). The result was expressed in mg/dl.

2.8.4 DETERMINATION OF LDL CHOLESTEROL

The LDL was determined by subtracting the HDL cholesterol value from the subtracted value of triglyceride from total serum cholesterol that was divided by five.

$$\text{LDL-C} = \frac{\text{Total serum Cholesterol} - \text{Triglycerides}}{5} - \text{HDL-C}$$

2.8.5 DETERMINATION OF BLOOD GLUCOSE

Procedure

The Blood glucose was determined after enzymatic hydrolysis with amylases. The blood glucose is determined by Biochemistry Humalyzer-3000 (Human type, Germany) according to GOD TAT method. The result was expressed in mg/dl.

2.9 HISTOPATHOLOGICAL PROCEDURE

Histopathological examination was performed in the Department of Anatomy and Histology, BAU, Mymensingh. Fixed tissue sections were processed, paraffin-embedded, sectioned and were routinely stained with Hematoxylin and Eosin (H & E) stain as per standard procedure.

2.9.1 COLLECTION OF SAMPLES

On the 90^{th} day of the experiment, liver and aorta from the experimental mice were collected by sacrificing in 10% buffered formalin and used for histopathological study.

2.9.2 PREPARATION OF 10% BUFFERED FORMALIN

Table 2.2: Preparation of 10% buffered formalin

37-40% formalin	100 ml
Distilled water	900 ml
Sodium Phosphate (monobasic)	4 gm.
Sodium Phosphate (dibasic)	6.5 gm.

The above ingredients were mixed thoroughly, preserved in an air tight container split in plastic jar @ 250ml/jar

2.9.3 CHEMICALS REQUIRED

(i) Alcohol (50%, 70%, 80%, 95% & absolute)
(ii) Chloroform
(iii) Paraffin
(iv) Xylene
(v) Distilled water
(vi) Hematoxylin
(vii) Acid alcohol
(viii) Ammonium water
(ix) Eosin

2.9.4 HISTOPATHOLOGICAL EXAMINATION PROCEDURE

Fixed tissue sections were processed for paraffin-embedding, sectioning [21]staining with Hematoxylin & Eosin stain.

2.9.5 PROCESSING OF TISSUES

The formalin fixed tissues were properly trimmed. The tissues were washed overnight under running tap water to remove formalin. The tissues were dehydrated in ascending grades of alcohol.

Table 2.3: Time required for dehydrating tissues

50% alcohol	1 hour
70% alcohol	1 hour
80% alcohol	1 hour
95% alcohol	1 hour

The tissues were cleared in 10% buffered formalin for two changes in chloroform, 1.5 hour in each. The tissues were embedded with melted paraffin wax at 56^0C for two changes, 1.5 hour in each. Paraffin block containing tissue pieces were made using templates. The tissues were sectioned with a microtome at 5 µm thickness, allowed to spread on warm water bath (40^0) containing a small amount of gelatin & taken on oil and grease free glass slides. The slides were air dried and kept in cool place until staining.

2.9.6 STAINING PROCEDURE

2.9.6.1 PREPARATION OF HARRIS HEMATOXYLIN SOLUTION

Table 2.4: Preparation of Harris hematoxylin solution

Hematoxylin crystals	5 gm.
Alcohol (100%)	50 ml
Ammonium or potassium alum	100 ml
Distilled water	100 ml
Mercuric oxide (red)	2.5 gm.

The hematoxylin was dissolved in the alcohol and the alum in the water by the aid of heat. Two solutions were thoroughly mixed and boiled as rapidly as possible. After removing from heat, mercuric oxide was added slowly and reheated to simmer unit it become dark purple. The solution was then removed from heat immediately and plunged the vessel into basin of cold water until become cool. Immediately before using, 2-4 ml of glacial acetic acid was added per 100ml of solution to increase the precision of the nuclear stain. Before using prepared solution was filtered and kept in the dark [21].

2.9.6.2 PREPARATION OF EOSIN SOLUTION (1% STOCK ALCOHOLIC EOSIN)

Table 2.5: Preparation of eosin solution

Eosin Y, water soluble	1gm
Distilled water	20 ml
Dissolved and 95% alcohol	80 ml

WORKING EOSIN SOLUTION

Eosin stock solution	1part
Alcohol, 80%	3 parts

Immediately before use 0.5 ml of glacial acetic acid was added to every 100 ml of stain & stirred.

2.9.6.3 ROUTINE HEMATOXYLIN & EOSIN STAINING PROCEDURE

The tissue sections were deparaffinized in 3 changes of Xyline (3 minutes in each). Rehydrations of the sectioned tissues were done through descending grades of alcohol [22].

Flow chart for Hematoxylin & Eosin staining:

95% alcohol for 2 minutes

↓

80% alcohol for 2 minutes

↓

70% alcohol for 2 minutes

↓

Distilled water for 5 minutes

↓

Staining with Harris Hematoxylin for 15 minutes

↓

Washing in running tap water for 15 minutes

↓

Differentiated in acid alcohol: 2 to 4 dip (1 part HCl in 99 parts 70% alcohol)

↓

The tissue sections were then washed in tap water for 5 minutes.

↓

Blue in ammonia water (2-3 quick dips)

↓

The sections were then stained with eosin for 1 minute.

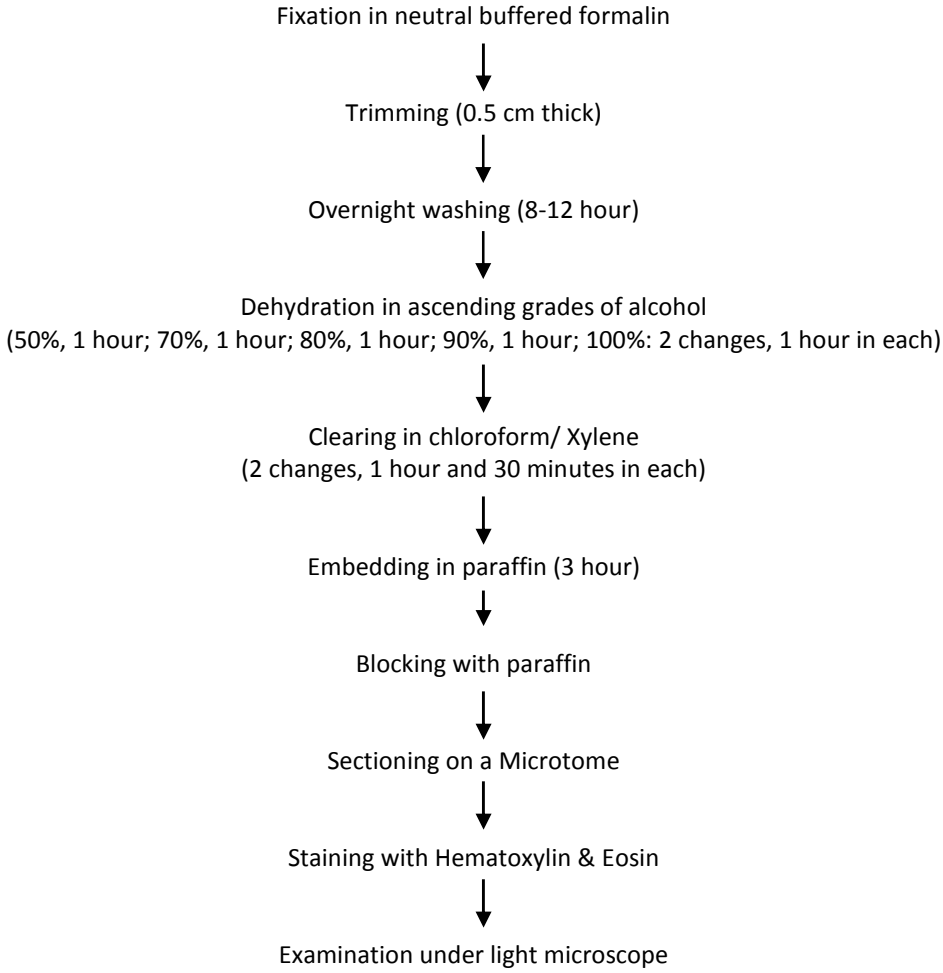
↓

Differentiation & dehydration in 95% alcohol:3 changes (1 dips in each).

↓

The stained sections were then cleaned by 3 changes in Xyline, 5 minutes in each. Finally the sections were mounted with coverslip using DPX.

Flow chart for histopathology:



2.9.7 HISTOPATHOLOGICAL STUDIES AND PHOTOMICROGRAPH

The tissues were examined and photomicrographs were taken in the Anatomy and histology laboratory, BAU, Mymensingh

2.10 STATISTICAL ANALYSIS

All data were expressed as mean ± SD, and differences among the groups of animals were compared using one-way ANOVA with post-hoc Duncans test. Paired t- tests were used to compare pre-treatment and post-treatment value of different groups. Statistical significance was set at $P < 0.05$. Statistical analysis was performed using SPSS software version 17 (SPSS Inc., Chicago, IL, USA.

3 RESULTS

The research work was conducted in 6 groups (each group consisting 10 mice) of mice following dietary supplementation of butter and estrogen. The results of the experiment are presented under the following Tables:

Table 3.1 Effect of butter and estrogen on lipid profile in mice

Sex	Groups	TC (mg/dl)	TG (mg/dl)	HDL (mg/dl)	LDL (mg/dl)	Blood sugar(mg/dl)	Body Weight (g)
		values	values	values	values	values	values
Male	M (Control)	48.74±1.20^{c}	53.60±0.75^{c}	20.05±1.04^{b}	29.37±1.74^{c}	48.26±1.05^{b}	29.87 ±0.35^{b}
	M_1 (Butter)	84.52±1.38^{a}	103.70±0.65^{a}	19.10±1.14^{b}	95.71±1.78^{a}	95.13±1.64^{a}	37.17 ±0.57^{a}
	M_2 (Estrogen)	55.47±1.92^{b}	72.24±0.81^{b}	48.81±1.15^{a}	35.69±2.62^{b}	47.84±1.22^{b}	33.93 ±1.20^{b}
Female	F (Control)	49.27±1.01^{c}	54.11±0.36^{c}	19.16±1.07^{b}	30.89±1.86^{c}	49.35±1.58^{b}	30.37 ±0.65^{b}
	F_1 (Butter)	132.38±1.89^{a}	139.04±1.56^{a}	19.00±1.23^{c}	97.42±3.43^{a}	102.92±1.14^{a}	38.63±0.45^{a}
	F_2 (Estrogen)	54.68±1.81^{b}	75.63±0.98	54.14±1.15^{a}	36.07±1.00^{b}	48.84±1.0^{b}	34.63 ±0.57^{b}

3.1 HISTOPATHOLOGY

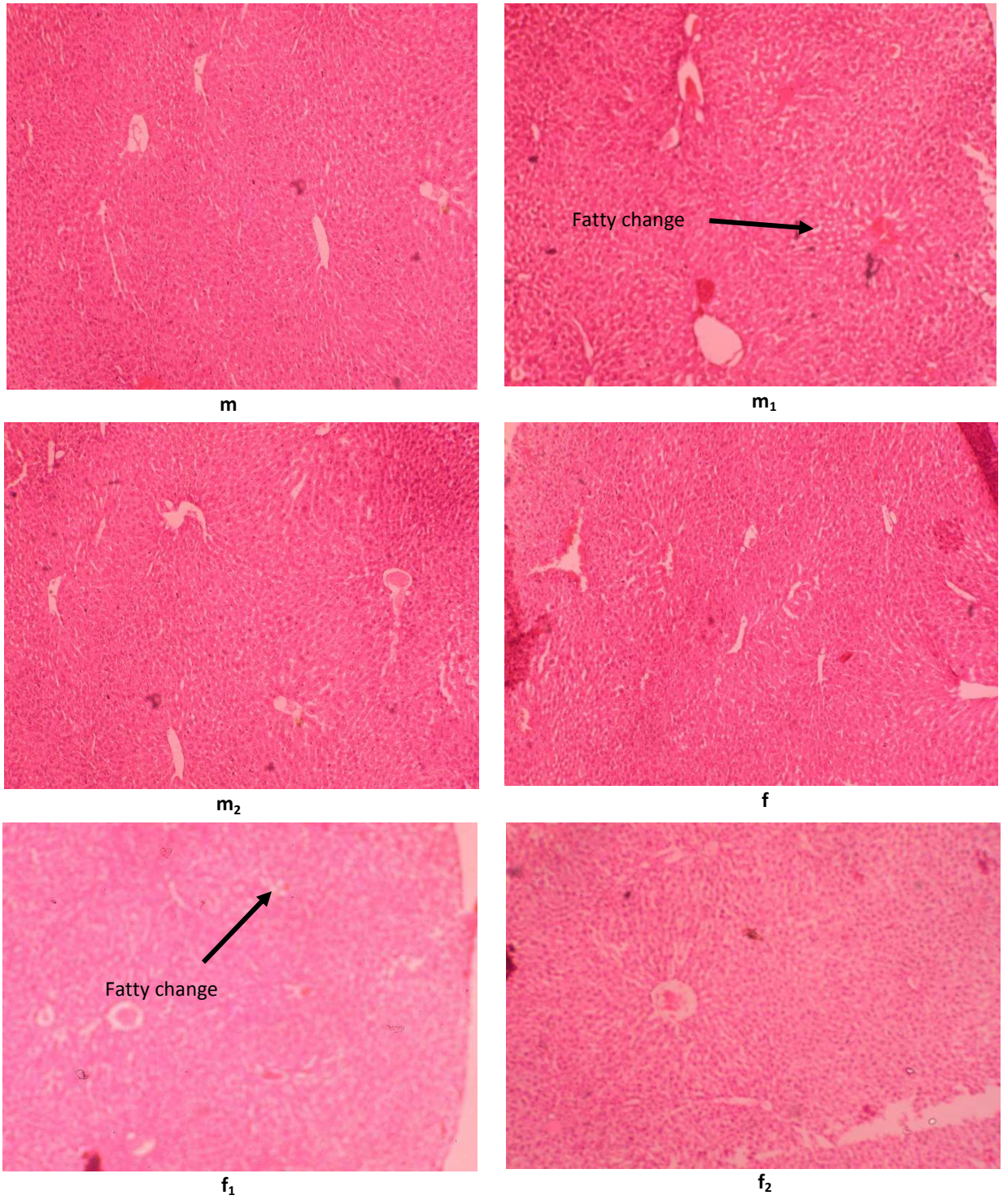


Figure. 3.1 Histopathological section of liver of mice (H & E x 400) (m) Control Male; (m_1) Butter treated male; (m_2) Estrogen treated male; (f) Control female; (f_1) Butter treated female; (f_2) Estogen treated female.

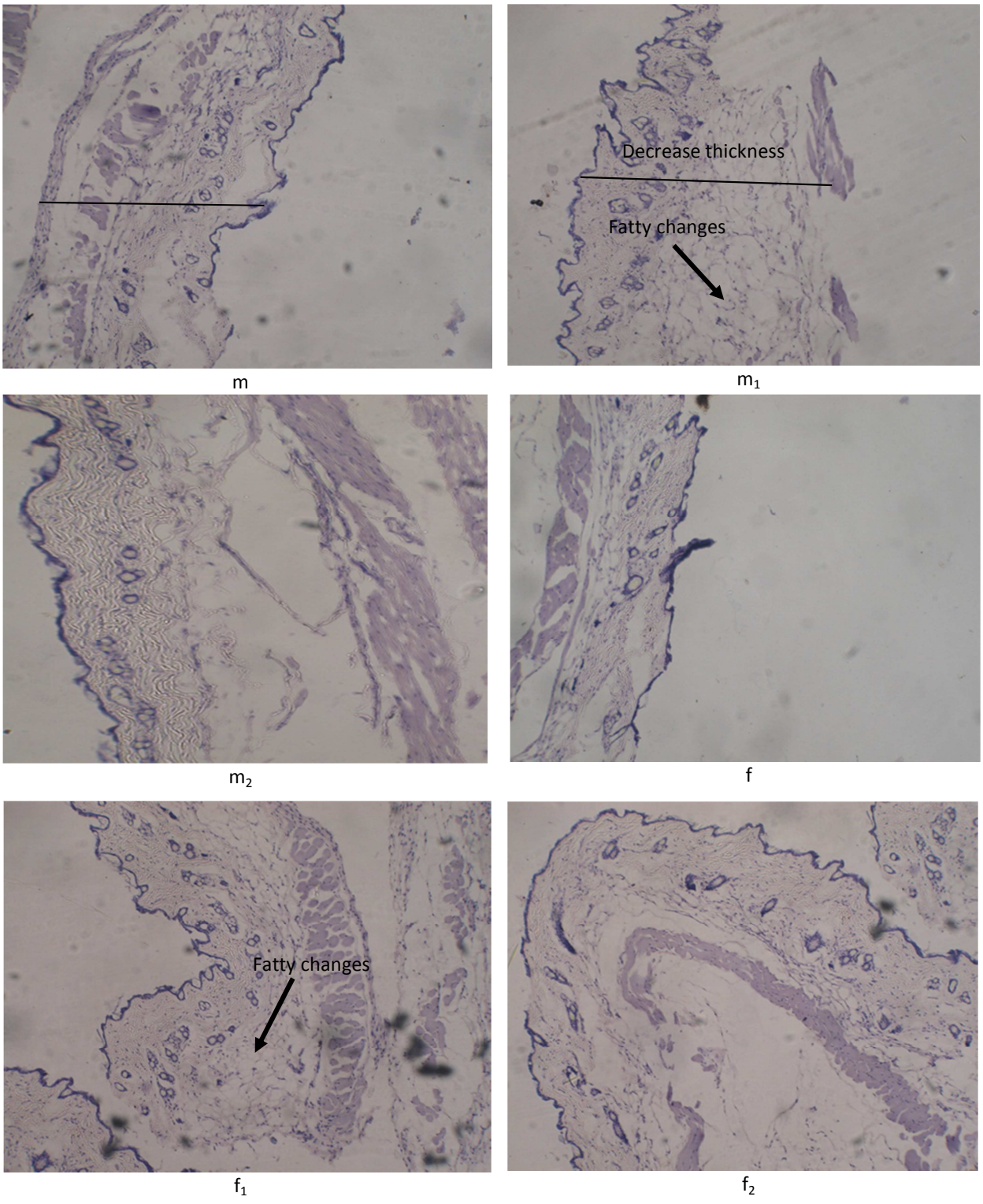


Fig. 3.2 Histopathological section of skin of mice (H & E x 400) (m) Control Male; (m_1) Butter treated male; (m_2) Estrogen treated male; (f) Control female (f_1) Butter treated female; (f_2) Estogen treated female.

4 SUMMARY AND CONCLUSION

The experiment was undertaken in order to investigate the effects of butter and estrogen supplemented diet on lipid profile, blood sugar and histopathology of liver and skin in relation to obesity of mice with a study period of 90 days. One month old 60 (30 male and 30 female) Swiss Albino mice *(Mus musculus)* with an average body weight of 15-18 g were used. The mice were randomly divided into 6 equal groups of which 3 groups (M, M_1, M_2) were of male and the remaining 3 groups (F, F_1, F_2) were into the female. Each group consisted of 10 mice (n=10). Group M and F were considered as control; Group M_1 and F_1 butter treated; Group M_2 and F_2 estrogen treated. Blood samples were collected at the beginning of the study that is on day 1 of the experiment (1 month old mice) and on day 90 i.e. at the end of the study (4 months old) by sacrificing the animals to analyze haematological parameters and blood biochemical profiles. At the end of experiment, histopathological examinations of two selected organs (liver and skin) were performed. The effects of butter and estrogen on blood sugar and lipid profiles of mice varied significantly in the present study.

Among all the treated groups, the mice of groups M_1 and F_1 (butter treated male and female respectively) exhibited significant (P<0.01) increase in body weight compared to the other groups. In lipid profile study, there was significant (P<0.05) changes in butter treated mice (M_1 and F_1). In butter treated mice, blood glucose level was increased significantly in group M_1 and F_1 compared to the other group (P<0.01). In histopathological examinations, significant changes were recorded in the liver and skin of butter treated groups in comparison with the mice of control group. There were fatty changes in skin but there were no tumours as found in high fat diet mice. After successfully completing the trials, among the treated groups; group F_1 and M_1 (butter treated group) showed the maximum body weight and obesity.

The present research findings help in drawing a conclusion that 20% butter supplementation would be able to cause changes in lipid profile, increased body weight and blood sugar level and would also produce degenerative changes in liver and skin.

The present study is a preliminary work on laboratory animal in this area. The study is in limitation due to the period of time, percentage of butter supplementation, amount of estrogen used, environmental facilities, no. of animals used and so on. Hence there remains an intension to perform the study in detail in future with the overcome of the present impediments in order to investigate the combined and counter effect of butter and estrogen in mice that would be able to get a rigid and confirm idea about obesity and its related complications in mammals and that could be used as a model for human.

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GENETIC VARIATION AND RELATEDNESS FOR BLB RESISTANCE IN BRRI RICE USING RAPD MARKERS

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ABSTRACT: In this study, ten BRRI released rice germplasms were used for the purpose of genetic variation and relatedness for BLB resistance in BRRI rice using RAPD markers. Out of ten decamer primers, four were selected finally for a marker-assisted selection program. The primer OPAB02 produced maximum number of bands (10) and showed 60% polymorphic loci. The highest and lowest percentage of polymorphic loci produced by primers S1027 (66.67%) and OPA02 (25%) respectively. In this study the percentage of polymorphic loci was 55.17%. The UPGMA dendrogram based on Nei's genetic distance between different pairs was correlated with their banding pattern. The dendrogram segregated ten germplasms of rice into two main clusters; the main clusters are further divided into sub clusters. BR 10, BR 14, BR 16, BR 26, BRRIdhan29, BRRIdhan32, BRRIdhan33, BRRIdhan34 and BRRIdhan38 formed cluster I whereas BRRIdhan31 comprised the cluster II. In cluster I BR10, BR 14, BR 16, BR 26, BRRIdhan32, BRRIdhan33, BRRIdhan34 BRRIdhan38 formed sub-cluster I and BRRIdhan 29 formed sub- cluster II. Sub-cluster I further divided into two sub-sub clusters based on similar banding pattern and minimum genetic distance. BR14 and BRRIdhan 32 had same banding pattern and lower genetic distance so were in same cluster. BR10, BR16, BRRIdhan33 and BRRIdhan34 were placed in same group due to their banding similarity, intergermplasm similarity and low genetic distance. Thus, RAPD perform a potentially simple, rapid and reliable method to evaluate genetic diversity and molecular characterization as well.

KEYWORDS: Genetic variation, Relatedness, BLB resistance, BRRI rice and RAPD marker.

1 INTRODUCTION

Rice (*Oryza sativa L.) (*2n = 24) belonging to the family *Graminae* and subfamily *Oryzoidea* is the staple food for one third of the world's population, it occupies almost one-fifth of the total land area covered under cereals [1]. It is a major source of food for more than 2.7 billion people on a daily basis and is planted on about one-tenth of the earth's arable land [2]. Being a major staple food, over 85 percent of the total, or 402 million tonnes, are estimated to be destined for human consumption [3]. The total area and production of rice in Bangladesh is about 11.7 million hectares and 31.98 million metric tons, respectively [4]. In Bangladesh, it is not only the main source of carbohydrate but also provides 75% of the calories and 55% of the proteins in the average daily diet of the people.

Blight refers to a specific symptom affecting plants in response to infection by a pathogenic organism. It is simply a rapid and complete chlorosis, browning and then death of plant tissues such as leaves, branches, twigs, or floral organs. Accordingly, many diseases that primarily exhibit this symptom are called blights. Bacterial leaf blight (BLB) caused by the rod-shaped bacterium, *Xanthomonas oryzae pv. oryzae (Xoo)* is one of the most devastating diseases in rice is an important disease throughout Asia [5]. It is a vascular disease whereby *Xoo* continues to grow until the xylem vessels are clogged with

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bacterial cells and extracellular polysaccharides [6]. The use of resistant cultivars is the most promising control method against the disease.

Most breeders are interested in utilizing BLB resistant varieties, and this goal is certainly achievable providing the availability of an easy strategy to identify resistance genes. The boro rice cultivar BR 14 showed resistance to five Japanese races I (T7174), II (T7147), III (T7133), IV (H75373Y), V (H75304) of *X. oryzae pv. Oryzae* [7]. In this study BR14 was taken as BLB resistant variety. At present, biotechnology progress continuously. Identification, cloning, and functional analyses of a gene can be performed relatively rapidly. As on date, 30 major genes have been reported to confer resistance against the rice bacterial pathogen *X. oryzae pv oryzae (Xoo),* which included 21 dominant and 9 recessive R genes [8]**.** The majority of BLB resistance genes were identified in rice *O. sativa* ssp. indica and wild rice *O.longgistaminata*, *O. rufiprogon*, *O. minuta* and *O. officinalis*, while some of them were identified in *O. sativa* ssp. japonica [9]. Some resistance genes are effective only in adult plants, while others are effective at all stages of growth. Some genes confer resistance to a broad spectrum of *Xoo* races, whereas others do so against only one or a few races. This observation could be influenced by particular geographical locations [10]. Several rice resistance genes are expressed at the highest level only in the adult stage [11]. *Xa21*-mediated resistance gene was shown to be expressed since the seedling stage but the plants were found susceptible, and *Xa7* gene showed broad resistance only in adult plants. On the contrary, *xa5* gene could confer resistance at all growth stages.

Molecular markers are the molecules that could be used to trace a desired gene(s) in test genotypes. In fact, a piece of DNA or a protein can be used as a marker that is readily detected and whose inheritance can easily monitor. However, DNA markers seem to be the best candidates for efficient evaluation and selection of plant material. Recently the concept of marker aided selection has provided an advantage of molecular marker based approaches for crop improvement as compared to selection based solely on phenotype [12]. Availability of a large number of polymorphic markers enables precise classification of the cultivars and available germplasm collections. Several molecular markers viz. RFLP [13] [14], RAPD [15] [16] SSRs, ISSRs [17], AFLP [18] [19] and SNPs [20] are presently available to assess the variability and diversity at molecular level [21]. With the development of a wide range of molecular techniques, marker assisted breeding is now used to enhance traditional breeding programs to improve crops [22].

RAPD stands for random amplification of polymorphic DNA. It is a type of PCR reaction, but the segments of DNA that are amplified are random. Advantages associated with RAPDs have made them a favourite marker technique in genome mapping, the determination of phylogenetic relationships, genetic diversity, and identification of cultivars and parents in a number of plant species. Since the RAPD technique involves enzymatic amplification of target DNA by PCR using arbitrary primers, it is also called Arbitrarily Primed Polymerase Chain Reaction (AP-PCR) or DNA Amplification Fingerprinting (DAF).In this study RAPD marker was used as it is important particularly for variety selection among ten HYV rice germplasms. The specific objectives of the study were as follows:

- Screening of BRRI released rice against BLB resistance.
- To establish the genetic relationship between BLB resistant BR14 and rest of the rice germplasms at molecular level.
- Molecular genetic analysis of ten rice germplasms to observe genetic variation among them was using RAPD.

2 MATERIALS AND METHODS

The experiment was carried out at the USDA Biotechnology Laboratory, Department of Biotechnology, and central laboratory of Bangladesh Agricultural University, Mymensingh.

2.1 STUDY MATERIAL

Ten germplasms of Rice viz. BR 14, BRRIdhan 29, BR 10, BR 16, BRRIdhan 31, BRRIdhan-32, BRRIdhan 33, BRRIdhan 34, BR26 and BRRIdhan 38 were used in the study were collected from Bangladesh Rice Research Institute.

2.2 ISOLATION OF RICE GENOMIC DNA

Genomic DNA of 10 rice germplasms were collected from USDA Biotechnology laboratory, department of Biotechnology, Bangladesh Agricultural University, Mymensingh, preserved at -20^0 C.

GENOMIC DNA EXTRACTION

To extract genomic DNA, young, actively growing fresh leaves were collected from 20 day old seedlings. DNA extraction was done by using the mini preparation Modified CTAB method. Collected leaf samples were cut into 2-3 cm pieces, 670 µl extraction buffer and 40 µl 20% SDS were added. Incubated for 10 minutes at 65^0C. 100 µl 5M NaCl was added and inverted gently. 100 µl CTAB was added and was incubated for 10 minutes at 65^0C. 900 µl chloroform (chloroform: isoamylalcohol = 24:1) was added and mixed well. Spinned for 5 minutes at 12000 rpm then transferred the supernatant in new tube. 600 µl ice cold isopropanol was added into new eppendorf tubes and inverted slowly for 5 minutes. The eoppendorf tubes were centrifuged at 12000 rpm 10 minutes and decanted the supernatant. Pellets were washed with 200 µl of 70% ethanol and removed the ethanol then the samples were kept for air- drying for overnight. The pelletes were resuspended in 30µl 1X TE buffer. Extrated DNA samples checked by using 0.8% agarose gel electrophoresisand quantified by using a spectrophotometer.

REAGENTS USED FOR THE EXTRACTION OF GENOMIC DNA

i. Extraction buffer (pH = 8.0), 50 mM Tris-HCl , 25 mM EDTA (Ethylene diamine tetra acetic acid) , 300 mM NaCl and 1% SDS (Sodium Dodecyl Sulphate)

ii. Phenol: Chloroform: Isoamyl alcohol = 25: 24: 1 (v/v/v); equilibrated to pH near 8.0 with TE buffer, iii. TE (Tris-EDTA) buffer, pH = 8.0 (10 mM Tris-HCl 1 mM EDTA) iv. Sodium acetate (3 M), pH = 5.2 v. Absolute (100%) Ethanol

2.3 CONFIRMATION OF DNA PREPARATION

DNA samples of ten rice germplasms were evaluated by performing (1%) agarose gel electrophoresis.

2.3.1 PREPARATION OF AGAROSE GEL (1%) FOR ELECTROPHORESIS

REAGENTS: Agarose powder (Fisher Biotech, USA), 5X TBE Buffer (pH 8.3): Composition (For 1000 ml); Tris: 54 g (Sigma, USA), Boric Acid: 27.5g (SRL, India), EDTA: 4.65 g (Loba chemie, India)**,** 1X TBE buffer (200 ml): 20 ml 5X TBE buffer was added to 180 ml ddH_2O to make total volume 200 ml and Ethidium Bromide (SRL, India)

PROCEDURE

For preparing 1% gel, 1.5 g agarose powder (Fisher Biotech) was taken into a 500 ml Erlenmeyer flask containing 250 ml of I x TBE buffer prepared by adding 50 ml of 5 x TBE buffer in 200 ml of sterile deionized water. To prevent excessive evaporation, the top of the flask was covered with aluminium foil paper. The flask was cooked into a microwave oven for about 5 minute to dissolve agarose into TBE buffer. Then the gel was kept in room temperature for 10-15 min to cool down at tolerable level. Then the gel was poured on to the gel bed (15 x 15 x2 cm 3 in size) that was placed on a level bench and the appropriate comb was inserted and finally, the bubbles were removed. Meanwhile, the gel became completely cooled and solidified and comb was removed gently.

2.3.2 DNA SAMPLE PREPARATION AND ELECTROPHORESIS PROCEDURE

The hardened gel was transferred to the electrophoresis chamber and keeping the gel horizontal and containing sufficient 1X TBE buffer to cover the gel ~1mm. For each sample, 2 µl of water was placed on a piece of aluminum foil paper and 1 µl loading dye (0.25% xylene cyanol, 0.25% bromophenol blue, 30% glycerol and I mM EDTA) was added to it using 0.5-10 µl adjustable micropipette. Loading buffer was used for monitoring loading and the progress of the electrophoresis and to increase the density of the sample so that it was stayed in well. Finally, 3 µl extracted DNA was added to it and mixed well using same micropipette. The samples were then added slowly to allow them to sink to the bottom of the wells. The gel was placed in the gel chamber containing I x TBE buffer. The final level of the buffer was -5 mm above the gel. The electrophoresis apparatus were then connected to the Power Supply and turned on to migrated the DNA from negative to positive electrode (Black to Red). Electrophoresis was carried out at l20 v for 1.20 hour to get the dye 1/4 of the gel length. When DNA migrated sufficiently, as judged from the migration of bromophenol blue of loading buffer, the power supply was switched off. 6 µl ethidium bromides (10 mg/ml) DNA stain was added to make the DNA visible under UV transilluminator and mixed well by gentle shaking for 20 minutes.

2.3.3 DOCUMENTATION OF THE DNA SAMPLES

After electrophoresis, the gel was taken out carefully from the gel chamber and the gel gently washed in running water and placed on the UV transilluminator in the dark chamber of the image documentation system (Labortechnik. Germany). The UV light of the system was switched on; the image was viewed on the monitor, focused, acquired and saved in a floppy disc, as well as printed on thermal paper. The electrophoregram of DNA of 10 rice germplasms.

2.4 QUANTIFICATION OF DNA CONCENTRATION

One of the important variables for PCR amplification is the concentration of genomic DNA. Because different DNA extraction methods produced DNA of widely different purity, it is necessary to optimize the amount of DNA used in the RAPD -assay to achieve reproducibility and strong signal. Excessive genomic DNA may result in smears or in a lack of clearly defined bands in the gel; on the other hand, too little DNA gives nonreproducible patterns [23]. Thus, it is necessary to optimize the DNA concentration. It is best to do a series of RAPD reaction using a couple of primers and a set of serial dilutions of each genomic DNA to identify empirically the useful range of DNA concentration, for which reproducible RAPD patterns are obtained.

For quantification of DNA concentration, the spectrophotometer's (Spectronict Genesis™, New York, USA) wavelength was set at 260 nm after the spectrophotometer UV lamp was warmed up. A square cuvette was filled with 2 ml sterile distilled water and place in the cuvette chamber and the absorbance reading was adjusted to zero for standardization. The test samples were prepared by taking 2 ul of each DNA sample in the cuvette containing 2 ml sterile distilled water and through mixing by pipetting. After recording the absorbance reading, the cuvette was rinsed out with sterile water, stamped out on a paper wipe, and absorbance readings for each sample was recorded in this way and are listed in Table 1. Using the absorbance reading, the original sample concentration was determined according to the following formula:

$$\text{Absorbance} \times \frac{\text{Volume of distilled water}(\mu l)}{\text{Amount of DNA sample}\,(\mu l)} \times \text{Conversion factor}\,(0.05) \times 1000$$

Table 1. Absorbance reading and concentration of different DNA samples at 260 nm (A)

Accession No.	Absorbance	DNA Conc. (ng/ µl)
1. BR14	0.015	750
2. BRRIdhan 29	0.005	250
3. BR10	0.010	500
4. BR16	0.007	350
5. BRRIdhan31	0.014	700
6. BRRIdhan32	0.010	500
7. BBRIdhan33	0.008	400
38. BRRIdhan34	0.007	350
9. BR26	0.006	300
10. BRRIdhan38	0.006	300

2.5 AMPLIFICATION OF RAPD MARKERS BY POLYMERASE CHAIN REACTION (PCR)

To perform amplification of RAPD, a single oligonucleotide of arbitrary DNA sequence is mixed with genomic DNA in the presence of a thermostable DNA polymerase and suitable buffer, and then subjected to temperature cycling conditions typical to the polymerase chain reaction (PCR). The products of the reaction depend on the sequence and the length of the oligonucleotide, as well as the reaction conditions. The reaction involves repeated cycles, each consisting of a denaturation, a primer annealing and an elongation step. In the first step, the DNA is made single stranded by raising the temperature to 94°C (denaturation). In the second step, lowering of the temperature to about an optimal (36°C) annealing temperature, the primer binds to their target sequences on the template DNA (annealing step). In the third cycle, temperature is chosen as where the activity of the thermos table Taq DNA polymerase is optimal, i.e., usually 72°C. The polymerase then extends the 3' ends of the DNA primer hybrids towards the other primer-binding site. Since this happens at both primer-annealing sites on both the DNA strands, the target fragment is completely replicated. Repeating these three cycles 40 to 50 times results in the exponential amplification of the target between the 5' ends of the two primer binding sites. Amplification products are separated by agarose gel electrophoreses and visualized by ethidium bromide staining.

2.5.1 PRIMER SELECTION

Ten primers of random sequence (Primer code- S1027, S1069, S1089, S1136, S1155, S1184, S1320, OPA02, OPAB02, and OPA320) were screened on a sub sample of two randomly chosen individuals from ten different cultivars to evaluate their suitability for amplifying DNA sequences, which could be accurately scored. Primers were selected on the basis of band resolution intensity, presence of smearing, consistency within individuals and potential for population discrimination.. Final subset of three primers exhibiting good quality banding patterns and sufficient variability were selected for further analysis. The details of the primers are given in (Table 2).

2.5.2 REACTION MIX PREPARATION TO PERFORM PCR

Conditions for RAPD, amplification reactions were maintained essentially following [24] with some modifications. PCR reactions were performed on each DNA sample in an l0µl reaction mix containing the following reagents: Taq polymerase buffer = 1 µl, dNTPs = 1 µl, Primers = 2 µl, $MgCl_2$ = 0.6 µl, Template DNA = 1.5 µl, Taq DNA polymerase = 0.2 µl and ddH_2O = 3.7 µ.

Table 2: Parameters of random primers used in the study for screening

SL.No.	Primer code	Sequence	GC Content (%)
1	S1027	ACGAGCATGG	60
2	OPA02	TGCCGAGCTG	70
3	S1155	GAAGGCTCCC	70
4	OPAB02	GGAAACCCCT	60

DNA amplification was performed in an oil-free thermal cycler (Master Cycler Gradient, Eppendorf). The reaction mix was preheated at 94°C for 3 minutes followed 40 cycles of 1 min denaturation at 94°C, 1 min annealing at 36°C and elongation or extension at 72°C for 2 minutes. After the last cycle, a final step of 7 minutes at 72°C was added to allow complete extension of all amplified fragments. After completion of cycling program, reactions were held at 4°C.

2.5.3 ELECTROPHORESIS OF THE AMPLIFIED PRODUCTS AND DOCUMENTATION

For each sample, 2 µl loading dye was added with the PCR products.The amplified products were separated electrophoretically on 1.4 % agarose gel. The gel was prepared using 1.4g agarose powder (Fisher Biotech, New Jersey, USA), 100 ml 1 x TBE buffer. Agarose gel electrophoresis was conducted in Ix TBE buffer at 120 V for 1.30 hour. One molecular weight marker 1 kb DNA ladder size and 20bp were electrophoresed along side the RAPD reactions. After completion of gel run 10 ul ethidium bromide mixed in water, gel was kept in this mixture for 20 minutes. DNA bands were observed under UV light on a Transilluminator and photographed by image documentation system (Labortechnik, Germany).

2.6 RAPD DATA ANALYSIS

This was used to estimate polymorphic loci, Nei's [25], gene diversity, population differentiation, (G_{ST}), gene flow (N_m), genetic distance (GD) and to construct a UPGMA (Unweighted Pair Group Method with Arithmetic Means) dendrogram among populations using a computer program, POPGENE (Version 1.31) [26].

Genetic-similarity values defined as the fraction of shared bands between the RAPD profiles of any two individuals on the same gel were calculated manually. RAPD markers of the same molecular weight on the data matrix according to the following formula:

Similarity index (SI) = $2\ N_{xy}/\ (N_x + N_y)$

Where, Nxy is the number of RAPD bands shared by individuals x and y respectively, and NX and NY are the number of bands in individual x and y, respectively [27] [28] [29].

3 RESULTS

3.1 PRIMER SELECTION AND RAPD PATTERNS

Ten rice germplasms collected from BRRI (Bangladesh Rice Research Institute), were analyzed as a group and a total of 29 RAPD bands were scored (Figure 1and 2). 10 primers were initially screened for their ability to produce polymorphic patterns and 4 primers (S1027, OPA02, S1155, and OPAB02) which gave reproducible and distinct polymorphic amplified products were selected. The selected 4 primers produced comparatively maximum number of high intensity band with minimal smearing.

The four primers showing good technical resolution and sufficient variation among different cultivars produced a total of 29 RAPD markers of which the number of polymorphic loci is 16. The percentage of polymorphic loci is 55.17 (either occurring in or absent in less than 29 of all individuals). The highest numbers of bands were generated by primer OPAB02 (10) showing 60 % polymorphic loci. On the other hand the lowest numbers of bands were produced by primer OPA02 (4). The percentage of polymorphic loci was higher for primer S1027 (66.67%) whereas the percentage was lower for primer OPA02 (25%). The average scorable and polymorphic bands produced by the four primers were 7.25 and 4 respectively (Table 3). Weak bands result from low homology between the primer and the pairing site on the DNA strand. Size range of PCR amplification products scored and banding patterns of 10 Rice germplasms using primers S1027, OPA02, S1155, and OPAB02 mentioned in table 3.

3.2 FREQUENCY OF POLYMORPHIC LOCI

The DNA polymorphisms were detected according to the presence and absence of bands. Absence of bands may be caused by failure of primers to anneal a site in some individuals due to nucleotide sequence differences or by insertions or deletions in primer sites [30]. Table 4 shows overall gene frequency. Here gene frequency values less than 1.0000 (< 1.0000) were considered as polymorphic. Among 29 loci, 16 had a value less than 1.0000 thus showed polymorphism.

3.3 INTER-GERMPLASM SIMILARITY INDICES (SIJ)

The pair-wise inter-germplasm similarity indices (Sij) ranged from 70.63 to 100%. The highest similarity index (100%) was found between BR 16 Vs BRRI dhan 33 (100%), while BR14 Vs BRRI dhan 31 showed the least inter-germplasm similarity (70.63%). Among the four primers, OPA02 showed highest inter-germplasms (95.128%) similarity whereas OPAB02 showed the least value of inter-germplasm similarity index (85.863%) (Table 5).

3.4 GENETIC DIVERSITY FOR FOUR PRIMERS IN ALL SAMPLES

Genetic diversity values of 10 rice genotypes for 4 primers are given in Table 6. Average gene diversity **(**h) and Shannon's Information index (I) across all primer against genotypes for all loci was found 0.1559 and 0.2472 respectively. High level of gene diversity was found for primer S1155 whereas the gene diversity value for primer OPA02 was low. Both locus S1155-1 and OPAB02-1 showed high level of gene diversity value and Shannon's Information index (4800) and (0.6730) respectively. Lowest level of gene diversity value and Shannon's Information index (0.0000 and 0.0000) was found in locus S1027-4, S1027-5, OPA02-1, OPA02-2, OPA02-4, S1155-6, S1155-7, S1155-8, S1155-9, OPAB02-4, OPAB02-5, OPAB02-6, OPAB02-7 (Table 6).

Table 3. RAPD primers with corresponding bands scored together with observed in polymorphic bands ten Rice germplasms

Primer codes	Total number of bands scored	Number of polymorphic bands	Polymorphic Loci (%)
S1027	6	4	66.67
OPA02	4	1	25
S1155	9	5	55.56
OPAB02	10	6	60
Overall	29	16	220.68
Average	7.25	4	55.17

In the present study the percentage of polymorphic loci was 55.17%. A diverse levels of polymorphism in rice genotypes were reported by [31] 53. 85%, [32] 95.65%, [33] 95.33%, [34] 90%, [35] 72.2%, [36] 94.36%, [37] 83.5%, [38] 74.1%.

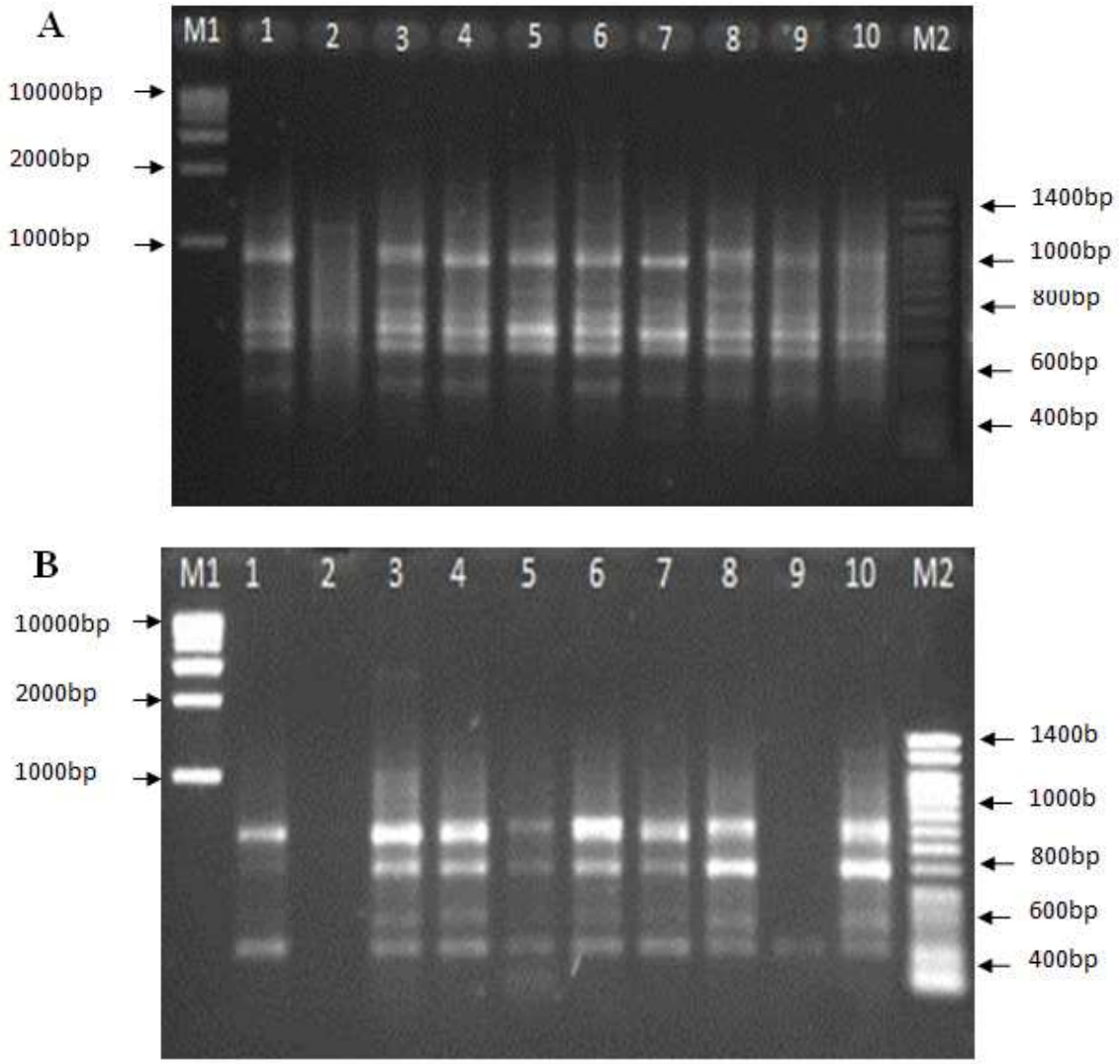


Figure 1: RAPD profile of 10 rice germplasms, Primer S1027 (A) OPA02 (B). (1-BR 14; 2-BR 29; 3- BR 10; 4-BR 16; 5- BRRIdhan31; 6-BRRIdhan32; 7- BRRIdhan33; 8-BRRIdhan34 ; 9-BR 26; 10-BRRIdhan 38; M1-1 kb DNA ladder, M2- 20bp DNA ladder).

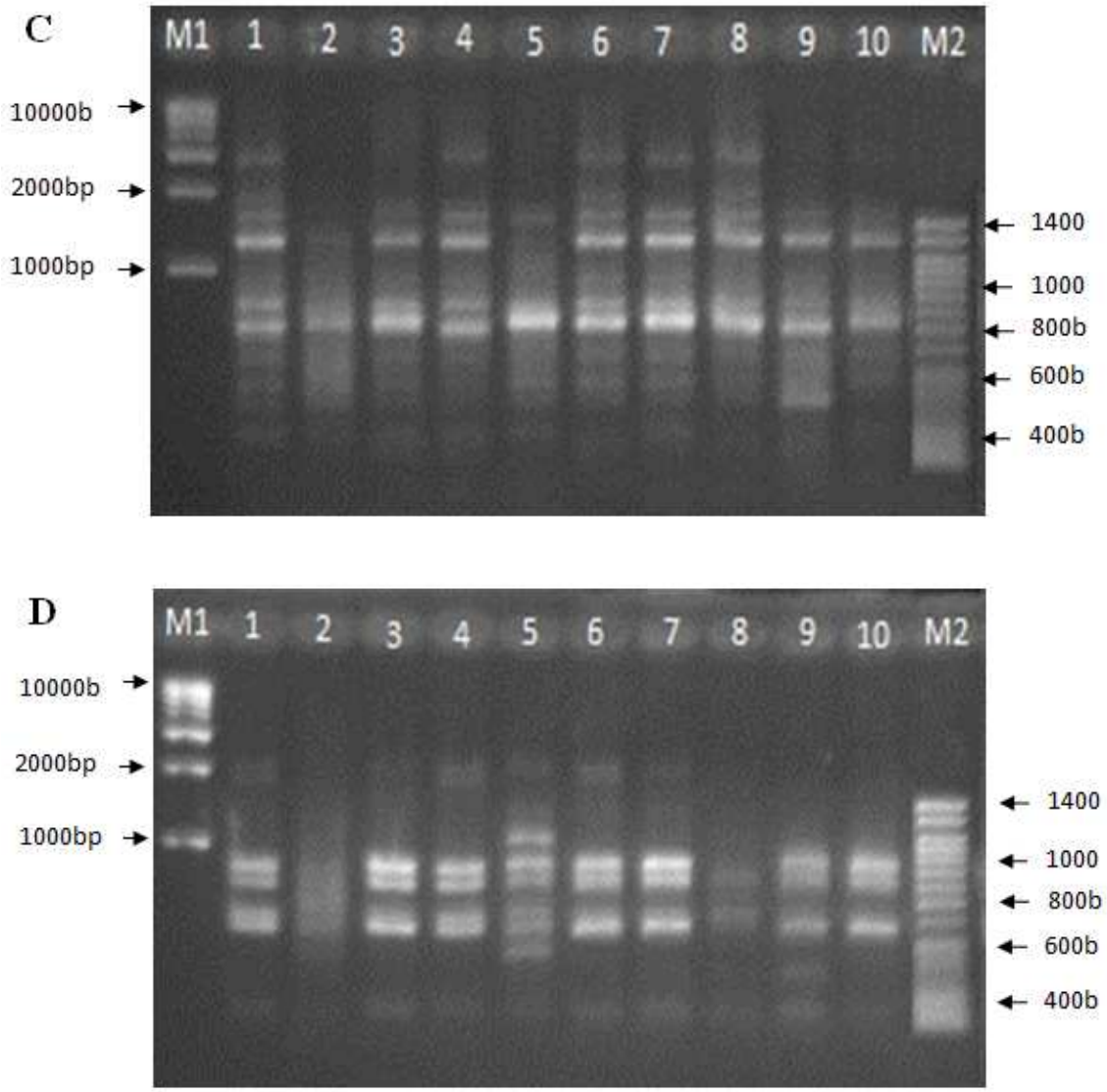


Figure 2: RAPD profile of 10 rice germplasms, Primer S1155 (C) and primer OPAB02 (D). (1-BR 14; 2-BR 29; 3- BR 10; 4-BR 16; 5-BRRIdhan31; 6- BRRIdhan32; 7- BRRIdhan33; 8- BRRIdhan34; 9-BR 26; 10-BRRIdhan 38; M1- 1kb DNA ladder, M2- 20bp DNA ladder).

Table 4. Overall Gene Frequency

Primer	**Gene Frequency**					
S1027	S1027-1 0.8000	S1027-2 0.9000	S1027-3 0.7000	S1027-4 1.0000	S1027-5 1.0000	S1027-6 0.8000
OPA02	OPA02-1 1.0000	OPA02-2 1.0000	OPA02-3 0.8000	OPA02-4 1.0000		
S1155	S1155-1 0.9000	S1155-2 0.9000	S1155-3 0.2000	S1155-4 1.0000	S1155-5 0.6000	S1155-6 0.3000
	S1155-7 1.0000	S1155-8 1.0000	S1155-9 1.0000			
OPAB02	OPAB02-1 0.6000	OPAB02-2 0.1000	OPAB02-3 0.1000	OPAB02-4 1.0000	OPAB02-5 1.0000	
	OPAB02-6 1.0000	OPAB02-7 1.0000	OPAB02-8 0.1000	OPAB02-9 0.1000	OPAB02-10 0.9000	

Table 5. Inter-germplasm similarity indices

Germplasm	Band Sharing Values (100%)				
	Primer S1027	Primer OPA02	Primer S1155	Primer OPAB02	Average
BR14 Vs BRRIdhan 29	75	85.71	62.5	80	75.8
BR14 Vs BR10	90.91	85.71	80	100	89.15
BR14 Vs BR16	91	85.71	87.5	100	91.05
BR14 Vs BRRIdhan 31	80	100	62.5	40	70.63
BR14 Vs BRRIdhan 32	91	85.71	100	100	94.17
BR14 Vs BRRIdhan 33	91	85.71	87.5	100	91.05
BR14 Vs BRRIdhan 34	91	85.71	94.11	91	90.46
BR14 Vs BR26	80	85.71	80	83.3	84.75
BR14 Vs BRRIdhan 38	89	85.71	93.3	91	89.75
BRRIdhan 29 Vs BR10	66.67	100	91	80	84.4
BRRIdhan 29 Vs BR16	66.67	100	83.33	80	82.5
BRRIdhan 29 Vs BRRIdhan 31	75	85.71	80	61.54	75.6
BRRIdhan 29 Vs BRRIdhan 32	66.67	100	71.42	80	80
BRRIdhan 29 Vs BRRIdhan 33	66.67	100	83.33	80	82.5
BRRidhan 29 Vs BRRIdhan 34	66.67	100	73	89	82.17
BRRIdhan 29 Vs BR26	75	100	91	80	86.5
BRRIdhan 29 Vs BRRIdhan 38	85.71	100	83.33	89	90
BR10-BR16	100	100	92.31	100	98.08
BR10 Vs BRRIdhan 31	91	85.71	91	46.15	78.46
BR10 Vs BRRIdhan 32	100	100	66.67	100	91.67
BR10 Vs BRdhan 33	100	100	92.31	100	98.07
BR10 Vs BRRIdhan 34	100	100	85.71	91	94.18
BR10 Vs BR26	91	100	100	83.33	93.6
BR10 Vs BRRIdhan 38	80	100	92.31	91	91
BR16 Vs BRRIdhan 31	91	85 .71	83.33	80	85
BR16 Vs BRRIdhan 32	100	100	87.5	100	97
BR16 Vs BRRIdhan 33	100	100	100	100	100
BR16 Vs BRRIdhan 34	100	100	93.33	91	96.1
BR16 Vs BR26	91	100	92.31	83.33	91.66
BR16 Vs BRRIdhan38	80	100	100	91	92.75
BRRIdhan 31 Vs BRRIdhan 32	91	85.71	71.43	80	82.035
BRRIdhan 31 Vs BRRIdhan 33	91	85.71	83.33	80	85.01
BRRIdhan 31 Vs BRRIdhan 34	91	85.71	77	71.43	81.285
BRRIdhan 31 Vs BR26	100	85.71	91	66.67	85.845
BRRIdhan 31 Vs BRRIdhan 38	89	85.71	83.33	71.43	82.3675
BRRIdhan 32 Vs BRRIdhan 33	100	100	87.5	100	96.875
BRRIdhan32 Vs BRRIdhan 34	100	100	94.18	91	96.295
BRRIdhan 32 Vs BR26	91	100	80	83.33	88.5825
BRRIdhan 32 Vs BRRIdhan 38	80	100	87.5	91	89.625
BRRIdhan 33 Vs BRRIdhan 34	100	100	93.33	91	96.0825
BRRIdhan 33 Vs BR26	91	100	92.31	83.33	91.66
BRRIdhan 33 Vs BRRIdhan 38	80	100	100	91	92.75
BRRIdhan 34 Vs BR26	91	100	92.31	91	93.5775
BRRIdhan 34 Vs BRRIdhan 38	80	100	93.33	100	93.3325
BR26 Vs BRRIdhan 38	89	100	92.31	91	93.0775
Average	87.466	95.128	86.654	85.863	88.81

Table 6: Summary of Genetic Variation Statistics for All Loci

Locus	Sample size	na*	ne*	h*	I*
S1027-1	10	2.0000	1.4706	0.3200	0.5004
S1027-2	10	2.0000	1.2195	0.1800	0.3251
S1027-3	10	2.0000	1.7241	0.4200	0.6109
S1027-4	10	1.0000	1.0000	0.0000	0.0000
S1027-5	10	1.0000	1.0000	0.0000	0.0000
S1027-6	10	2.0000	1.4706	0.3200	0.5004
OPA02-1	10	1.0000	1.0000	0.0000	0.0000
OPA02-2	10	1.0000	1.0000	0.0000	0.0000
OPA02-3	10	2.0000	1.4706	0.3200	0.5004
OPA02-4	10	1.0000	1.0000	0.0000	0.0000
S1155-1	10	2.0000	1.9231	0.4800	0.6730
S1155-2	10	2.0000	1.7241	0.4200	0.6109
S1155-3	10	2.0000	1.2195	0.1800	0.3251
S1155-4	10	2.0000	1.2195	0.1800	0.3251
S1155-5	10	2.0000	1.4706	0.3200	0.5004
S1155-6	10	1.0000	1.0000	0.0000	0.0000
S1155-7	10	1.0000	1.0000	0.0000	0.0000
S1155-8	10	1.0000	1.0000	0.0000	0.0000
S1155-9	10	1.0000	1.0000	0.0000	0.0000
OPAB02-1	10	2.0000	1.9231	0.4800	0.6730

Table 6: Summary of Genetic Variation Statistics for All Loci (continued)

Locus	Sample size	na*	ne*	h*	I*
OPAB02-2	10	2.0000	1.2195	0.1800	0.3251
OPAB02-3	10	2.0000	1.2195	0.1800	0.3251
OPAB02-4	10	1.0000	1.0000	0.0000	0.0000
OPAB02-5	10	1.0000	1.0000	0.0000	0.0000
OPAB02-6	10	1.0000	1.0000	0.0000	0.0000
OPAB02-7	10	1.0000	1.0000	0.0000	0.0000
OPAB02-8	10	2.0000	1.2195	0.1800	0.3251
OPAB02-9	10	2.0000	1.2195	0.1800	0.3251
OPAB02-10	10	2.0000	1.2195	0.1800	0.3251
Mean	10	1.5517	1.2391	0.1559	0.2472
St. Dev		0.5061	0.2907	0.1667	0.2483

** na = Observed number of alleles, * ne = Effective number of alleles, * h = Nei's (1973) gene diversity and * I = Shannon's Information index*

3.5 NEI'S (1972) GENETIC DISTANCE

The values of pair-wise comparisons of Nei's [25] genetic distance between 10 rice genotypes were computed from combined data sets for the four primers ranging from 0.0000 to 0.4299 (Table 7). The highest Nei's [25] genetic distance (0.4299) was observed in BRRIdhan 29 Vs BRRI dhan 31 and BRRIdhan 31 Vs BRRIdhan 38 and the lowest genetic distance (0.0000) was estimated in BR 16 Vs BRRIdhan 33. Furthermore, high level of genetic distance (0.3716) was found in BR 14 Vs BRRIdhan 29, BR 14 Vs BRRIdhan31, BRRIdhan29 Vs BRRIdhan32, BRRIdhan31 Vs BRRIdhan32, BRRIdhan31 Vs BRRIdhan34, BRRIdhan31 Vs BRRIdhan26 germplasms pair.

3.6 DENDROGRAM

A dendrogram based on Nei's [25] genetic distance using UPGMA segregates ten germplasms of rice into two main clusters. The main clusters are further divided into sub clusters (Figure 3). BR 10, BR 14, BR 16, BR 26, BRRIdhan29, BRRIdhan32, BRRIdhan33, BRRIdhan34 and BRRIdhan38 formed cluster I whereas BRRIdhan31 comprised the cluster II. In cluster I BR10, BR 14, BR 16, BR 26, BRRIdhan32, BRRIdhan33, BRRIdhan34 and BRRIdhan38 formed sub-cluster I and BRRIdhan 29 formed sub- cluster II. Sub-cluster I further divided into two sub-sub clusters. Sub-sub cluster I consisted of BR 10, BR14, BR16, BRRIdhan32, BRRIdhan33 and BRRIdhan34 due to similar banding pattern. BR 26 and BRRIdhan38 formed the sub- sub cluster II. Again, sub-sub cluster I grouped into two clusters. BR14 and BRRIdhan 32 had same banding pattern so they are in same group. BR10, BR16, BRRIdhan33 and BRRIdhan34 were placed in same group due to similarity in their banding pttern. In this study, the RAPD technique was found to discriminate ten rice germplasms. Germplasms having higher similarity were close in the dendogram. According to the results, BRRIdhan 31 was found more genetically diversified comparative to the other germplasms. Germplasms having high level of similarity indices showed low level of genetic distance. Inter-germplasm similarity index between BR 16 Vs BRRI Dhan 33 was 100% so genetic distance was lower between the pair (0.0000) than rest of the germplasms pair.

Table 7. Genetic distance value for different germplasms

Variety	BR14	BR29	BR10	BR16	BRRI dhan31	BRRI dhan32	BRRI dhan33	BRRI dhan34	BR26	BRRI dhan3
BR14										
BRRIdhan29	0.3716									
BR10	0.1892	0.2318								
BR16	0.1484	0.2763	0.0351							
BRRIdhan31	0.3716	0.4229	0.2318	0.2763						
BRRIdhan32	0.0715	0.3716	0.1092	0.0715	0.3716					
BRRIdhan33	0.1484	0.2763	0.0351	0.0000	0.2763	0.0715				
BRRIdhan34	0.1484	0.2763	0.1092	0.0715	0.3716	0.0715	0.0715			
BR26	0.3228	0.2763	0.1092	0.1484	0.3716	0.2318	0.1484	0.1484		
BRRIdhan38	0.1892	0.2318	0.1484	0.1092	0.4229	0 .1892	0.1092	0.1092	0.1092	

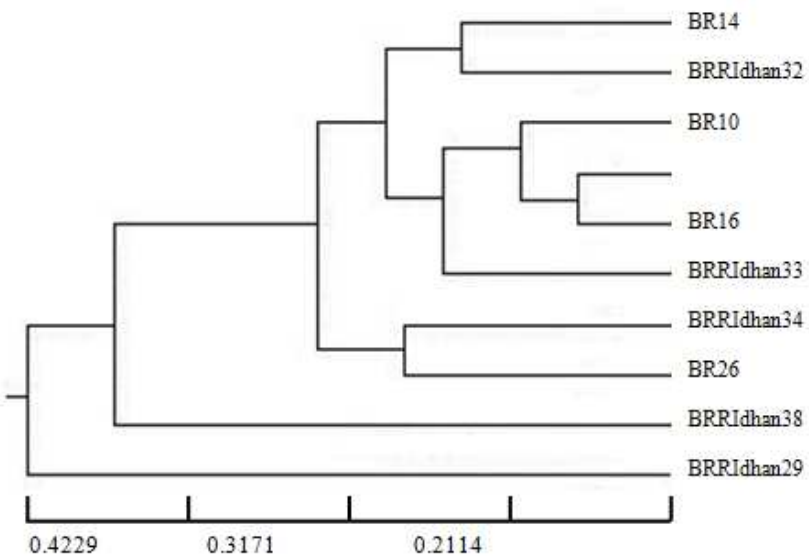


Figure 3: UPGMA Dedogram based on Nei's genetic distance, summarizing the data on differentiation among 10 Rice germplasms according to RAPD analysis.

BR14 Vs BRRI dhan 31 showed the least inter-germplasm similarity index (70.63%) had maximum genetic distance in dendogram. On the other hand, genetic similarity between BR 10 Vs BR 16 (98.08%), BR 10 Vs BRRIdhan33 (98.07%), BR 10 VS BRRI Dhan 34 (94.18%) germplasm pairs was high so genetic distance between each pair was low. Therefore, this study clearly indicates that there is a high level of genetic variation among different germplasms. Mean diversity across all population for all the loci studied was 0.1559 indicating some degree of genetic variation in rice germplasms. Genetic variation refers to the differences in the heredity constitutions of the individuals of a species and it is important in maintaining the developmental stability and biological potential of plant species.

Among BRRI released 10 rice germplasms used in this study, BR 14 is BLB resistant [7]. In this study BRRIdhan 29 is BLB susceptible variety. Genetic distance between BR 14 VS BRRIdhan 32 is (0.0715) it is the least value between BR14 VS any germplasms, again their genetic similarity is 94.17. It indicates that BRRIdhan 32 has high level similarity to BLB resistant BR14. Again their banding is also similar. It can be concluded from this study, due to close similarity between BR14 and BRRIdhan 32, BRRI dhan 32 may have resistance power to BLB. Thus it has resistance power against BLB close to BR 14. On the other hand, BR 14 VS BRRIdhan 31 had high genetic distance (0.3716) also lowest similarity. Also these two are more distant in demdogram. It can conclude that BRRIdhan 31 may possess minimal resistance against BLB.

The resistance genes from BR14 and other resistant variety will be useful in the development of durable BLB resistant rice cultivars. On the basis obtained results, we can conclude that some of the resistant materials found in this study could be used in hybridization programs for varietal improvement against the BLB. Therefore, a breeding programme should be initiated to transfer these resistance genes to the high yielding and better grain quality but BLB susceptible cultivars to control the disease effectivelty.

4 CONCLUSION

Screening of BLB resistant rice using RAPD technique from the selected rice genotypes was the main objectives of the study. Ten rice genotypes were used for screening BLB resistant at the seedling stage following IRRI standard protocol.

The genetic diversity in 10 rice genotypes were analyzed by PCR-based RAPD markers by using 4 arbitrary decamer primers (S1027, OPA02, S1155, OPAB02). Selected four primers generated a total of 29 bands. Out of the 29 bands, 16 bands (55.17) were polymorphic and 13 bands (44.83%) were monomorphic.

The four different primers generated various banding patterns, ranging from 4 (OPA02) to 10 (OPAB02). Among a total of 29 bands, four primers generated an average of 7.25 polymorphic bands.

According to Nei's [25], the genetic distance between BRRIdhan 29 Vs BRRIdhan 31, BRRIdhan31 Vs BRRIdhan 38 was highest (0.4229) and in the dendogram they were placed in different clusters. Second highest genetic distance was 0.3716 between BR14 VS BRRIdhan 29, BR14 VS BRRIdhan 31, BRRIdhan 29 Vs BRRI dhan 32, BRRIdhan 31 Vs BRRI dhan 32, BRRIdhan 31 VS BRRIdhan 34, BRRIdhan 31 VS BR 26.

On the other hand, least genetic distance was seen between BR 16 VS BRRIdhan 33(0.0000). BR 10 VS BR 16, BR 10 VS BRRIdhan 33 had minimal genetic distance (0.0351) and they were placed in same clusters. Intergermplasm similarity was highest between BR16 Vs BRRIdhan 33 (100%), again genetic variation was (0.0000) least between them. They are also very close in the dendogram.

The UPGMA dendrogram based on Nei's [25] genetic distances between different pairs were correlated with their sources of origin. The dendrogram indicates segregation of ten germplasms of rice into two main clusters; the main clusters are further divided into sub clusters. The BLB resistant BR-14 was close to the germplasm BRRIdhan 32 with the least genetic distance. Both of these two germplasms are in the same cluster.

It is concluded that some of the resistant materials found in this study would be useful for varietal improvement against the BLB. Finally, it is said that RAPD markers can be sensitive, simple, efficient and powerful tool for screening BLB resistant rice among rice genotypes and effectively trace their genetic relationships. The results of this study can be used as a base for future genetic analysis of rice varieties in Bangladesh. Besides RAPD, the use of different primers (SSR, RFLP, AFLP) etc. could be useful in future research.

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Investigation of Silicon carbide based thin films for Solar cell applications

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ABSTRACT: In today's predominant silicon based technology, a lot of research is carried out in using various silicon based matrices especially for new, efficient and reduced cost solar cells. This has led to a deep research into third generation silicon based thin film solar cells that consist of nanostructures. In this respect, a variety of silicon based host matrices have been investigated for solar cell applications including silicon dioxide and silicon nitride. Recently, interest has been extended to silicon carbide (SiC) because of its lower band gap (2.5 eV) as compared to SiO_2 (9eV) and Si_3N_4 (5.3eV), in order to favor better electrical conductivity. This paper reports the initial works carried out on silicon carbide based thin films, where in, optical and structural properties of the film were investigated. These results would be useful in carrying out further research on the fabrication of Si nanostructures in SiC based matrix which is a challenge in today's research scenario.

KEYWORDS: Silicon carbide, Magnetron sputtering, XRD, XRR, profilometry, FT-IR spectroscopy, ellipsometry, AFM, DRS

1 INTRODUCTION

Due to the alarming rate of increase of carbon dioxide in our atmosphere which is causing global wide increase in temperatures, together with the depletion of fossil fuels and their increasing prices, there is a need of the hour to shift to renewable and green sources of energy. In this respect, solar energy plays a pivotal role because of its abundant supply and non-toxicity to nature. Solar cell is one of the ways to trap and harness solar energy and research is ongoing to reduce the cost as well as increase the efficiency of the solar cells.

In the research on third generation of solar cells, many studies have been carried out in producing nanostructures in the active layer of solar cells using a variety of host matrices such as GaAs [1-3], Si [4-5], InGaN [6-7], etc. In the case of silicon based materials, silicon oxide and silicon nitride based matrices have been used and are still being investigated as a dielectric matrix. Recently, silicon carbide based matrices have also gathered attention as a host matrix for silicon nanostructures because of its lower band gap (2.5eV) compared to the SiO_2 (9eV) and Si_3N_4 (5.3eV) [8], thereby promising a better electrical conductivity. However, obtaining quantum confined nanostructures in this matrix may be a challenge due to the lower band gap as compared to the other two matrices mentioned above. Research on SiC based matrices is at its infancy and is only a couple of years [9-11] old. It is therefore important to carry out research on this to investigate the formation of nanostructures in various dielectric matrices based on silicon, and investigate its performance before incorporating it collectively in an All-Si tandem cell [12]. In this context, the aim of this paper would be to carry out a preliminary detailed investigation of SiC based thin films with varying stoichiometry and parameters in order to study the formation of Si nanostructures.

2 EXPERIMENT

Silicon carbide films were co-sputtered using Si and C targets by DC magnetron co-sputtering setup equipped with the *Angstrom Sciences make* magnetrons placed in confocal geometry at UGC-DAE CSR Indore. The substrate was rotated for ensuring the uniformity of the deposited samples. The deposition was carried out on a p-type single crystal (1 0 0) oriented

silicon substrate at room temperature. The films were prepared with varying silicon excess. The deposition rate of silicon and carbon was calculated by depositing silicon and carbon individually for half an hour and then measuring the thickness of the film using X-ray reflectivity. The individual deposition rates of silicon and carbon was found to be 78Å/min and 9Å/min respectively. Using these deposition rates, the power supplied to silicon and carbon were changed to get varying silicon excess (see table 1) and varying thickness. With a base pressure of 1×10^{-6} mbar, the deposition was carried out at a working pressure of 5×10^{-3} mbar. The mass flow rate of Argon was maintained at 14 sccm.

Table 1: Deposition Parameters

Sample	Power supplied to Si (Watts)	Power supplied to C (Watts)	Aimed Si:C Ratio (Å)	Thickness
I1	46	100	4:1	1400
I2	17.3	100	3:2	1500
I3	11.5	100	1:1	1400
I4	11.5	100	1:1	700
I5	46	100	4:1	2500
I6	27	100	7:3	1900

The thickness of all the samples have been measured using profilometry (Ambios Technology, XP1) and then counter-checked from X-ray reflectivity (XRR). To study the effect of annealing in atmospheric conditions on the films deposited, the samples I2 and I3 were annealed at 1000^{o}C for 1 hour, and sample I4 at 500^{o}C for one hour in a furnace in atmospheric conditions. All the samples were also annealed in a fast heating electron beam annealing setup [13] in ultra high vacuum of $1x10^{-7}$ mbar at 1000^{o}C for 1 hour. The analysis of crystal structure was carried out with Bruker D8 Advance X-ray diffractometer (XRD). The X-rays were produced using a sealed tube and the wavelength of X-ray was 1.54Å (Cu-Kα). The refractive index and thickness of each sample was then obtained using J.A. Woollam Co. Variable-angle spectroscopic ellipsometer. The sample surface was then observed under Atomic Force Microscope to know about the average grain size, surface roughness and the average height of the grains in the films deposited. To know the chemical species present in the films, the samples were analyzed in Bruker, Germany, model: Vortex 70, FTIR spectrometer. The diffused reflectance spectrum (DRS) in the UV-Visible range was recorded using Thermo Scientific Evolution 300 UV-Visible spectrophotometer, to estimate the optical band gap.

3 RESULTS

A silicon rich silicon carbide matrix upon thermal treatment with temperatures above 700^{o}C undergoes phase separation and is expected to form Si crystals, whereas the onset of SiC crystals is at 1000^{o}C [14]. In order to analyze this, structural and optical characterizations were performed and the results analyzed.

3.1 STRUCTURAL ANALYSIS

3.1.1 X-RAY DIFFRACTION (XRD)

The XRD was carried out in θ-2θ mode. The crystal properties including the grain size have been studied using the XRD results shown in Figure 1 (a) and 1 (b).

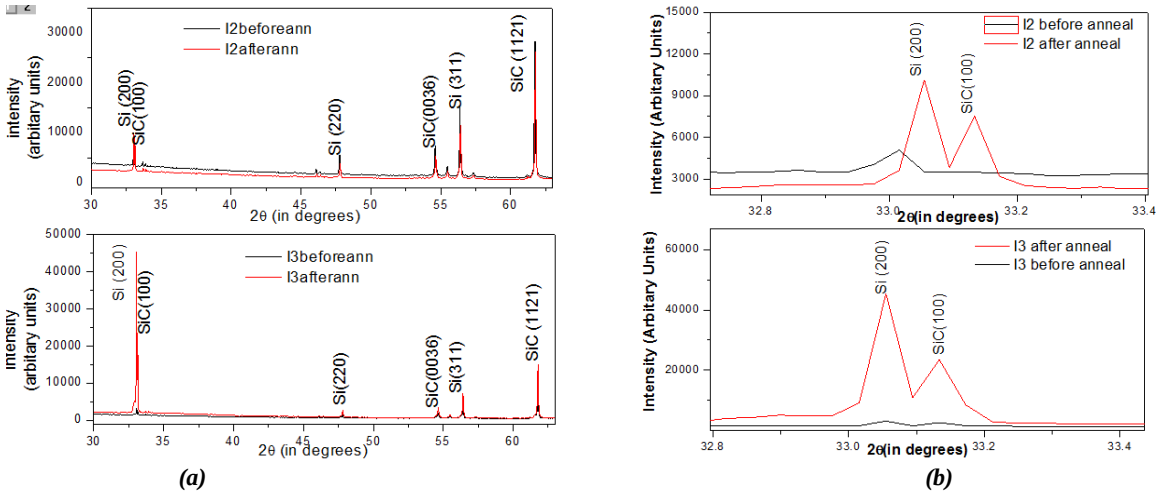


Figure 1: (a) XRD Peaks showing Si and SiC for samples I2 and I3(before and after annealing) (b) XRD of samples I2 and I3 (before and after annealing at 1h 1000^{o}C under atmospheric conditions)

The peaks at 33.01^{o}, 33.13^{o}, 47.77^{o}, 54.6^{o}, 56.36^{o}, and 61.74^{o} correspond to Si (2 0 0), SiC (1 0 0), Si (2 2 0), SiC (0 0 36), Si (3 1 1) and 3C-SiC (1 1 21) respectively as obtained from PCPDFWIN Software. From, Figure 1(a), it can be seen that in both I2 and I3, intensity of Si(2 0 0) plane increased in intensity after annealing which can be attributed to the long range ordering of the samples upon thermal treatment.

The increased intensity of SiC (1 1 21) at the angle of 61.74^{o} in sample I3, is due to the nearly stoichiometric composition of I3, as compared to I2 which is silicon rich and which has a lower intensity of SiC (1 1 21) peak but increased intensity of Si(2 0 0) peak. Also, in Figure 1(b) which zooms the region between 31^{o} to 34^{o}, it can be seen that the SiC (1 0 0) appears in both the samples I2 and I3 only after annealing. This confirms the reordering of the matrix upon thermal treatment leading to the crystal formation.

The XRD data on the raw Si wafer also showed multiple peaks which coincided with the positions obtained from the thin films. This originates due to the formation of polycrystalline layer on the surface during polishing. Since the peaks of SiC and Si are at similar positions, further investigations are needed to understand the crystalline phases in the samples.

3.1.2 FT-IR SPECTROSCOPY

Figure 2(a), 2(b) and 2(c) shows the FTIR spectra of the as-deposited SiC films, films annealed in ultra high vacuum (VA) at 1000^{o}C, and the films annealed in atmospheric conditions (AA) at 1000^{o}C (I2 and I3) and 500^{o}C (I4), respectively.

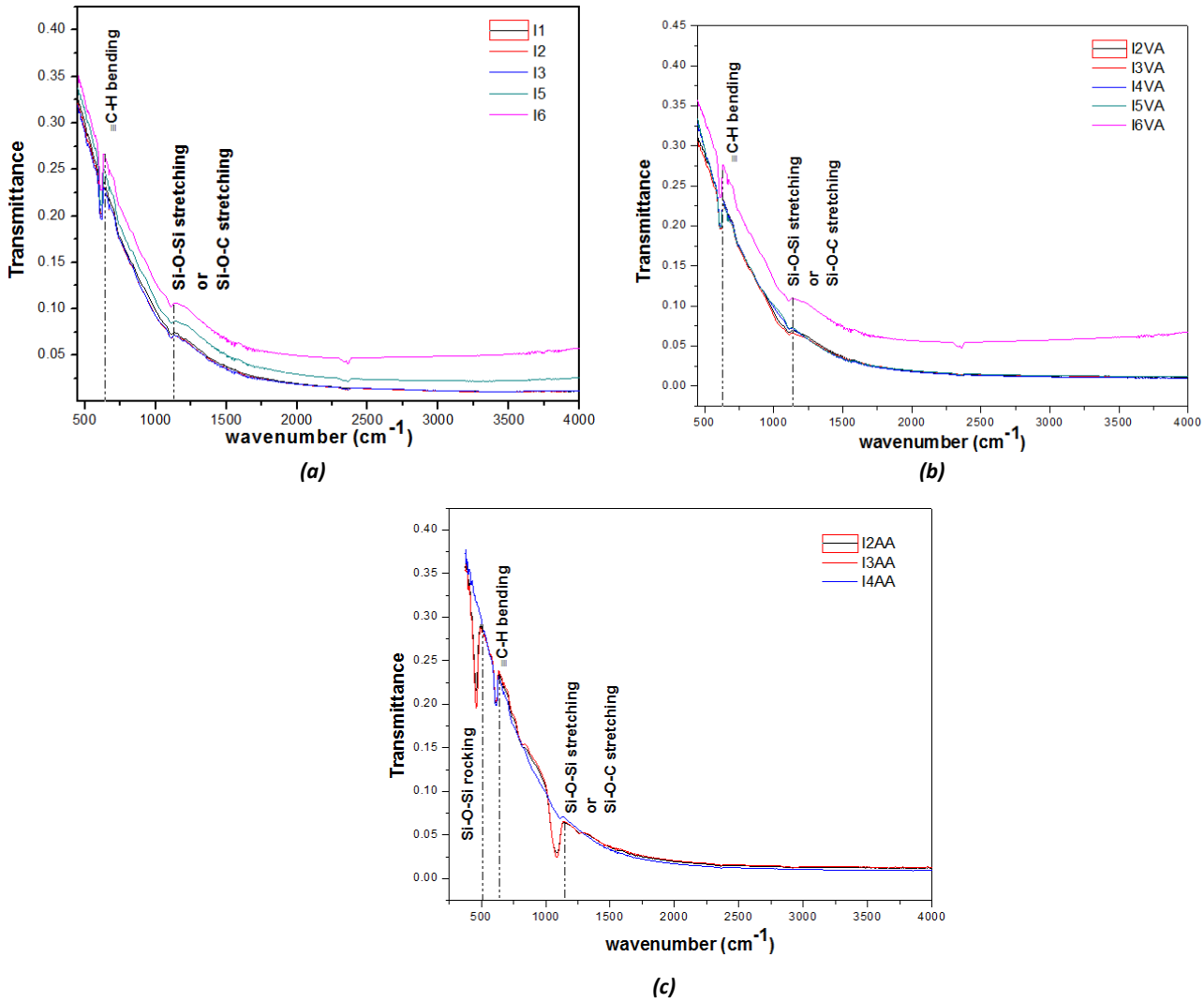


Figure 2: Transmittance vs. wave number plot for films (a) before annealing (b) vacuum annealing (c) atmospheric annealing

In the spectrum, the peak at 634cm^{-1} can be attributed to alkaline C-H bending band, and small peak at 1100cm^{-1} can be attributed to Si-O-Si or Si-O-C stretching band [15] in the case of as-deposited and vacuum annealed (1000^{o}C) samples. However, the peak at 1100cm^{-1} becomes significant after annealing in atmospheric conditions and another peak at 495cm^{-1} attributing to Si-O-Si rocking mode [16] is also obtained after atmospheric annealing for samples I2 and I3 which were annealed at 1000^{o}C. However, in case of sample I4 which was annealed at 500^{o}C in atmospheric conditions both the peaks at 1100cm^{-1} and 495cm^{-1} were absent. FTIR Results suggest the formation of SiOC instead of SiC thin films which can be attributed to the atmospheric oxidation. This is confirmed by observing the peaks at 495cm^{-1} and 1100cm^{-1} in case of atmospheric annealing. Also it can be inferred that the Si-O bonds are formed at temperatures greater than 500^{o}C and hence very predominant in samples annealed at 1000^{o}C in atmospheric conditions.

3.1.3 Atomic Force Microscopy

To observe the surface of the film after annealing, samples I1 (vacuum annealed), I2 and I3 (atmospheric and vacuum annealed) were observed under Atomic Force Microscopy (Figure 3). Table 2 shows the average grain size, surface roughness and the average height of the samples. It can be seen from the table that the average grain size is high which may be attributed to the agglomeration of crystals possibly because of the low barrier SiC offers as compared to SiO_2 and Si_3N_4. It can be observed that the average grain size was lower in the case of vacuum annealed samples than the samples annealed in atmospheric conditions.

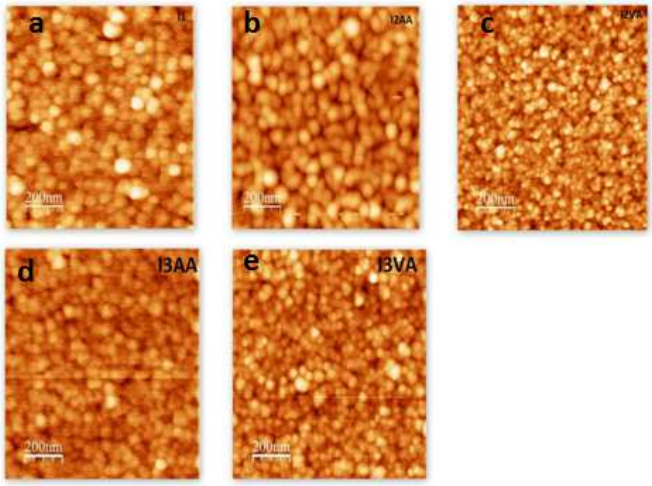


Figure 3: AFM images showing the grain structure of a. I1VA b. I2AA c. I2VA d. I3AA e. I3VA

Table 2: Avg. grain size, surface roughness and avg. height of the grains of sample I1, I2, and I3 (post annealed)

Sample	Average grain size (nm)	Surface roughness (nm)	Average Height (nm)
I1VA	65	2.29	8.85
I2AA	80	1.32	5.16
I2VA	25	3.63	14.63
I3AA	75	2.66	11.01
I3VA	50	2.89	9.61

3.2 Optical Analysis

3.2.1 Optical Bandgap And Refractive Index

Table 3 shows the optical band gap and refractive index of the samples. Optical band gap was obtained from diffused reflectance spectrum in the UV-Vis range and then plotted using the Tauc plots. The refractive index of the samples has been estimated by ellipsometry using the β-spline model at 632.8nm for 65^{o} angle.

Table 3: Optical band gap of samples

Sample	Optical Band gap (in eV)	Sample	Refractive Index
I1	4.60	I1	1.75
I1VA	7.70	I2	1.80
I2	3.25	I2AA	1.45
I2AA	9.70	I3	1.78
I2VA	3.61	I3AA	1.47
I3	3.09	I4	1.55
I3AA	7.50		
I3VA	3.20		
I4	2.50		
I4AA	5.00		
I4VA	4.00		
I5	5.17		
I5VA	5.95		
I6	5.85		
I6VA	6.60		

The band gap was observed to increase after annealing which can be correlated to the oxidation of the samples. Also for the samples having the same composition, i.e. a comparison between sample I1 (thickness: 140nm) and I5 (thickness: 250nm) having similar silicon excess (of Si:C = 4:1), it was observed that the band gap of I5 was higher than I1. It can be also be noted that the band gap increases with the increase in thickness of the samples. Similar is the case for I3 (thickness: 140nm) and I4 (thickness: 70nm), where the band gap of I3 is higher than I4. This is attributed to the decrease of localized states in the gap, which causes an increase in band gap [17-19], with increase in film thickness. The lowest band gap after annealing (in vacuum conditions) was obtained for sample I3, which we can say is the most optimized sample among those discussed in terms of band gap as lower the band gap, better is the electrical conductivity, which would be useful for the solar cell applications.

Considering the refractive index data, it can be seen that I2-annealed and I3-annealed gives refractive indices in the range of 1.45-1.47. This confirms again the formation of silicon oxycarbide [20], resulting from the annealing treatment in atmospheric conditions. Also, samples with higher thickness, gives a higher refractive index. This can be seen by comparing I1 and I2, in which I1 has lower refractive index (and lower thickness) even though it has a higher silicon excess than I2, which should otherwise give higher refractive index of I1 (as n of Si is about 3.5).

4 CONCLUSION

Silicon carbide based nanostructured thin films with varying silicon excess and thickness were successfully deposited on silicon substrate by DC magnetron co-sputtering at room temperature using Si and C targets. We reported silicon oxycarbide formation when annealing in atmospheric conditions and at temperatures beyond 500^0C and very predominant at 1000^0C. We reported that the refractive index increased with thickness. The bandgap of the films increased after annealing due to formation of oxides. We also reported increase in bandgap with increase in thickness of films having similar silicon excess.

The future scope of this project can be the characterization of films using Raman spectroscopy to identify the Si-Si bond intensity after annealing of the samples. This will give an indication of the silicon quantum dot formation. The samples can be observed under Tunneling Electron Microscope (TEM) in order to find out the nanocrystal size and to find out the density of the quantum dots formed. X-ray photoelectron spectroscopy (XPS) can be done on the samples in order to quantitatively find out the silicon excess present in the films deposited.

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Nouvelle méthode de production des pièces découpées du Zellij traditionnel

[New method for production of traditional Zellij parts]

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ABSTRACT: Our work is within the framework of a study aiming at industrializing the manufacturing technique of decorative plates in parts of traditional Zellij, starting from geometrical reasons constructed with the help of the Computer Aided Design. We propose in this article a new method of a continues carving the primitive forms of Zellij, compared to the current traditional process : manual lithic reduction face by face. This new method allows to obtain the path of the tool of carving following an automatic recognition of the contour of each primitive forms of Zellij. Dimensions and colors of primitive forms that are going to be carved can be modified to the level of the Computer Aided Design.

KEYWORDS: Analysis of motives, image processing, automatic range, automatic recognition, detection of contour, CAD.

RESUME: Notre travail se situe dans le cadre d'une étude visant à promouvoir et automatiser la technique de fabrication de plaques décoratives en pièces de Zellij traditionnelles à partir de motifs géométriques construits à l'aide de la Conception Assistée par Ordinateur. Nous proposons dans cet article une nouvelle méthode de découpe continue des "pièces de Zellij" pour améliorer le procédé traditionnel actuel : façonnage manuel face par face. Cette nouvelle méthode permet d'obtenir la trajectoire de l'outil de découpe suite à une reconnaissance automatique du contour de chaque forme primitive "pièce Zellij". Les dimensions et les couleurs des formes primitives qui vont être découpées peuvent être modifiées au niveau de la Conception Assistée par Ordinateur.

MOTS-CLEFS: Analyse des motifs, traitement d'image, gamme automatique, reconnaissance automatique, détection de contour, CAO.

1 INTRODUCTION

Cet article résume des études menées au sein du Laboratoire de Productique, d'Energétique et du Développement Durable à l'EST des Fès, et concernant la promotion des plaques réalisées par assemblage de pièces de Zellij traditionnelles

(figure 1). Cette promotion est actuellement freinée par deux problèmes essentiels : la découpe des pièces dans des carreaux de Zellij et la fixation de ces pièces en vue de la réalisation des plaques de grandes dimensions. Ces problèmes limitent de manière importante la possibilité d'exportation et même l'utilisation locale. De nouvelles techniques de fixation visant à diminuer le poids et la fragilité des plaques sont développées par ailleurs et ne seront pas abordées dans cette étude. Nous nous intéresserons, pour notre part, à la découpe géométrique au placement des pièces de Zellij. Les matériaux constituant les carreaux de Zellij sont constitués d'argile rugueuse et d'argile lisse et sont revêtus par une paeinture spéciale.



Fig. 1. Exemple de pièces assemblées du Zellij sur un mur

On doit au génie de l'art musulman le développement, à partir de formes primitives simples, d'un langage d'une originalité, d'une richesse et d'une puissance d'expression extraordinaires.

Les formes géométriques simples (figures 2), de type primitives (formes primitives selon la terminologie utilisée en CAO), sont assemblées sans vide ni recouvrement en un motif capable, par report symétrique, de "paver" [1] une surface idéale infinie. De tels assemblages donneront naissance à des formes secondaires qui enrichiront le répertoire à disposition des artistes. Celles-ci engendreront à leur tour, par un même mouvement, d'autres formes nouvelles. C'est ainsi, à partir de compositions très simples, que la mosaïque s'est peu à peu enrichie et compliquée jusqu'à devenir un art majeur, à forte cohérence interne, qui culminera dans les réalisations de motifs en Zellij (figures 3 (a) et (b)) du Maroc contemporain.

Dans cet article nous proposons une méthode qui consiste à analyser un ensemble de motifs traditionnels (analyser un motif, c'est en extraire un ensemble d'informations nécessaires et suffisantes pour le reconstruire), puis à reconnaître automatiquement le contour de chaque forme primitive.

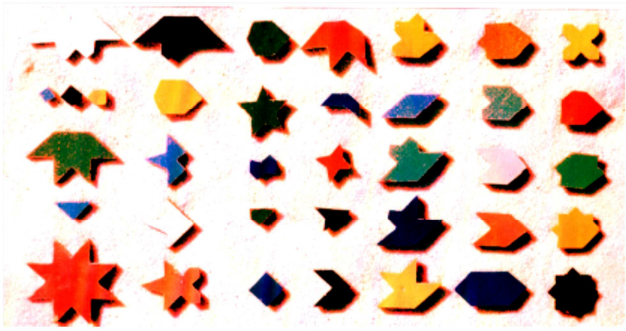


Fig. 2. Types de formes primitives

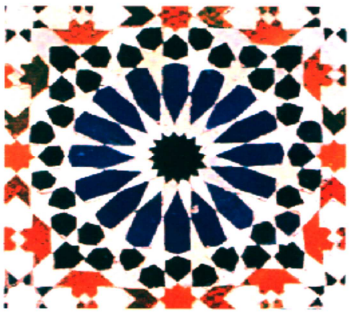


Fig. 3. (a) un motif simple "étoile à 16"

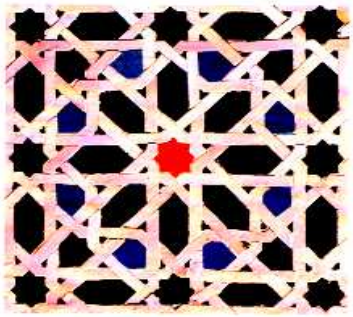


Fig. 3. (b) un motif simple "étoile à 8"

2 EXTRACTION DES CONTOURS

Les techniques actuelles d'analyse des images sont déjà capables de fournir une aide substantielle pour la navigation intelligente dans les bases d'images. La recherche d'images par le contenu, initiée aux Etats-Unis au début de la décennie, est maintenant un thème de recherche de prédilection de la vision par ordinateur.

Un système d'indexation - recherche d'une base d'images de mosaïque est proposé [2]. Ces images opèrent sur des formes géométriques simples, assemblées sans vide ni recouvrement pour constituer un motif capable, par report symétrique, de "paver" une surface. Il s'agit de développer des outils permettant d'exploiter une base d'images de mosaïque de l'art arabo - mauresque. Dans ce but [2] évoque l'intérêt de l'indexation automatique des images fondée sur leur contenu, qui permet d'éviter toute interprétation de haut niveau de la scène. Cette méthode présente l'avantage de limiter la difficulté pour l'utilisateur en lui évitant la traduction de l'image recherchée en mots ou en chiffres.

Compte tenu de la nature des images traitées, l'utilisation de la forme des objets étudiés est la solution retenue pour indexer la base d'images. Cette forme est généralement représentée par un ensemble connexe de pixels ou par son contour. L'extraction des caractéristiques de formes qui constitue une phase primordiale de la conception du système indexation-recherche repose sur des techniques connues en traitement et en analyse d'images (annexe 1).

Le principe du système d'indexation - recherche, proposé dans le cadre de ce travail est le suivant:

- Dans une première phase, il s'agit d'appliquer une méthode de segmentation [3] en vue d'extraire le contour de toutes les formes élémentaires de l'image requête (tesseels).
- L'algorithme de suivi de contour de Rosenfeld utilisé dans [2] est appliqué sur chaque contour pour identifier la position (x, y) des points contour.
- Dans une deuxième phase, ces positions (x, y) sont utilisées pour calculer l'index de forme de chaque forme élémentaire présente dans l'image requête [4].
- Dans une phase finale, ces index calculés sont comparés à des index préalablement calculés et stockés dans la base représentant toutes les formes élémentaires utilisées pour la construction des scènes de Zellij (en appliquant des calculs de similarité floue).

Ce travail repose, en partie, sur les outils de la morphologie mathématique, qui ont pour but d'étudier ou de traiter un ensemble à l'aide d'un autre ensemble, appelé élément structurant, qui sert de sonde. À chaque position de l'élément structurant, on regarde s'il touche ou s'il est inclus dans l'ensemble initial. En fonction de la réponse, on construit un ensemble de sortie. On obtient ainsi des opérateurs de base qui sont relativement intuitifs [5], [6].

Le principal domaine d'application de la morphologie mathématique est le traitement d'images. Elle fournit, en particulier, des outils de filtrage, de segmentation et de quantification. Depuis son apparition, en 1964, elle connaît un succès grandissant et désormais contribue à garnir la boite à outils de tout traiteur d'images.

Les filtres morphologiques binaires sont utilisés pour supprimer les bruits présents dans une image résultant d'un seuillage (annexe 1). Les filtres par reconstruction constituent une opération préalable de pré-traitement, précédant celle de détection des contours. Un algorithme rapide de squelettisation basé sur la théorie des automates finis est ensuite développé. La figure 4 montre une image originale filtrée par reconstruction, puis son contour correspondant squelettisé avec suppression des bords.

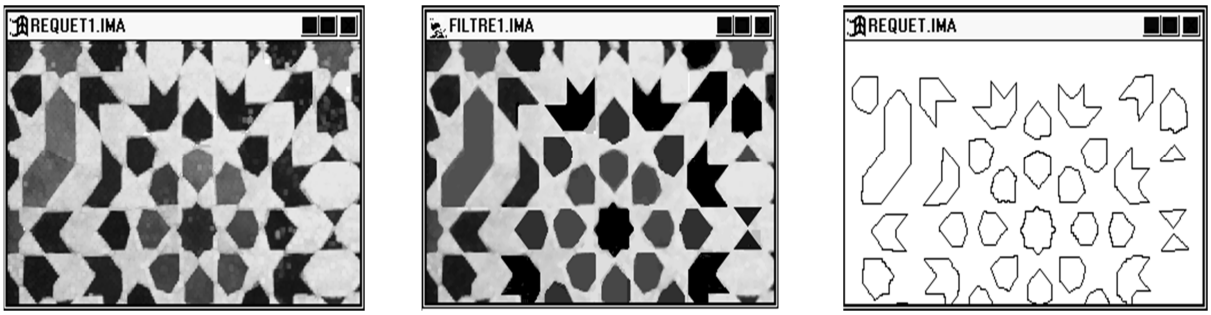


Fig. 4. Image requête et le contour correspondant

La figure 4 montre le résultat du filtrage, de gauche à droite : image originale, image filtrée par reconstruction, contour correspondant squelettisé avec suppression des bords.

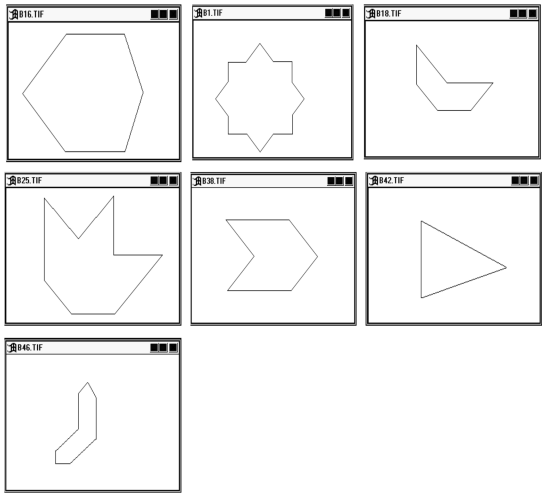


Fig. 5. Formes primitives présentes dans l'image requête

La figure 5 représente les objets identifiés par une procédure de recherche utilisant les index de Fourrier.

Les techniques modernes d'indexation - recherche se basent d'une manière générale sur la couleur, la forme, la texture ou une combinaison de ces attributs. L'objectif de la première étape de développement du procédé présenté dans ce travail est d'isoler et de reproduire une forme élémentaire, donc d'une même couleur. L'information couleur n'est pas discriminante. D'autre part, vu la nature de la base d'images traitées dans le cadre de ces travaux, l'attribut texture n'est pas non plus significatif. La forme donc est un attribut de niveau bas adapté pour représenter l'information.

3 CONSTRUCTION DE MOTIFS

Il y a deux démarches de construction de motif [1] :

⇒ Démarche à posteriori

⇒ Démarche a priori

La démarche à posteriori consiste à réduire le motif à une partie minimale asymétrique, généralement triangulaire "triangle minimal ou graine" (figure 6a). Reconnaître les rapports ordonnant la disposition des quelques lignes inscrites dans le triangle minimal. Cette méthode laborieuse, s'applique à un motif particulier : pour une autre étoile, il faut tout recommencer. Par ailleurs, elle laisse l'opérateur démuni pour la recherche et la création de nouveaux motifs.

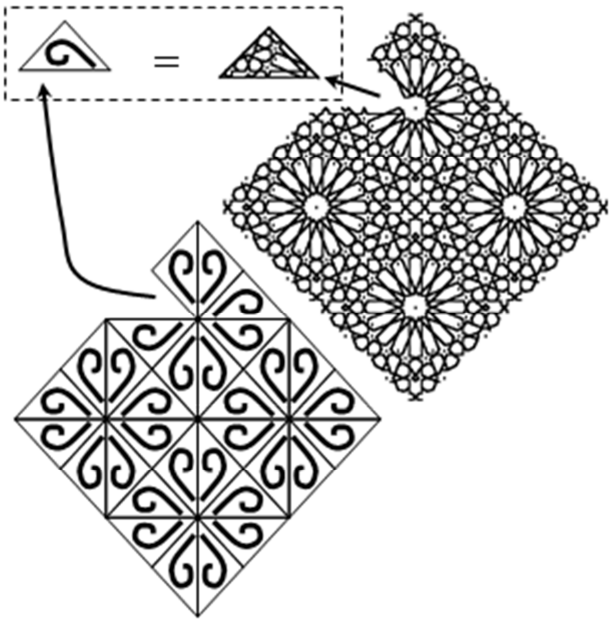


Fig. 6. (a) : de gauche à droite : schéma de structure, triangle minimal et motif analysé.

La démarche à priori ou méthode "géométrie douce" consiste à découvrir, par des jeux de transformations graphiques, un vaste ensemble de motifs traditionnels à complexité croissante en ne partant que des formes les plus simples. La plupart des motifs sont construits à partir de structures polygonales où alternent deux pièces essentielles [1] : l'octogone étoile ou "sceau de Salomon" et le "saft" (figure 6b). L'alternance "sceau de Salomon - saft" génère des rubans polygonaux aux angles multiples de 45 degrés. Lorsque le ruban se ferme il peut être considéré comme un squelette (figure 6c).

La figure 6b représente un motif obtenu à partir du squelette "petit octogone" de la figure 6c.

La construction des motifs fait appel à une géométrie élémentaire "méthode géométrie douce" [1]. Elle consiste tout d'abord à poser les premières bases, puis à appliquer systématiquement le même procédé avec des hypothèses allant du plus simple au plus complexe.

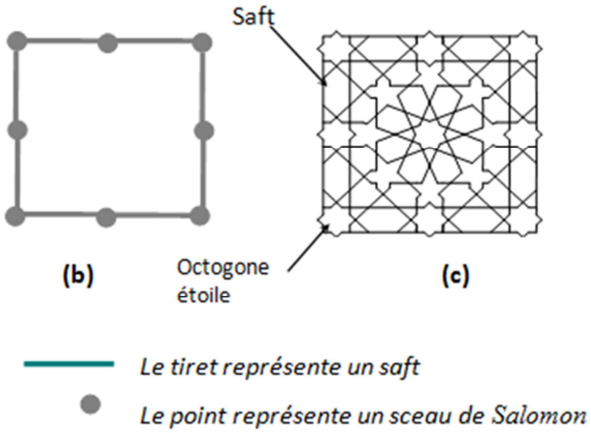


Fig. 6. (b) motif obtenu à partir du squelette "petit octogone", (c) squelette de la plus simple des étoiles à 8 (petit octogone).

Dans la plupart des cas, les squelettes sont à symétrie centrale. La plus simple des étoiles à ''8'' (figure 7b) sur un squelette carré de côté 2 (figure 7a) pourra être la base de découverte de nouvelle étoile à ''8'' par une simple rotation ou élimination du squelette (figure 7b). Partant du squelette en octogone étoilé de la figure 7c, nous inscrivons au centre une étoile à 8 safts (figure 7d). La figure 7e montre une possibilité, parmi plusieurs, de raccordements de traits. Nous pouvons obtenir plusieurs motifs en partant d'un seul type de squelette suite à des combinaisons de raccordements ou rotations d'étoile. Le même motif peut avoir aussi plusieurs aspects de couleurs différentes (figure 7f) puisqu'une même forme primitive du motif peut être découpées dans des carreaux de base de couleurs différentes.

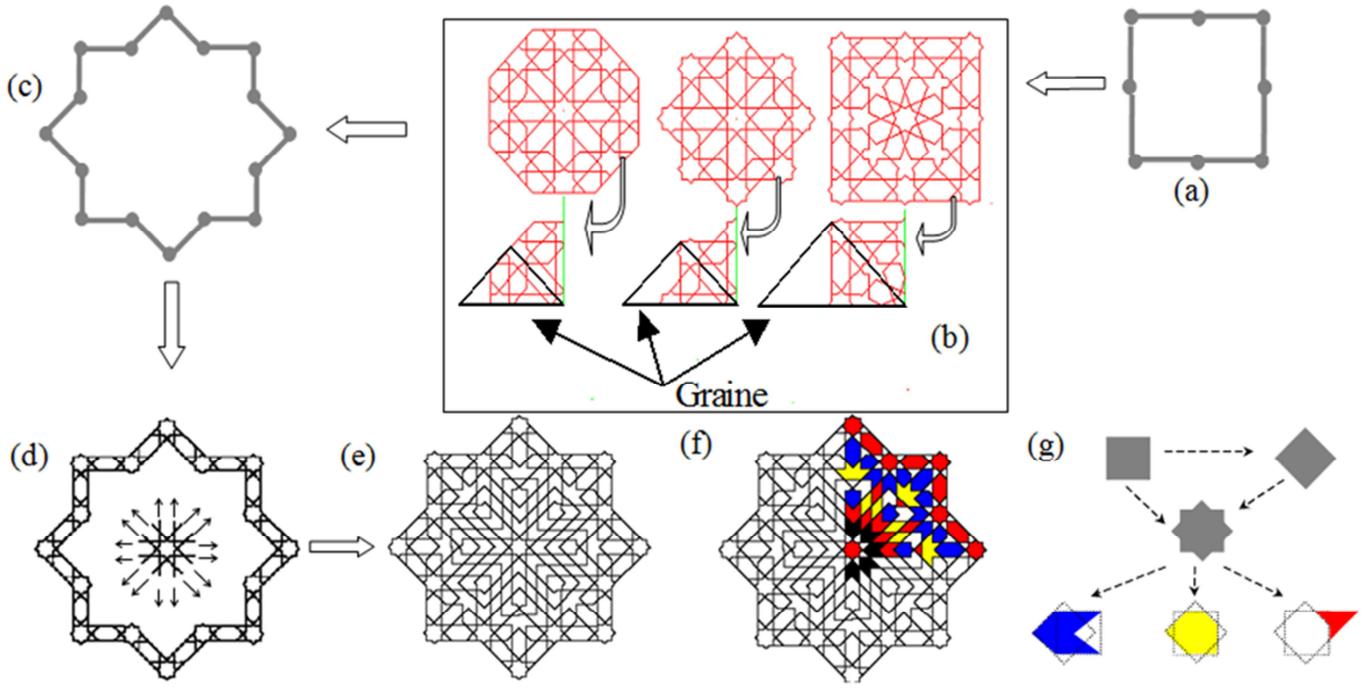


Fig. 7. : (a) squelette carré, (b) différentes interprétations de l'étoile à 8, (c) squelette en octogone étoilé, (d) étoile à 8 safts au milieu du squelette, (e) motif obtenu, (f) exemple de coloration (g) exemple de différentes formes primitives obtenues à partir du carré.

C'est ainsi qu'un vaste ensemble de motifs traditionnels sera défini, commençant par l'étoiles à ''8'' et aboutissant selon une même logique au moyen de clés complémentaires aux grandes étoiles, de 16 à 96 pétales. En chemin des formes primitives de Zellij apparaîtront successivement (figure 7g). Une bibliothèque de motifs et de formes primitives est enrichie à chaque nouvelle création. Il y a aussi la possibilité de paramétrer les dimensions des formes primitives alors qu'à ce jour, les formes primitives découpées à la tradition ont les mêmes dimensions. Chaque motif choisi ou créé est constitué d'un ensemble de formes primitives qui doivent être découpées.

Le diagramme de décision de la figure 8 explique le choix des décisions globales. Le problème de la détection de contours dans une image numérisée, où plus généralement celui de la segmentation d'une image, peut apparaître dans divers domaines où un certain traitement d'images est nécessaire : télédétection, reconnaissance de formes, contrôle qualité, télémédecine,...

Si on caractérise les contours étudiés dans ces diverses situations par le profil de niveau de gris sur une ligne d'image, on obtient quatre types de contours idéaux [9].

On peut dire qu'un contour est une zone de transition plus ou moins brutale séparant deux plages de textures différentes ou de niveaux de gris différents. Il est bien connu qu'un algorithme de détection de contours est conçu en fonction de l'utilisation ultérieure des contours obtenus, et que la précision requise est différente pour les différentes utilisations de ces contours.

Les difficultés rencontrées par la plupart des détecteurs de contours classiques (gradient, laplacien, … etc) proviennent du bruit important présent dans les images bruitées (bruit du capteur, bruit d'échantillonnage, irrégularité de la surface des objets,...). Cependant les opérateurs de type Gaussiens permettent à la fois la détection des contours et la suppression du bruit. A leur tour, ces opérateurs présentent un problème lié au choix du paramètre d'échelle σ (conflit : suppression du bruit, localisation de contours).

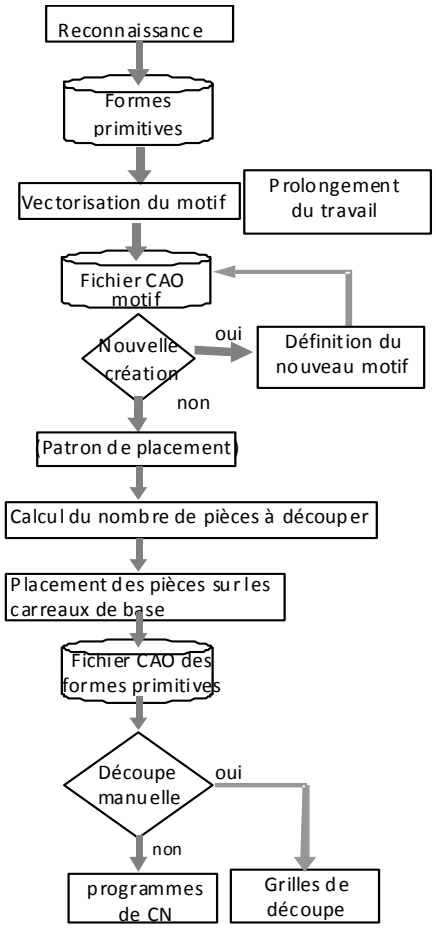


Fig. 8. Diagramme de décision

La figure 8 explique le choix des décisions commençant par la reconnaissance jusqu'au programme de commande numérique. Le motif défini en CAO est édité puis utilisé comme "patron" pour le placement des différentes formes primitives découpées en vue de les assembler.

L'algorithme figure 9 examine l'ensemble des points du contour de la forme primitive et en extrait ensuite le tableau des points $P_{i(i=0,3)}$ qui constituent les sommets du rectangle circonscrit.

Entrée : Ensemble des entités du contour de la FUC

Sortie : tableau T des points $P_{i(i=0,3)}$ du rectangle circonscrit
INITIALISATIONS :
i ← 0
j ← 0
Début
Répéter pour chaque entité "i" du contour
Répéter pour chaque point "j" de l'entité
Trouver les coordonnées x_j et y_j du rectangle circonscrit (valeurs extrêmes)
Jusqu'à j = 2
i ← i +1
Jusqu'à i = nombre d'entité
Fin

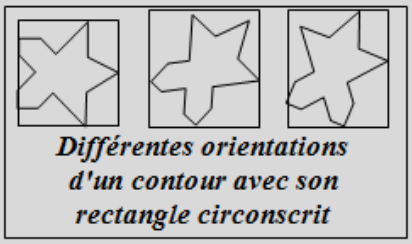


Fig. 9. Algorithme de recherche du rectangle circonscrit

4 USINAGE DES FORMES PRIMITIVES

Les procédés actuels de production de Zellij restent traditionnels. La réalisation des formes primitives devant constituer les motifs élémentaires avant leur fixation sous forme de plaques, actuellement passe par deux étapes essentielles :

1. la préparation du carreau de base de Zellij d'environ 11*11*1.2 cm^3 (préparation de la pâte "en argile", aplatissement, découpe, dessèchement, cuisson, revêtement, …)
2. le taillage des formes primitives à partir des carreaux de base de Zellij (façonnage manuel, face par face, par une main d'œuvre qualifiée et coûteuse).

Dans ce qui suit, nous proposons un procédé continu de taillage des formes primitives. Cette nouvelle méthode de découpe permet d'obtenir la trajectoire de l'outil de découpe, à partir des contours de formes primitives placées sur un plan (les dimensions de ce plan sont ceux de la face colorée du carreau de base).

4.1 PLACEMENT ET DÉFINITION DES TRAJECTOIRES

La méthode consiste à extraire, à partir d'un fichier CAO des motifs, les contours fermés qui sont constitués par un ensemble de segments (position (x,y) des deux points définissent un segment) qui construisent les formes primitives.

Le contour de chaque forme primitive définit les faces à usiner, il englobe la Face d'Usinage Commune (FUC). La FUC [7], [8] est une face d'usinage de poids maximal (le poids représente le cardinal de l'ensemble minimal des arrêtes issues de l'intersection de la face d'usinage considérée et des autres faces d'usinage), la figure 8 représente l'exemple de la FUC d'une pièce de Zellij obtenues à partir d'un modèle de faces frontières (annexe B).

Le balayage du contour de la forme primitive (modèle 2D) ou de la FUC (modèle de faces frontières) par un outil de coupe conique à 60° garanti la découpe de la pièce de Zellij.

Le contour d'une FUC peut avoir plusieurs orientations. Chaque orientation est obtenue par la position verticale d'une entité (de type segment) parmi les entités du contour. Pour chaque position du contour obtenu nous déterminons son rectangle circoncit. La duplication, de ce rectangle, permet de définir la trajectoire de l'outil de coupe.

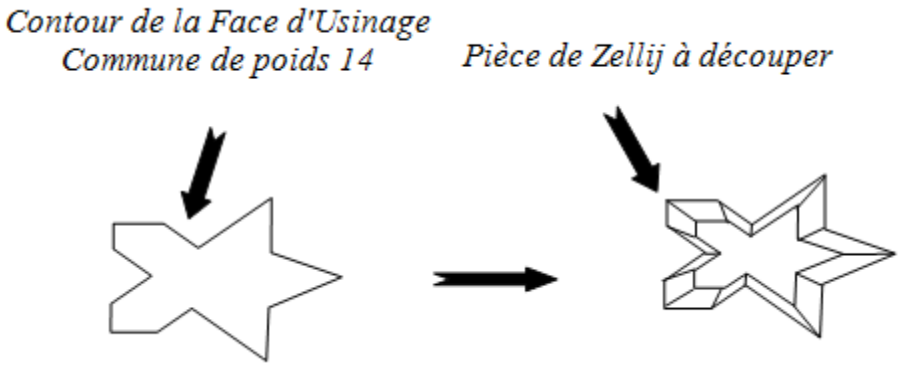


Fig. 10. Exemple de Faces d'Usinage Communes d'une pièce de Zellij obtenues à partir d'un modèle de faces frontières.

Le contour d'une forme primitive peut avoir plusieurs orientations. Chaque orientation est obtenue par la position verticale d'une entité (de type segment de droite) parmi les entités du contour. Le nombre des orientations dépend du nombre de segments du contour.

Pour chaque orientation du contour obtenu nous déterminons son rectangle circonscrit (figure 9). La duplication, de ce rectangle permet de définir la trajectoire de l'outil de coupe (figure 11).

La duplication symétrique est la mieux adaptée puisqu'elle optimise les chutes. En effet, de nouvelles pièces sont récoltées après la découpe d'un carreau de base et elles peuvent être utilisées pour constituer d'autres motifs. Par exemple, l'octogone étoile est obtenue par une duplication symétrique de la pièce (figure 11).

D'autres orientations de contours peuvent être obtenues, selon le besoin, en faisant de simples combinaisons et duplications des trente-sept formes primitives utilisées dans la création des motifs.

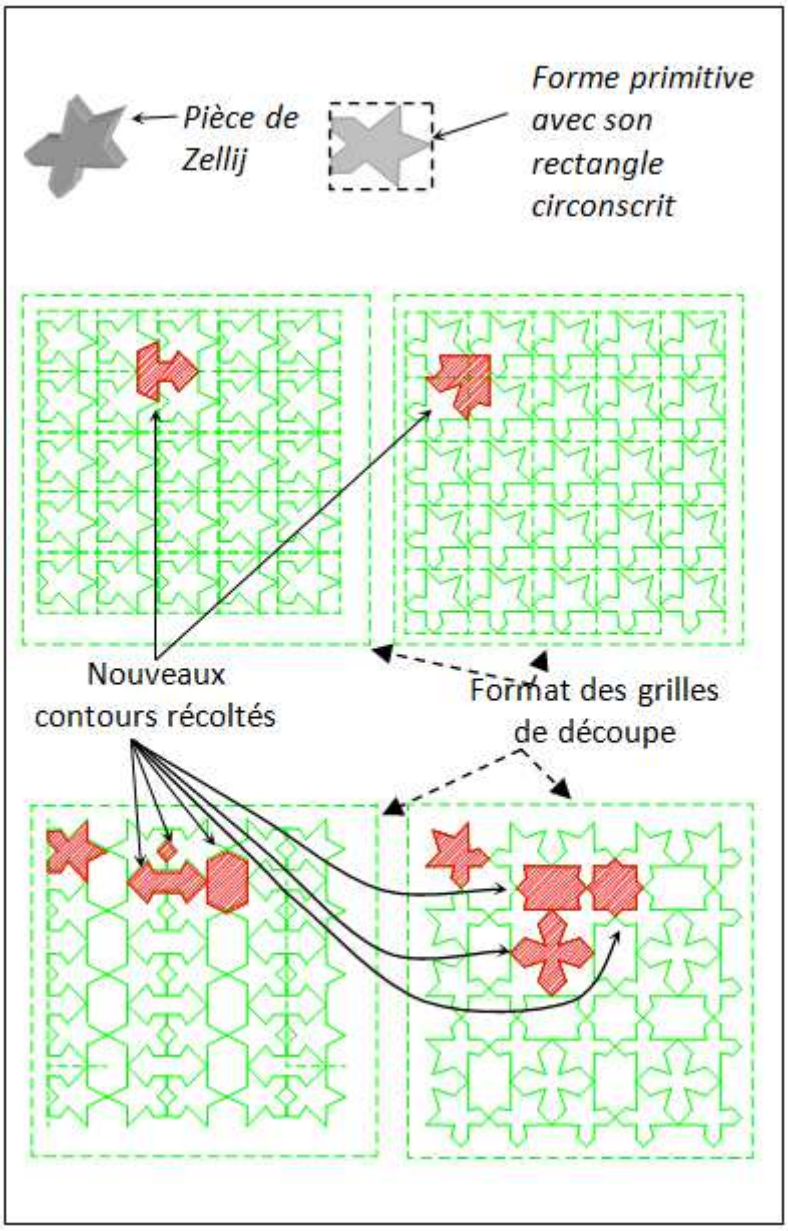


Fig. 11. Exemples d'orientations de contours de formes primitives

4.2 DÉCOUPE

Dans ce paragraphe, nous proposons deux modèles de découpe, le premier manuel, utilise une grille de découpe, l'autre fait appel à un ''porte-pièce'' monté sur deux axes numérisés.

Déplacement manuel :

Les contours de formes primitives serviront à l'élaboration des grilles de découpe (Figure 11). Ces grilles de la taille d'un carreau de base de Zellij, sont obtenues par simple usinage et permettent, la définition da la trajectoire de l'outil. Dans le cas du déplacement manuel pour la découpe (Figure 12), la pointe à suivre est logée dans des rainures en V de la grille (système de copiage). Les déplacements de l'ensemble {grille-carreau} sont effectués manuellement selon les axes X, Y. Pour ce procédé manuel, la phase de découpe nécessite deux opérations, la première c'est une opération d'ébauche avec l'outil 1 (outil conique pour réaliser la dépouille nécessaire pour la bonne fixation des pièces entre elles par l'intermédiaire du liant) et la deuxième c'est une phase de finition avec l'outil 2 de faible diamètre.

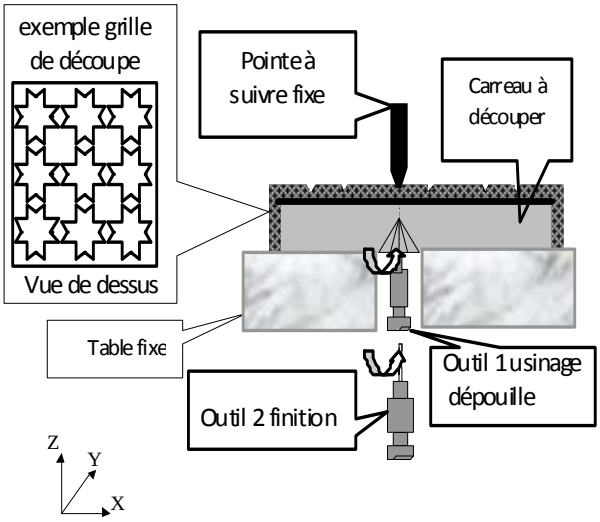


Fig. 12. Principe de découpe manuelle

Déplacement automatisé :

Dans le cas d'un déplacement automatisé, la grille de découpe est remplacée par deux axes numérisés. Le programme de commande numérique (code ISO) est généré à partir des contours de la FUC comme profil fini pour établir le sous-programme. Ce dernier est appelé autant de fois que de duplications, en utilisant les fonctions préparatoires de translation et de rotation du système de coordonnées. L'utilisation des fonctions de symétrie et l'imbrication des programmes sont nécessaires. Dans ce cas, l'utilisation simultanée des deux outils 1 et 2 (Figure 13) est possible, leurs pénétrations est donnée par un système vis-écrou mené en rotation par un moteur électrique.

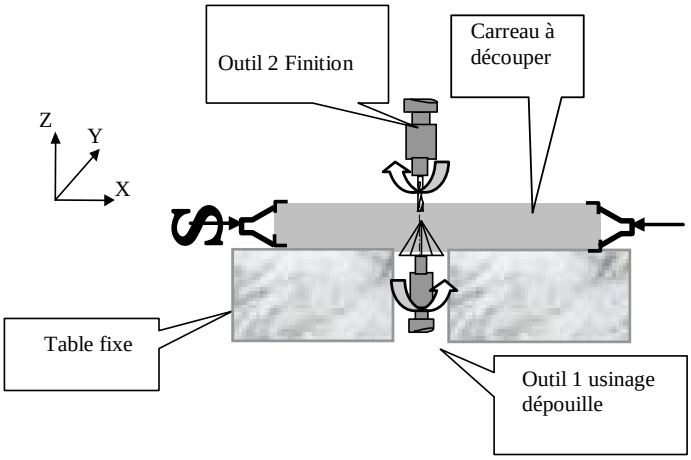


Fig. 13. Principe de découpe automatisée

5 CONCLUSION

La méthode proposée dans cet article consiste à extraire un ensemble d'informations nécessaires et suffisantes pour reconstruire un ensemble de motifs traditionnels. La reconnaissance du contour des formes primitives est une étape essentielle. En effet, les contours reconnus sont à la base du choix du type de motif ou de construction de nouveaux motifs. Le motif défini en CAO est édité puis utilisé comme "patron" pour le placement des différentes formes primitives découpées.

La reconnaissance automatique du contour de chaque forme primitive est nécessaire pour générer la gamme de découpe. Nous avons proposé une méthode pour le choix du positionnement du contour, dans un plan qui a les dimensions de la face

colorée du carreau de base de Zellij à découper, pour optimiser les chutes. A la suite nous avons proposé deux méthodes de découpe, le premier manuel utilise une grille de découpe, l'autre utilise deux axes numérisés.

Ce procédé ouvre la possibilité de composer les motifs par assemblage des formes primitives de natures différentes: pièces de Zellij, pièces de marbre, pièces en bois. Il est possible d'envisager aussi le choix automatique des motifs (couleurs et dimensions), par une homothétie du squelette et de calculer le nombre de formes primitives qu'il est nécessaire de découper pour une surface donnée.

Les prolongements de cette étude sont multiples et peuvent être classés selon deux orientations :

- La première orientation est liée à la fabrication proprement dite. Dans cette voie, les développements concernent les modes possibles de fixation, l'utilisation d'autres techniques de découpe telles que jet d'eau. Cependant le respect du contexte local conditionne la réussite, l'acceptation des évolutions proposées, critère jugé prioritaire pour ce projet.
- La seconde orientation se situe en amont et concerne les développements des modes possibles de fixation des pièces découpées.

A noter aussi, que nous sommes entrain d'étudier une autre méthode d'obtention des pièces de Zellij, c'est l'estampage des formes primitives, elle consiste à graver les formes primitives (figure 14) directement sur le carré de base. cette méthode qui n'est pas chère à mettre en œuvre va permettre de réduire d'une manière très importante les chutes de matière première et surtout de réduire la consommation de l'énergie. Cette étude consiste à trouver le comportement et le rétrécissement des pièces après la cuite au four.

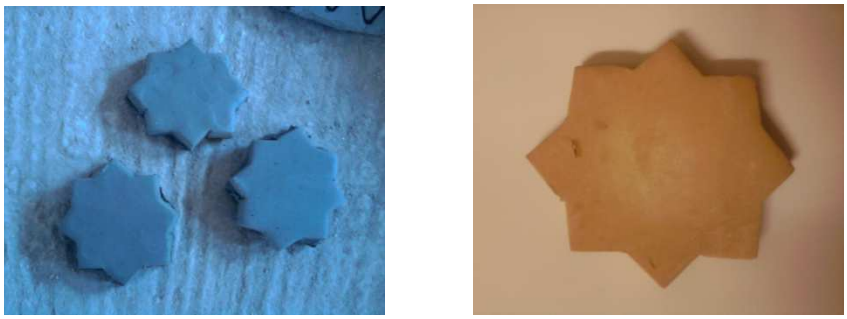


Fig. 14. Estampage de la forme primitive étoile à ''8'', avant (gauche) et après (droite) la cuite au four

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ANNEXE 1 FILTRE DE CANNY (CAS MONO DIMENSIONNEL)

L'approche de Canny [10] est présentée à une dimension, elle consiste à trouver le filtre optimal de réponse impulsionnelle f(m) satisfaisant les trois contraintes suivantes pour un signal d'entrée en échelon :

- Une bonne détection
- Une bonne localisation
- Une faible multiplicité des maximums dus au bruit.

Canny exprime les points de contour par:

$I_e(m) = A\, u_{-1}(m) + b(m)$

$I_e(m)$ contour observé, b(m) bruit Gaussien de moyenne nulle et de variance σ_0 .

$u_{-1}(m)$ contour vrai avec :

$$u_1(m) = \begin{cases} 1 & si \;\; m \geq 0 \\ 0 & \sin on \end{cases}$$

Soit h la réponse impulsionnelle du filtre de lissage $I_s = I_e * h$, on calcule alors le gradient

$$\nabla I_s = \nabla(I_e * h) = I_e * \nabla h \qquad posons \;\; f = \nabla h$$

Il s'agit de convoluer l'image I_e par un opérateur de détection f(m) pour obtenir le gradient de I_s . L'opérateur f(m) doit satisfaire les trois critères suivants :

- Bonne détection : maximisation du rapport signal sur bruit (SNR) avec :

$$SNR = \frac{A}{n_0} \frac{\left| \int_{-\infty}^{0} f(m)dm \right|}{\sqrt{\int_{-\infty}^{+\infty} f^2(m)dm}}$$

- Bonne localisation : mesurée par L :

$$L = \frac{A}{n_0} \frac{\left| f'(0) \right|}{\sqrt{\int_{-\infty}^{+\infty} f^2(m)dm}}$$

- Réponse unique : à un contour détecté doit correspondre un seul maxima de la sortie ∇I_s, les maxima de ∇I_s doivent être les plus éloignés possibles les uns des autres.

Soit x_{max} , distance moyenne entre deux maxima de la sortie ∇I_s, on l'exprime par :

$$x_{\max} = 2\pi \sqrt{\frac{\int_{-\infty}^{+\infty} f'^2(m)dm}{\int_{-\infty}^{+\infty} f''^2(m)dm}} = K$$

En tenant compte de ces trois critères, Canny montre que la fonction f qui maximise le produit SNR x L et donne un x_{max} égal à K, s'exprime par :

$$f(m) = a_1 e^{\alpha m} \sin(\omega m) + a_2 e^{\alpha m} \cos(\omega m)$$
$$+ a_3 e^{-\alpha m} \sin(\omega m) + a_4 e^{-\alpha m} \cos(\omega m) + C$$

Les différents coefficients sont déterminés à l'aide des conditions aux limites pour trouver un opérateur f(m) sous la forme d'un filtre à réponse impulsionnelle finie.

Ainsi, l'opérateur de Canny correspond à la première dérivée du filtre gaussien, nous donnerons ci dessous son implémentation dans le cas bi-dimensionnel. Le filtre gaussien est défini par:

$$G(m,n) = \frac{1}{2\pi\sigma^2} e^{-\frac{m^2+n^2}{2\sigma^2}}$$

Les deux composantes orthogonales du gradient de l'image brute filtrée par la gaussienne sont données par:

$$y_m = -\frac{m}{\sigma^2} G(m,n) * x_{mn} \qquad y_n = -\frac{n}{\sigma^2} G(m,n) * x_{mn}$$

ANNEXE 2 FILTRE DE DERICHE

a - cas monodimensionnel

Deriche reprend le formalisme de Canny en recherchant une fonction f optimale vérifiant les critères précédents réalisant un filtre à réponse impulsionnelle infinie. D'où une fonction f(m) :

$$f(m) = \frac{S}{\omega} e^{-\alpha|m|} \sin(\omega m)$$

Avec S pente à l'origine de f(m). Il tire alors l'expression des critères de performance :

$$L = \sqrt{2\alpha} \qquad L \times SNR = \frac{2\alpha}{\sqrt{\alpha^2 + \omega^2}}$$

$$SNR = \sqrt{\frac{2\alpha}{\alpha^2 + \omega^2}} \qquad K = \sqrt{\frac{\alpha^2 + \omega^2}{5\alpha^2 + \omega^2}}$$

Le meilleur indice de performance est obtenu lorsque $\alpha >> \omega$. Dans ce cas, la fonction optimale s'écrit :

$g(x) = c \times e^{-\alpha|m|}$

b - cas bidimensionnel

- Lissage : Le filtre utilisé combine deux filtres monodimensionnels dans les directions m et n. Le filtre de lissage choisi est l'intégrale h(m) du filtre optimum :

$$g(m) = c \times e^{-\alpha|m|}$$
$$h(m) = K(\alpha|m| + 1)e^{-\alpha|m|}$$

On a alors dans le cas bidimensionnel :

$$h(m,n) = K(\alpha|m| + 1)e^{-\alpha|m|} - K(\alpha|n| + 1)e^{-\alpha|n|}$$

- Gradient

Le calcul du gradient est effectué à l'aide des dérivées premières, g_m et g_n , selon m et n de l'image lissée. On obtient :

$$g_m(m,n) = c|m|e^{-\alpha|m|} \times K(\alpha|n| + 1)e^{-\alpha|n|}$$

= (Calcul du gradient suivant m)*(lissage suivant n)

$$g_n(m,n) = c|n|e^{-\alpha|n|} \times K(\alpha|m| + 1)e^{-\alpha|m|}$$

= (Calcul du gradient suivant n)*(lissage suivant m)

Ces filtres sont séparables et peuvent s'implémenter récursivement

- Laplacien : Pour le calcul du Laplacien Deriche utilise l'opérateur de lissage h(m) tel que :

$h(m) = K e^{-\alpha|m|}$

D'où un opérateur bidimensionnel dérivée seconde :

$$x_{mn} = e^{-\alpha|m|}e^{-\alpha|n|} - K\alpha e^{-\alpha|m|} \qquad - K\alpha e^{-\alpha|n|}$$

D'autres filtres optimaux de détection de contours ont été développés. Ils reposent sur des principes similaires (lissage et application d'un opérateur différentiel) et utilisent d'autres critères d'optimisation [11], [12].

ANNEXE 3 : DÉFINITION DE LA FACE D'USINAGE COMMUNE "FUC"

La figure 16 montre comment extraire des FUC [5] [6] avec un poids maximal :

Face d'usinage "FU": Enveloppe de l'ensemble des points de contact entre l'outil et un élément caractéristique de l'entité (face plane ou face cylindrique) au cours du mouvement de travail de l'outil.

Poids d'une face d'usinage: Considérons les faces qui enveloppent l'ensemble des sommets d'une entité de forme qui ont en commun une même coordonnée suivant l'un des axes du repère. Le poids d'une face d'usinage est le cardinal de l'ensemble minimal des arêtes convexes issues de l'intersection de la face d'usinage considérée avec les autres faces d'usinage. Deux faces d'usinage ayant en commun au moins une arête sont représentées par une seule arête au niveau de l'ensemble minimal (figure 16).

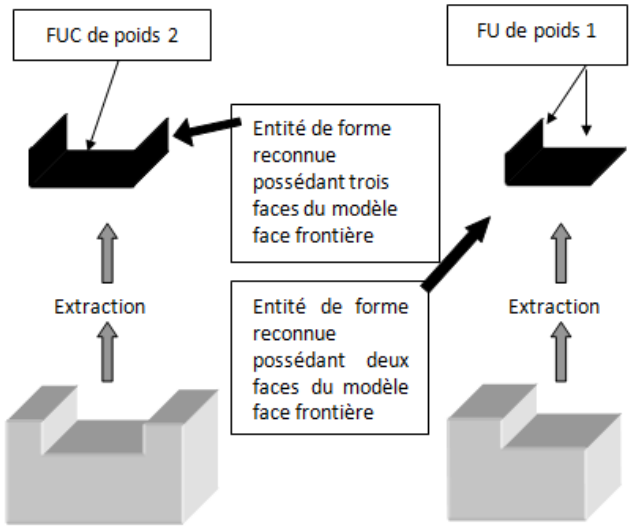


Fig. 15. Exemple de FUC et le poids correspondant

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L'éco-conception une clé pour un développement durable

[Eco-design the key of sustainable development]

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ABSTRACT: The awareness of the environmental impacts of human activity has led to the adoption of several initiatives to promote more sustainable development. Producing and consuming, while minimizing impacts on the environment is one approach to reduce environmental degradation. Pressure from governments and consumers leads companies to introduce environmental constraints among the criteria to take into account in their activities. As product is at the heart of their activities, attention is focused on it since its design phase and this for its entire life cycle. This new approach consists to consider the environmental constraints the same way as other constraints related to cost, quality and delay at the design stage. This process, known as eco-design, attracts the attention of both industry and academia. Many tools and methods have been proposed to allow the deployment of this new approach. In this paper, we reviewed the impact of eco-design, and proposed approaches to help companies to realize more important saving.

KEYWORDS: environment, eco-design, sustainable development, optimisation, tools, methods.

RESUME: Une prise de conscience de plus en plus générale des conséquences environnementales de l'activité humaine a favorisé la prise de plusieurs initiatives en faveur d'un développement plus durable. L'une des actions en faveur de l'environnement consiste à produire et consommer tout en minimisant les impacts sur l'environnement. Les entreprises, et sous la pression des pouvoirs publics et des consommateurs, commencent à introduire les contraintes environnementales parmi les critères à tenir en compte dans leurs activités. Le produit étant au centre de leur activité, une attention particulière lui est portée dès sa phase de conception et ceci pour l'ensemble de son cycle de vie. Cette nouvelle approche consiste à considérer les contraintes environnementales au même titre que les autres contraintes liées au coût, à la qualité et au délai dès la phase de conception. Ceprocessus, connu sous le nom d'éco-conception, attire l'attention aussi bien des industriels que des chercheurss. De nombreux outils et méthodes ont été proposés pour permettre le déploiement de cette nouvelle approche. Dans cet article nous allons présenter d'une façon globale l'importance de l'éco-conception et son rôle dans le Développement Durable et sur les objectifs de croissance et de développement des entreprises.

MOTS-CLEFS: environnement, développement durable, éco-conception, optimisation, outils, méthodes.

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1 INTRODUCTION

L'air des grandes cités est de plus en plus pollué, des dizaines de millions d'habitants dans le monde n'ont pas accès à l'eau potable, des forêts sont détruites et des espèces disparaissent, les ressources naturelles sont souvent surexploitées, les catastrophes écologiques se multiplient, les menaces globale sur l'environnement s'aggravent et le rend de plus en plus fragile (changement climatique, raréfaction des ressources naturelles avec en particulier le rapprochement du pic pétrolier, écarts entre pays développés et pays en développement, sécurité alimentaire, perte drastique de biodiversité, croissance de la population mondiale,…) [1]. Tous ces exemples de dégradation environnementales, qu'elles soient crées ou accentuées par l'homme, et de la difficulté qu'il semble y avoir pour y remédier ne manquent pas [2].

Une telle situation, dont rien n'indique qu'elle va s'améliorer prochainement, a des conséquences économiques évidentes, que l'on pense aux couts qu'il faudrait engager pour éviter les dégradations, ou à ceux qu'implique la réparation des dommages. Il importe donc, de mettre en place des politiques environnementales efficaces, pour lutter contre les causes de cette dégradation environnementale et les raisons de sa persistance [3]. On parle alors du développement durable. Plusieurs axes peuvent assurer un Développement Durable, en outre dans nos travaux de recherches suivants nous allons s'intéresser à l'axe concernant l'éco-conception.

L'éco-conception est une démarche de conception de produit (et de son emballage) qui doit permettre, de minimiser ses impacts environnementaux, tout au long de son cycle de vie, dans un processus d'amélioration continue et à coût maîtrisé. C'est une approche qui se développe, notamment depuis les années 1990 en Europe du Nord, basée sur le fait que tout produit et processus ont un impact sur l'environnement, qu'il s'agisse de production de biens ou de service. Toutefois, considérer l'éco-conception comme une contrainte, notamment du fait de la pression réglementaire, ce qui constitue au sens des industriels une vision négative et réductrice de ce concept. Par contre il vaut mieux considérer qu'il s'agit d'une opportunité, d'un réel défi à relever pour innover. L'éco-conception, vue sous cet angle, peut en effet devenir un vecteur de différenciation qui pousse à faire et proposer des produits et des services différents de ceux des concurrents. Dans le présent article, nous essayons de présenter les effets positifs que peut générer l'intégration d'une démarche d'éco-conception.

2 DÉVELOPPEMENT DURABLE

2.1 DÉFINITION DU DÉVELOPPEMENT DURABLE

La notion du développement durable (ou soutenable, tiré de l'Anglais « sustainable ») a été introduite depuis 1987 par la Commission Mondiale sur l'Environnement et le Développement, présidée par le premier ministre Norvégien de l'époque, Gro Harlem Brandtland. Le rapport final, intitulé « notre avenir à tous » (Our Common Future), définit le développement durable comme : un développement qui permet la satisfaction des besoins présents, sans compromettre la capacité des générations futures à satisfaire les leurs. Très vite, l'expression a connu un succès extraordinaire, à tel point que, dès 1989 cette notion de développement durable a connu plus de soixante définitions [4].

L'objectif du développement durable est de définir des schémas viables qui concilient les trois aspects économique, social, et écologique des activités humaines : « trois piliers » à prendre en compte par les collectivités comme par les entreprises et les individus [5]. La finalité du développement durable est de trouver un équilibre cohérent et viable à long terme entre ces trois enjeux. À ces trois piliers s'ajoute un enjeu transversal, indispensable à la définition et à la mise en œuvre de politiques et d'actions relatives au développement durable : la gouvernance [6]. La gouvernance consiste en la participation de tous les acteurs (citoyens, entreprises, associations, élus...) au processus de décision ; elle est de ce fait une forme de démocratie participative. Le développement durable n'est pas un état statique d'harmonie, mais un processus de transformation dans lequel l'exploitation des ressources naturelles, le choix des investissements, l'orientation des changements techniques et institutionnels sont rendus cohérents avec l'avenir comme avec les besoins du présent. On peut considérer que les objectifs du développement durable se partagent entre trois grandes catégories [7]:

- Ceux qui sont à traiter à l'échelle de la planète : rapports entre nations, individus, générations ;
- Ceux qui relèvent des autorités publiques dans chaque grande zone économique (Union européenne, Amérique du Nord, Amérique latine, Asie…) ;
- Ceux qui relèvent de la responsabilité des entreprises.

Si les objectifs du développement durable font l'objet d'un relatif consensus, c'est son application qui demeure source d'oppositions. L'une des questions posées par le terme de « développement durable » est de savoir ce que l'on entend par « durable ». Or, la nature peut être vue de deux manières, complémentaires : il existe d'une part un *"capital naturel"*, non-

renouvelable à l'échelle humaine (la biodiversité par exemple), et d'autre part des *ressources renouvelables* (comme le bois, l'eau...). Cette distinction étant faite, deux conceptions sur la durabilité vont s'opposer [8].

2.2 LES PRINCIPAUX CONCEPTS DU DÉVELOPPEMENT DURABLE

Au risque d'être trop schématique, on distingue quatre grands concepts du développement durable. Le premier, concerne les tenants de l «'écologie profonde », qui accorde une valeur à la nature indépendante des besoins humains et ont une position protectionniste absolue qui ne peut conduire qu'à un état stationnaire de l'économie. Le deuxième concept, est pris pas les « éco-centristes », qui pensent qu'il est toujours possible de substituer du capital produit aux actifs naturels, et donc qu'il n'y a pas de réelle contrainte environnementale, pour eux, la nature n'a de valeur qu'instrumentale et le progrès technique apportera toujours des solutions pour réparer les dommages avant qu'ils ne deviennent trop importante.

Au-delà des divergences qui caractérisent ces deux concepts, il y a une idée commune qui relie la soutenabilité à une certaine capacité de garder quelque chose de constant sur la durée, et il y a justement divergence sur la spécificité de ce qui doit constant. De plus, l'insistance mise sur la dimension temporelle du concept soulève le problème, qui semble à première vue insurmontable du point de vue financement, de la prise en compte des préférences des générations futures. Cette difficulté est redoublée du fait des effets à très long terme (effet de serre) de nombre de nos décisions sur les problèmes présents [9]. C'est ainsi que le soutien de la voiture individuelle, comme un des vecteurs de la croissance dans les pays industrialisés à la sortie de la seconde guerre mondiale, révèle cinquante ans plus tard ses effets négatifs.

3 L'ÉCO-CONCEPTION

3.1 INTRODUCTION À L'ÉCO-CONCEPTION

Dans la littérature, plusieurs termes sont utilisés pour désigner l'éco-conception, les plus fréquents sont : ecodesign, ecological design, environmental design, design for the environment et life cycle design. A noter que les définitions de ces termes comportent certaines différences selon les modes d'évaluation des impacts environnementaux. On va prendre la définition suivant : « L'éco-conception est un processus d'intégration des aspects environnementaux dans la conception et le développement de produits qui a pour objectif la réduction des impacts environnementaux des produits tout au long de leur cycle de vie » [10].

La première vague d'intégration de l'environnement en développement de produits date du début des années 1970. Son objectif principal est de diminuer la quantité de déchets solides qui se retrouvent dans les sites d'enfouissement. Elle est associée à l'approche bouclage des flux de matières. Selon Millet (1995), « cette approche consiste à poser que les impacts environnementaux occasionnés par le produit seront minimisés si l'on réalise le bouclage des flux de matières intervenant dans la phase fin de vie du cycle de vie du produit ».

Rapidement, des chercheurs américains notamment, s'intéressent à des démarches incluant de multiples impacts environnementaux, selon lesquelles l'optimum écologique est obtenu en minimisant cinq critères (l'énergie, la matière, les déchets solides, les rejets dans l'eau et les rejets dans l'air) durant l'élaboration d'un produit ou d'un service [11].

Au départ, l'approche multicritères consiste à intégrer les bilans matières, utilisés par l'industrie chimique, aux bilans énergétiques développés à la suite du choc pétrolier pour avoir une vision plus complète des ressources nécessaires à l'élaboration de produits. Plus tard apparaissent les « REPA » (Ressources and Environmental Profile Analysis). Dans ces analyses, outre les ressources utilisées, on prend en compte les rejets générés par le système de production à l'étude.

Au milieu des années 1970, l'urgence de la diminution des déchets capte toute l'attention. Ce n'est qu'au début des années 1980 que l'intérêt pour ces analyses revient. Ainsi, en 1979, des industriels américains créent la SETAC (Society of Environmental Toxicology and Chemistry), avec l'objectif de développer et de promouvoir les outils permettant d'évaluer les impacts environnementaux d'une technique ou d'une activité. Durant les années 1980, on intègre dans les analyses d'impact les matériaux, l'énergie, les déchets solides, les rejets dans l'eau et dans l'air pour obtenir une vision de plus en plus complète des impacts générés par des produits ou des systèmes.

Il convient en conséquence, pour minimiser l'impact du produit (tout au long de sa vie) sur l'environnement, d'agir sur sept axes majeurs que sont :

- les matières premières,
- les substances,
- l'énergie,

- la pollution de l'air,
- la pollution de l'eau,
- la pollution des sols,
- les déchets.

Outre le souci du citoyen de préserver l'espèce humaine et son environnement, l'industriel doit tenir compte de l'éco-conception pour des raisons purement réglementaires et aussi pour satisfaire les exigences de ses clients soucieux du respect de l'environnement pour leur image. C'est ainsi que les acheteurs des administrations et des collectivités locales intègrent des critères environnementaux dans leurs appels d'offres, que dans le code des marchés publics, l'aspect protection de l'environnement est cité, et qu'enfin, il convient de ne pas oublier une demande latente des consommateurs pour une pratique responsable de la part des industriels.

Toutefois, considérer l'éco-conception comme une contrainte, notamment du fait de la pression réglementaire, ce qui constitue à notre sens une vision négative et réductrice de ce concept. Par contre il vaut mieux considérer qu'il s'agit d'une opportunité, d'un réel défi à relever pour innover. L'éco-conception, vue sous cet angle, peut en effet devenir un vecteur de différenciation qui pousse à faire et proposer des produits et des services différents de ceux des concurrents.

3.2 AVANTAGES DE L'ÉCO-CONCEPTION

Néanmoins, la préoccupation principale des entreprises demeure le critère économique, l'intégration des questions environnementales se fait alors de plus en plus par l'éco-efficience [12]. Présenté au Sommet de la Terre à Rio en 1992 par Stephan Schmidheiny (homme d'affaire suisse), le concept d'éco-conception revêt un caractère économique et environnemental. Le préfixe « éco », selon Schmidheiny, fait référence à la fois à économie et écologie. D'une manière générale, l'éco-efficience cristallise en sept points les principes et critères reliés aux approches environnementales développées au fil des ans, qui sont :

1. Réduire l'intensité des matériaux ;
2. Réduire l'intensité énergétique ;
3. Réduire la dispersion des substances toxiques ;
4. Améliorer la recyclabilité ;
5. Maximiser l'utilisation de ressources renouvelables ;
6. Prolonger la durée de vie ;
7. Accroître l'intensité du service.

Au niveau environnemental, l'éco-efficience consiste à diminuer l'utilisation des ressources naturelles (éléments 1, 2 et 5) et à réduire l'émission de rejets dans l'environnement (éléments 3, 4 et 6). L'éco-efficience est une mesure relative qui consiste à mettre en relation la performance économique et la performance environnementale (ou écologique) d'un produit ou d'un service. Le but de la démarche n'est pas de produire moins, mais de produire mieux. Selon le WBCSD, (World Business Council for Sustainable Development), la mise en œuvre de l'éco-efficience nécessite la mise en place d'une structure de base incluant :

1. L'implantation d'un système de management environnemental ;
2. L'intégration de la pensée cycle de vie dans la gestion ;
3. L'éco-conception ;
4. Une gestion de la chaîne d'approvisionnement.

Le système de management environnemental a pour objectif de mettre sur pied une unité de gestion et de suivi qui assure l'amélioration environnementale continue de l'entreprise. Cette entité fixe les objectifs de réduction des impacts environnementaux de l'entreprise et assure le suivi en ce qui concerne l'atteinte ou non de ces objectifs. L'intégration de la pensée cycle de vie dans la gestion est fondamentale. Elle permet d'avoir une vision plus large de l'ensemble des activités nécessaires à l'élaboration des produits et services, ce qui favorise une meilleure compréhension des relations entre ces activités. Le troisième élément, l'éco-conception, permet d'intégrer les aspects environnementaux dès la conception des produits. Finalement, avec une meilleure gestion de la chaîne d'approvisionnement, l'entreprise devrait pouvoir s'assurer que les fournisseurs qui collaborent avec elles intègrent aussi les aspects environnementaux [13].

L'éco-conception est ainsi une composante primordiale pour l'intégration de l'environnement dans le développement des produits et services. Elle est aussi une démarche qui peut procurer de nombreux bénéfices pour l'entreprise, ses clients et ses partenaires. Nous avons constaté que plusieurs axes, peuvent donner lieu à des réductions de coûts. Ainsi, un produit plus facilement recyclable peut être conçu en « mono matériau », ce qui est souvent moins cher, plus facile à assembler, et

peut permettre une récupération plus facile à la fin de sa vie. L'utilisation d'une matière recyclée peut s'avérer moins coûteuse qu'une matière vierge. Les matières renouvelables, comme le bois, peuvent être moins coûteuses que celles qui sont non renouvelables. Au niveau de l'optimisation des matières, plusieurs possibilités existent; par exemple, l'emballage peut être minimisé, ce qui peut se répercuter de façon positive au niveau de la chaîne logistique comme à l'entreposage et lors du transport. Par ailleurs, le rendement énergétique de tout produit peut être amélioré. L'utilisation d'énergies renouvelables, comme dans le cas de chauffe-eau solaires, peut également générer des économies. Enfin, des produits plus durables peuvent entraîner des réductions de coûts chez les clients et améliorer leur fidélisation.

4 PROPOSITION D'UN MODÈLE D'INTÉGRATION DE L'ÉCO-CONCEPTION DANS LE PROCESSUS DE CONCEPTION ET DE DÉVELOPPEMENT

4.1 INTRODUCTION

Tenir des objectifs à caractère environnemental dans l'activité de conception de produit ne se réduit pas à l'intégration d'une contrainte technique de plus. Les aspects organisationnels de l'entreprise doivent également être considérés [10]. A l'image de la conception classique, on ne peut définir un schéma unique d'éco-conception. Chaque entreprise, en fonction de ses spécificités déterminera l'organisation à mettre en place pour éco-concevoir ses produits. Néanmoins, un cadre générique peut être déni. Celui-ci pourra par la suite être adapté à chaque cas particulier.

Dans ce chapitre nous proposons un modèle générique d'éco-conception dans lequel nous donnons des indications générales.

4.2 L'IMPORTANCE DE L'ENGAGEMENT DE LA DIRECTION

A l'instar de tout projet au sein de l'entreprise, un processus d'éco-conception nécessite une implication active de la direction. Dans la majorité des cas, elle est l'initiateur d'un tel projet. Les responsables opérationnels (production, conception et environnement) ont également une influence mais plutôt en tant que prescripteur ou conseil.

Ainsi, dans l'étude de l'ADEME [14], parmi les entreprises interrogées et qui envisagent la mise en place d'une démarche d'éco-conception, 86% des personnes susceptibles de jouer un rôle sont des décideurs (DG/ gérants/ directeurs de sites/ responsables commerciaux/ marketing) contre 23% des responsables Etudes et Conception. Au cours de l'étude franco-québécoise, 24 entreprises sur 30 ont cité la direction comme étant à l'origine de l'introduction de la démarche d'éco-conception suivi par la RD avec 10 citations.

Qu'elle soit à l'origine ou pas du processus d'éco-conception, l'engagement de la direction est une condition indispensable à son aboutissement. Selon la norme XP ISO/TR 1462, les actions que la direction peut engager dans la démarche d'éco-conception sont entre autres :

- la définition de la vision et de la politique environnementales ;
- la définition des objectifs et des cibles pour assurer le respect des dispositions juridiques et réduire les impacts environnementaux négatifs des produits ;
- l'allocation des ressources ;
- l'attribution des responsabilités, des tâches et des responsabilités financières ;
- la définition, le soutien et le suivi des programmes de conception et développement des produits ;
- la définition et la mise en œuvre des programmes de revue du processus de conception et développement des produits ;
- l'organisation/la structuration des fonctions et processus environnementaux de conception et développement de produit ;
- l'identification des besoins de recrutement et de formation pour la mise en oeuvre des programmes ;
- la définition des indicateurs de mesure et de performance et le suivi et la fourniture d'informations en retour sur les performances environnementales.

A cause de son aspect pluridisciplinaire, l'éco-conception fait intervenir des corps de métiers et disciplines très variés : le marketing, l'environnement, le bureau d'étude, l'ingénierie, la qualité, l'approvisionnement, la prestation de service, etc.

Chacun de ces intervenants est appelé à jouer un rôle dans la prise en compte des aspects environnementaux dans le processus de conception et de développement.

4.3 RÔLE DES ACTEURS IMPLIQUÉS DANS LE PROCESSUS DE CONCEPTION ET DE DÉVELOPPEMENT

Un projet d'éco-conception, comme un projet de conception classique, est un processus multidisciplinaire qui fait intervenir la direction, le bureau d'étude, la planification, la mercatique, la production, la qualité, l'environnement, l'approvisionnement, le personnel de service, les clients ou leurs représentants, les fournisseurs, les sous-traitants, les recycleurs etc.

Nous indiquons ci-dessous les rôles que peuvent jouer des acteurs clés de l'intégration des aspects environnementaux dans la conception et le développement de produit selon la norme XP ISO/TR 14062.

Tableau 1. Rôles joués par les acteurs impliqués dans une démarche d'éco-conception

Acteurs	Rôles
Marketing	• Veille sur l'évolution de la législation, les besoins des clients, l'action des concurrents et la mise à disposition d'informations stratégiques sur la direction poursuivie en matière de développement des produits et sur la détermination du prix du produit final
Direction	• Recherche et distribution d'informations sur les alternatives de conception, de mode de fabrication, de matériaux ou procédés possibles • Vérification de la faisabilité technique • L'établissement de systèmes de référence environnementale
Environnement	• L'étude et la documentation des aspects et des impacts environnementaux et la recherche de solutions alternatives. • L'augmentation de la prise de conscience environnementale par la formation et l'éducation
Planification, Bureau d'étude	• La recherche et la mise en œuvre de solutions créatives dans la conception et le développement de produit • La re-conception des produits en fonction des objectifs environnementaux de l'entreprise
Approvisionnement	• La collecte et la qualification de données sur les matériaux et les composants/sous-ensembles et la transmission aux fournisseurs d'informations relatives aux exigences environnementales de l'organisme. • La spécification des exigences environnementales et leur présentation aux organismes de la chaîne d'approvisionnement • L'évaluation des performances environnementales des fournisseurs
Fournisseurs, sous-traitant	• Mise à disposition des informations environnementales relatives à leur produit
Clients	• Etablissement du cahier de charges • Validation des solutions proposées Gestionnaire de la fin de vie • Participant au choix des solutions • Mise à disposition d'informations sur les différents scenarii de fin de vie

4.4 PROPOSITION D'UNE DÉMARCHE D'ÉCO-CONCEPTION

Planification : C'est pendant cette phase que les exigences qui doivent s'appliquer au futur produit sont formulées y compris celles liées aux aspects environnementaux. Ces exigences sont formulées en tenant compte de tous les facteurs externes (besoins des clients, la concurrence, le marché, les aspects réglementaires, l'environnement dans lequel le futur produit sera utilisé,..) et internes (Capacité des moyens de production, ressources financières et humaines, disponibilité des données, capacité des partenaires externes,). Plusieurs outils peuvent être utilisés pendant cette phase. Les outils classiques de la qualité peuvent être utilisés avec parfois certaines adaptations. L'application du système QFDE (Quality Function Deployment for Environment) permet par exemple d'identifier les parties du produit responsables des principaux impacts environnementaux et trouver la conception la plus optimisée. Les analyses SWOT (forces, faiblesses, opportunités, menaces) permettront de choisir les meilleures stratégies. Une ACV peut être menée sur les produits existant an d'en établir un profil environnemental et identifier les points à améliorer.

Conception préliminaire : A cette étape, les concepts du produit sont générés et évalués les uns par rapport aux autres en fonction des exigences déterminés à l'étape précédente. Les outils de créativité et d'innovation comme le brainstorming et l'EcoTRIZ, le logiciel CES Selector pour faire un choix de matériaux, les bases de données des matériaux et les Guidelines

sont entre autres les outils utilisés pendant cette phase. La comparaison des performances environnementales peut être obtenue à l'aide d'une ACV simpliée.

Conception détaillée : Les concepts retenus à la phase précédente sont concrétisés. On affine le choix de la géométrie, des matériaux, etc. On détermine les pièces à fabriquer et celles que l'on doit acheter. A ce stade, les outils CAO sont utilisés pour construire les modèles numériques, les bases de données sont utilisées pour le choix des matériaux. Les logiciels de simulation sont utilisés pour l'optimisation du produit et des processus du cycle de vie.

Essais/prototype : Différentes versions de prototype sont construits pour évaluer la performance et la fiabilité du produit et identifier les points à améliorer avant le lancement de la production. Les techniques de prototypage numérique permettent de réaliser des économies par rapport au prototypage physique. Les résultats du prototypage et des essais peuvent être utilisés en complément aux données disponibles sur le produit et son cycle pour réaliser une ACV plus ou moins complète.

Production : Après avoir corrigé les éventuelles erreurs constatées lors de l'étape d'essais/prototypage, la production est lancée. Une attention doit être portée sur le système de production pour atteindre les objectifs de performance en termes de coût, qualité et environnemental.

Commercialisation : L'étape de commercialisation permet de communiquer sur les caractéristiques environnementales du produit. Ces caractéristiques serviront à se différencier de la concurrence et servir d'argument de vente au près des clients. Dans le cadre de la communication environnementale, la série ISO 14020 : étiquettes et déclarations environnementales fournit les directives pour le développement et l'utilisation des déclarations et étiquetage environnementaux concernant un produit ou un service.

Utilisation et fin de vie : Un accompagnement peut être fourni aux consommateurs an d'utiliser efficacement le produit et optimiser cette étape du cycle de vie du produit. C'est aussi l'occasion de recueillir des données réelles sur le fonctionnement du produit.

Revue du produit : Les informations obtenues lors de la phase d'utilisation permettront d'enrichir la base de connaissances environnementale et servir pour une ACV complète. Les résultats des analyses permettront d'améliorer les futurs produits.

Tableau 2. Démarche d'éco-conception

Phases	Actions	Sortie de la phase	Outils
Planification	•Formuler les exigences environnementales en fonction des facteurs externes et internes •Choisir les approches de conception environnementale appropriées	Idées de conception	Enquête, Benchmarking, QFD environnemental, ACV simplifiée, check-list, diagrammes de Pareto, Matrice eco-portfolio, AMDEC, analyse de la valeur, Normes, Guide
Conception préliminaire	• Faire des analyses orientées CV • Formuler des cibles mesurables selon les exigences prédéfinies • Proposer des concepts	Concepts	QFDE, Guide, Check-list, BDD, ACV, brainstorming CES, EcoTRIZ
Conception détaillée	• Concrétiser les concepts • Finaliser les spécifications du produit	Solution de conception	Bases de données, Simulation, CAO, FAO
Essais/prototype	Vérifier que toutes les spécifications liées aux impacts environnementaux du CV sont respectées	Prototype	Outils de prototypage, Simulation, ACV, check-list
Production	S'assurer de l'optimisation environnementale des procédés de fabrication et de la logistique	Produit	Check-list
Commercialisation	Communiquer les aspects environnementaux du produit	Déclaration environnementale	Rapport Environnement, écolabels
Utilisation et fin de vie	Optimiser l'utilisation et la fin de vie	Accompagnement, retour de terrain	Gestion des connaissances
Revue du produit	Capitaliser sur les retours de terrain pour une éventuelle re-conception	Idées d'amélioration	ACV, PDCA (roue de Deming), check-list

4.5 PROPOSITION D'UN MODÈLE D'ÉCHANGE D'INFORMATION

Les données sur le produit et celles sur les processus du cycle de vie proviennent de divers sources. Ces données et celle produites par les outils d'éco-conception doivent être échangées entre les différents acteurs impliqués. Un support de communication et d'échange est donc nécessaire pour assurer une meilleure coordination entre eux, on parle alors du PLM, qui est une approche globale incluant les composants, les documents, les nomenclatures, les résultats d'analyse, les spécifications de test, les informations sur les composants voisins, les normes de qualité, les spécifications d'ingénierie, les ordres de modification, les procédures de fabrication, les informations sur les rendements du produit, les fournisseurs de composants, et bien d'autres.

Il permet de relier les différentes installations d'une entreprise multi sites mais aussi assurer la connexion avec les fournisseurs, les partenaires, et même les clients [15]. Les quelques fonctionnalités d'un PLM sont :

- La gestion des articles (ou composants) : c'est l'une des fonctions de base d'un outil PLM. Il contrôle les informations et le statut de l'article ainsi que les processus liés à la création et la maintenance de l'article.
- La gestion de la structure et de la maintenance du produit : le PLM identiffie les informations individuelles et leur connexion avec les autres à l'aide de la structure du produit, qui sont des articles liés ensemble.
- La gestion des privilèges utilisateurs : le PLM est utilisé pour définir les droits à l'accès et de maintenance de l'information. Il détermine ceux qui peuvent créer de nouvelles informations ou effectuer, vériffier et accepter des changements, et ceux qui ne sont autorisés qu'à lire l'information ou des documents dans le système.
- Maintenir l'état et le statut des documents et des articles : l'outil maintien l'information concernant l'état et la version (exemple : croquis, projets, acceptés, distribués, obsolète) de chaque document et article, et concernant les changements qu'ils ont subi : quel changement, quand, et par qui.
- La recherche de l'information : l'une des principales tâches du PLM est la recherche de l'information. Il intensiffie et facilite la recherche de l'information

Dans le modèle que nous proposons, le PLM constitue l'outil central où toute l'information est stockée. Les producteurs de l'information y stockent les dernières versions des données et les "consommateurs" de l'information y cherchent l'information dont ils ont besoin. Ceci évitera les liaisons point à point entre les outils, l'incohérence et la redondance
De l'information.

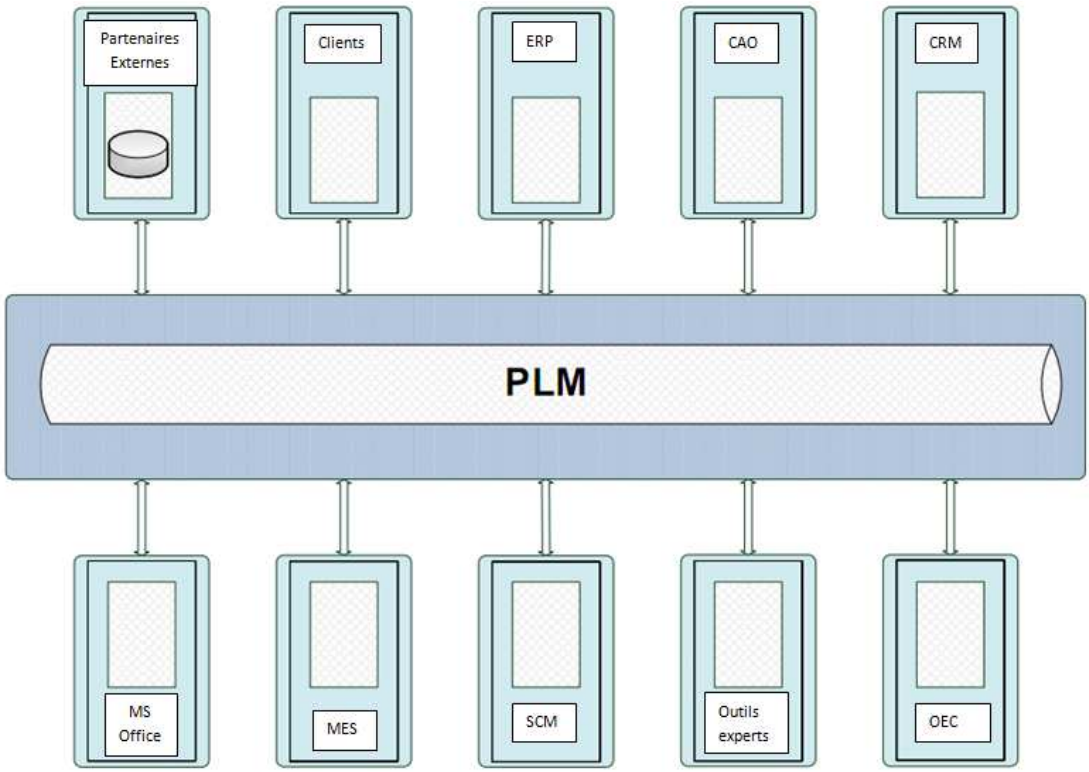


Fig. 1. Modèle d'échange d'information

- Partenaires externes :

Avec l'augmentation de la part des approvisionnements dans les coûts de production du produit et la tendance à se concentrer sur leur coeur de métier, les entreprises deviennent de plus en plus dépendantes de leurs fournisseurs. L'importance des changements produit augmente et le sourcin devient de plus en plus dynamique. Avec la prise en compte des aspects environnementaux, les entreprises deviennent de plus en plus regardantes sur leur chaine d'approvisionnement Les sous-traitants, les fournisseurs, les gestionnaires de la n de vie peuvent se connecter au processus métier de l'entreprise pour fournir les informations ou pour recevoir des commandes, des cahiers de charges ou autres.

- Clients

Les clients pourront obtenir certaines informations comme les manuels, les catalogues mis à disposition à partir du PLM.

- ERP

Le PLM est plus utilisé par les fonctions productrices de données sur les produits (Bureau d'étude, ingénierie,) et l'ERP par celles consommatrices des données sur le produit (achat, fabrication, maintenance,). L'intégration du PLM avec l'ERP fournit l'accès aux données produit ainsi que les données des autres services à tous.

- CAO

Les premières solutions PLM commercialisées étaient essentiellement destinées à la gestion des modèles CAO. Ce qui fait que, de nos jours, les fonctionnalités du PLM dédiées aux fichiers CAO sont assez matures. A travers le PLM, on peut accéder et visualiser la maquette numérique du produit et d'autres informations telles que la nomenclature du produit, les matériaux, la masse, le volume, etc.

- CRM

Le CRM permet de développer une relation privilégiée avec le client. Les données sur les historiques de consommation, des réclamations, les informations sur les clients sont des données utiles à la détermination des prix, des promotions de vente et de façon générale de la stratégie marketing. Les informations sur les pièces de rechange et les versions des produits fabriqués et commercialisés sont accessibles dans le PLM.

- MS Office

Beaucoup de documents échangés entre les membres de l'équipe de conception sont des fichiers Word ou Excel. Les solutions PLM proposent les fonctionnalités facilitant le rangement aisé de ce type de chier.

- MES

Le MES stocke les données recueillies sur le système de production dans le PLM. Ces données sont par suite utilisées par le service qualité, la maintenance, l'ordonnancement, les experts environnementaux et autres. Les informations sur les changements opérés sur les dessins, les plans par exemple sont mis à la disposition des équipes de production à travers le MES.

- SCM

Les flux de marchandises, les flux financiers et les flux d'informations augmentent avec la taille de l'organisation, son expansion géographique. La connexion du SCM avec le PLM permettra de gérer plus efficacement les données liées à la chaine logistique et les intégrer plus facilement dans le système d'information du produit.

- Outils experts

Les outils spécialisés comme les logiciels de comptabilité, de gestion de projet pourront recueillir les données dans le PLM et y stocker les résultats de calcul ou d'analyse.

- OEC

Toutes les informations nécessaires à l'évaluation environnementale sont rendues disponibles en un seul endroit grâce à cette solution. Les résultats des analyses et autres guidelines d'amélioration sont fournis aux autres membres impliqués dans le processus à travers le PLM. L'échange de données entre le PLM et les autres systèmes peut se faire par transfert manuel, par copie de fichiers, l'intégration de base de données des systèmes ou encore l'intégration des systèmes à l'aide d'intergiciels.

5 CONCLUSION

Cet article permettra donc de découvrir d'une façon globale l'importance de l'éco-conception et son rôle dans le Développement Durable, et surtout d'identifier l'intérêt du respect de l'environnement sur les objectifs de croissance et de développement des entreprises.

Le constat fait de nos jours de la pratique de l'éco-conception est que l'utilisation industrielle des outils et méthodes d'éco-conception proposés reste très faible. L'une des causes de cette réalité est la non intégration de ces outils/méthodes dans l'environnement de conception. Les concepteurs devaient utiliser ces nouveaux outils/méthodes en parallèle avec leurs outils/méthodes habituels. Pour favoriser l'acceptation de ces nouveaux outils, ils doivent s'intégrer avec ceux de l'ingénierie numérique. Durant ce stage dont le thème porte sur la contribution de l'ingénierie numérique à l'éco-conception nous avons abordé cette relation entre les outils d'ingénierie numérique et ceux de l'éco-conception. Parmi les outils d'ingénierie numérique, nous nous sommes focalisés sur le PLM qui est le plus utilisés.

La prise en compte des aspects environnementaux dans la conception des produits induit des changements dans l'organisation. Pour aborder donc l'aspect organisationnel de l'éco-conception, nous avons proposé une démarche d'éco-conception tout en insistant sur le rôle primordial de la direction. Dans cette démarche, nous spécifions pour chaque phase de l'éco-conception, les actions à mener, les outils pouvant être utilisés et la sortie de l'étape. Enfin, nous proposons un modèle d'échange d'information dans le cas d'une approche d'éco-conception.

Nous envisageons aussi, par la suite, d'intégrer une approche éco-conception dans un secteur spécial, c'est l'industrie artisanale au Maroc, afin de minimiser la consommation d'énergie et l'utilisation de la matière première, pour cela, nous allons automatiser la technique de fabrication de plaques décoratives en pièces de Zellij traditionnel [16].

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THE EFFECTIVENESS OF MEASUREMENT AND EVALUATION IN ZIMBABWEAN PRIMARY SCHOOLS: TEACHERS AND HEADS' PERCEPTIONS

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ABSTRACT: Measurement and evaluation in education is very important on a wide spectrum across the board. They provide information needed in overall education planning. Decisions on instructional aims, units, grades or marks enable teachers and school administrators to determine the extent to which pupils are growing towards the desired goals. Through measurement and evaluation, a teacher can diagnose the strengths and weaknesses of pupils and takes a progress on remedial action. If effectively utilised, measurement and evaluation may lead to the improvement of both instruction and the learning situation. Without evaluation and measurement, it is impossible to know a student's needs and preferences. In the Zimbabwean primary school system, heads and teachers use measurement and evaluation to ascertain the abilities and levels of attainment by students in areas such as reading, writing, and in all subject areas. This research investigated the effectiveness of measurement and evaluation in Zimbabwean schools using the quantitative paradigm. The study adopted the descriptive survey design. The target population comprised all primary school teachers in Bulawayo's Mzilikazi district with a teacher establishment of 120 teachers. The sample consisted of 100 teachers and 10 heads of schools. Of the sample respondents, 85 were female and 25 were male. All the information was collected through a questionnaire which had both close-ended and open-ended questions. Descriptive statistical analysis was used to interpret data. The study revealed that heads predominantly used summative evaluation and teachers preferred tests, class work and oral work. The study also revealed that lack of resources hampered efforts by both heads and teachers to conduct effective measurement and evaluation sessions. The study recommends that schools should mobilise more resources towards measurement and evaluation.

KEYWORDS: Effectiveness, Measurement, Evaluation, Primary school, District, Teachers, Heads.

INTRODUCTION

The most basic purpose of educational evaluation is to determine what a student's needs are. With proper testing and evaluation in the early grades, learning disabilities and handicaps can be identified (Gay, 2013). Without testing, problems can go unrecognised for years. The streaming of students into educational programs begins with standardized testing, which identifies student aptitudes and abilities. Education is effective when students improve overtime. Without measurement and evaluation, it is impossible to know whether students are making any progress (Chase, 2009). Tests and assignments can tell teachers which students are trying to learn and which students are not trying at all. As Camerroon (2008) argues, the progress in a student's grades overtime can say a lot about where that student is and where he/she needs to be. Therefore, it is apparent that the education process is characterized by a variety of activities undertaken by different people in educational institutions. The overall measurement of school effectiveness is determined by the quality of output produced by the school. Assessment of the effectiveness of the school as an organization is done through measurement and evaluation (Gay, 2013). The teaching and learning process cannot be complete without measurement and evaluation. This study therefore set out to explore the effectiveness of measurement and evaluation in Zimbabwean primary schools.

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LITERATURE REVIEW

Measurement and evaluation involves a number of approaches undertaken in the course of effective education (Madziyire, 2010). Some of the terms used interchangeably with measurement and evaluation are assessment, testing and appraisal (Drawnie, 2005). According to Drawnie (2005), measurement refers to the assignment of numbers, exact and quantitative numbers to objects. Measurement does not just start from assigning of numbers, but from administration of tests. After awarding marks an evaluation is required. Evaluation, unlike measurement is qualitative and not quantitative (Pophan, 2008). Pophan (2008) further states that evaluation is a formal assessment of the worthiness of an educational phenomenon. It involves judgement. The worth of the education process is determined by the output of the school.

Through effective measurement and evaluation, judgements are made. Cohen and Manion (2009) state that, measurement and evaluation incorporates both classroom based and formal evaluation. Tests are used to evaluate pupils in the classroom and formal evaluation occurs through supervision and appraisal of pupils, teachers and schools in general.

Literature reveals that measurement and evaluation is essential and is carried out all over the world and has been used in different countries. Evaluation is basically used to promote an individual teacher's work. As Chakanyuka (2010) postulates, teachers need to be aware of individual differences among their pupils. The teachers should be flexible and willing to do something about pupils' individual differences and provide individual pupils with opportunities to excel. Evaluation, therefore, is basically carried out to improve instruction.

Ogunniyi (2011) views supervision by, in most cases heads of schools as important evaluation. The heads as supervisors can only perform the functions for ensuring effective measurement and evaluation if they possess the competency to carry out the process. As Ogunniyi (2011) asserts, heads of schools should be well trained in the techniques of educational evaluation, be well acquainted with planning, blue print, construction and implementation of the curriculum programmes, possess qualities such as integrity, fairness but firmness, friendliness, enthusiasm and other leadership and possess up to date knowledge of subjects being evaluated, be an experienced teacher himself / herself and ready to accept suggestions from teachers. According to Madziyire (2010) heads do not only assess teachers and pupils. They also use the context, input, process and product (CIPP) model of evaluation to evaluate effectiveness of curricula and learning materials.

Teachers on the other hand, have immediate contact with pupils in terms of measurement and evaluation (Mpofu, 2009). Teachers perform formative evaluation which covers before-teaching, during teaching and after teaching in order to guide teaching. According to Mpofu (2009) before teaching evaluation determines the pupils' existing competencies in the area of learning and this is compared with results. This is referred to as diagnostic testing. During teaching, testing is done to try and determine whether pupils have requisite knowledge, concepts or skills about what was taught to them and are able to link up new knowledge with previous learning. Therefore as Mpofu (2009) argues, teachers act as navigators and they are with the syllabus on the ground. After teaching, testing is meant to determine how much the pupils have grasped the particular learning unit. These tests are usually used for grading purposes (Mpofu, 2009). Besides testing, teachers supervise children at work and they also report pupils' performance to the head of school as well as to parents through record books and reports. Reports and record books are critical features in measurement and evaluation (Madziyire, 2010). This underlines the need for the school and the home to work together.

According to Mpofu (2009) in Zimbabwe there are four types of tests used in schools. These are oral tests, objective tests, essay tests and practical tests. Teachers use their discretion on which type of test to use for what situation or context. However, each of the test type has strengths and weaknesses. Oral tests for example, provide no written record and give poor comparative evaluation and they are also time consuming. Objective tests, on the other hand, give an extensive sample and are more valid and reliable since they have clearly stated objectives (Ogunniyi, 2011, and Mpofu, 2009). However, they may frequently neglect measurement of higher thought processes. They are costly in terms of time to construct. Practical tests, on the other hand, stress application of knowledge and measure skills and abstract abilities not easily measured by other test forms (Mpofu, 2009). However, these tests are difficult to construct, difficult to grade and are time consuming.

STATEMENT OF THE PROBLEM

Measurement and evaluation in schools play a very critical role during the teaching and learning processes. This study sought to explore the effectiveness of measurement and evaluation processes in Zimbabwean primary schools.

PURPOSE OF THE STUDY

The study sought to explore and find out about the forms of measurement and evaluation techniques used in primary schools in Zimbabwe in order to reveal the challenges experienced by heads and teachers in their quest towards effective measurement and evaluation.

RESEARCH QUESTIONS

1. What are the forms of measurement and evaluation used in primary schools?
2. What challenges do heads of schools and teachers meet towards effective measurement and evaluation?
3. How can the process of measurement and evaluation be improved in order to make it more effective?

SIGNIFICANCE OF THE STUDY

The importance of the study is premised on the fact that it attempted to provide a picture of how measurement and evaluation is carried out in schools so as to suggest ways of making the process more effective for the benefit of the learning process. The study also envisaged to promote an awareness amongst educators about the role of measurement and evaluation in enhancing quality learning and teaching.

LIMITATIONS OF THE STUDY

The study is limited to investigating the effectiveness of measurement and evaluation techniques in Zimbabwean primary schools using the descriptive method which according to Ary and Razaviah (2010), lacks predictive power since the research may discover and describe "what is" and unable to predict "what would be". The study also used a small sample which made generalization quite difficult.

DELIMITATIONS OF THE STUDY

The study was delimited to the way how primary schools carry out measurement and evaluation using a small sample of 100 respondents made up of 85 females and 25 males from Bulawayo's Mzilikazi district. The respondents were made up of 100 teachers and 10 heads from the primary schools. Views from other key educational stakeholders like education officers, education directors and inspectors were outside the purview of this study.

RESEARCH METHODOLOGY

The study employed the quantitative methodology and made use of a survey research design. According to Leedy (2009), the descriptive survey method looks with intense accuracy at the phenomenon of the moment and then describes precisely what the researcher sees. The questionnaire was used as the instrument for collecting data because as Anderson (2011) argues, it increases reliability as an instrument of gathering data because of its greater impersonality.

DATA COLLECTION AND ANALYSIS

Data were gathered by means of a questionnaire which was largely made up of close-ended questions and two open-ended questions. All respondents were given the questionnaires by the researchers in their schools. The researchers also collected the questionnaires personally in order to increase on the rate of return of the instrument. As a result, all the questionnaires were returned and there were no non-returns. According to Phillips and Pigh (2011), non-returns introduce a bias in as much as they are likely to be different from respondents in many ways thereby adversely affecting reliability and validity of the findings. Data collected from the questionnaire produced descriptive statistics around the variables under study. These statistics were computed and inferential implications then deduced and recorded.

FINDINGS AND DISCUSSION

The study sought to investigate the effectiveness of measurement and evaluation techniques used in Zimbabwean primary schools. This part is presented in two parts, namely actual findings and discussion.

FINDINGS

Table 1: Category of respondents (N=110)

Category	Frequency	Percentage
Heads	10	9
Teachers	100	91
Total	**110**	**100**

Table 1 above shows that the majority of respondents were teachers since they constitute the bulk of educators in the school set-up.

Table 2: Distribution of Respondents by Sex (N=110)

Category	Frequency	Percentage
Male	25	23
Female	85	77
Total	**110**	**100**

Table 2 shows that there were more female respondents than male ones. The datum was considered statistically significant to the extent that most urban schools in Zimbabwe had more female teachers than male ones.

Table 3: Composition of Respondents by Professional Qualifications (N=110)

Professional Qualifications	Frequency	Percentage
Certificate in Education	14	13
Diploma in Education	86	78
Bachelors Degree	10	9
Masters Degree	0	0
Total	**110**	**100**

The information in table 3 above shows that the majority of respondents (78%) were holders of the Diploma in Education qualification, followed by the Certificate in Education (13%) and the Bachelor's Degree (9%). None of the respondents were holders of the Master of Education qualification. Relevant professional qualifications provide the capacity of respondents to understand issues involved in measurement and evaluation.

Table 4: Responses to: "Forms of measurement and Evaluation used in your school" (N=110)

Procedure	Heads (N=10)		Teachers (N=100)		Totals (N=110)	
	F	%	F	%	F	%
Formative	2	20	10	10	12	11
Summative	3	30	17	17	20	18
Standardized	0	0	19	19	19	17
Diagnostic	0	0	12	12	12	11
Period tests	2	20	30	30	32	29
Supervision	2	20	0	0	2	2
Placement	0		3	3	3	3
Oral Work	0		4	4	4	4
Class Work	1	10	5	5	6	5
Appraisals	0	0	0	0	0	0
Totals	**10**	**100**	**100**	**100**	**110**	**100**

Table 4 above shows that heads mainly use formative (20%), summative (30%), period tests (20%) and supervision (20%) to evaluate goings-on in the schools. On the other hand, teachers relied on period tests (30%), standardized tests (19%), summative (17%), and a bit of class work (5%) formative (10%), as well as oral work (4%). The responses show that there are varied techniques that are used to measure and evaluate the learning and teaching process by heads and teachers. It is also clear that teachers and heads are aware of various forms of measurement and evaluation at their disposal.

Table 5: Responses to the question: "What is the frequency of assessment of core-curricular subjects?" (N=110)

Frequency of Assessment	**Number**	**Percentage**
Weekly	11	10
Fortnightly	11	10
Monthly	10	15
Termly	72	65
Total	**110**	**100**

Table 5 shows that the majority of respondents (65%) assessed the learning in the core-curricular subjects on a termly basis. Those who carried out the assessment on a monthly basis followed with 10% and those who indicated that they assessed core-curricula subjects fortnightly and weekly were both at 10% respectively.

Table 6: Responses to the question: "What problems do you encounter when carrying out measurement and evaluation? (N=110)

Challenges	**Heads (N=10)**		**Teachers (N=100)**		**Totals (N=110)**	
	N=10		N=100		N=110	
	F	%	F	%	F	%
Lack of resources	3	30	15	15	18	16
Time shortage	5	50	11	11	16	15
Invalid tests	0	0	0	0	0	0
Large classes	0	0	3	3	3	3
Lack of knowledge	1	10	42	42	43	39
Lack of support	1	10	29	29	30	27
Totals	**10**	**100**	**100**	**100**	**110**	**100**

The information on table 6 above reveals that the most common problems faced by heads include time shortage (50%), lack of resources (30%) and a few heads indicated that they lacked knowledge (10%) as well as support (10%). On the other hand, the major problem highlighted by the majority of teachers 42% related to lack of knowledge, followed by lack of support (29%), lack of resources (15%), lack of time (11%) and large class sizes (3%).

The questionnaire had two open-ended questions which bolstered data from the close-ended questions. The first question wanted to find out from both heads and teachers what they understood to be the main functions of measurement and evaluation during the teaching and learning process. The majority of the respondents stated that measurement and evaluation if properly carried out promoted accurate recording of pupils' progress or lack of thereof in order to improve instruction and ultimately pupil learning. The second question wanted to find out what sort of support and assistance did respondents require to carry out effective measurement and evaluation. Most of the respondents indicated that they needed in-service sessions and workshops to be equipped with competencies to carry out effective measurement and evaluation. They further revealed that because of their lack of knowledge and skills pertaining to current trends in terms of techniques for measuring and evaluating the learning programs, they were window dressing in order to hoodwink authorities.

DISCUSSION

Information from the study reveal that there are varied techniques used by both teachers and heads of schools to measure and evaluate pupils and teachers. Teachers appear to know many ways to assess or use as forms of measurement and evaluation. The most commonly used are period tests, standardized tests and summative evaluation. Heads of schools mainly relied on summative and formative evaluation. The data also show that teachers responded to measurement and evaluation in relation to pupils whereas heads were referring to both teachers and pupils. As Chakanyuka (2012) postulates,

teachers need to be aware of individual differences among their pupils and heads need to know both the strengths and weaknesses of their teachers and children.

Findings also show that most respondents resorted to termly tests and reports due to pressure of work and shortage of time. This implies that heads and teachers do not use continuous assessment which helps in the immediate diagnosis of learning problems that pupils come across. As Mpofu (2009) states diagnostic testing is done to try and determine whether pupils have requisite knowledge, concepts or skills about what was taught to them and are able to link up new knowledge with previous learning. Therefore, to wait for the end of the term to measure and evaluate the learning of pupils and the effectiveness of teaching methods might fail to provide the necessary remedial action needed to assist the pupils.

Data from the study also reveal that teachers and heads of schools encounter a number of challenges as they carry out measurement and evaluation. The major challenges include lack of resources, shortage of time, lack of knowledge as well as lack of support to effectively carry out measurement and evaluation. This information tallies with findings by Dawnie (2005) who found that the reason why most schools were not conducting effective measurement and evaluation of their learning and teaching was due to the failure by the education system to provide the wherewithals for this process. With the amount of work that heads and teachers do, it leaves them with very little time and energy to do proper measurement and evaluation.

The information from the study also reveal that the majority of respondents, particularly the heads of schools, lacked the competencies not just to conduct their own measurement and evaluation, but also to guide and support teachers to carry out proper measurement and evaluation in their teaching as well. As Ogunniyi (2011) observed, the heads as supervisors can only perform the functions for ensuring effective measurement and evaluation if they possess the competency to carry out the process. According to Madziyire (2010) heads do not only assess teachers and pupils; they also use the context, input, process and product, model of evaluation to evaluate the effectiveness of curricula and learning materials.

CONCLUSION

- Both theoretical and empirical data in this study converge on the fact that there is no effective measurement and evaluation in Zimbabwean primary schools.
- Teachers and heads carry out tasks they believe are measurement and evaluation as a way of hoodwinking education authorities.
- Heads and teachers generally tend to rely on termly tests reports at the expense of formative and continuous evaluation due to shortage of time and work overloads.
- Teachers and heads experience a multiplicity of challenges as they try to implement measurement and evaluation which include lack of support and lack of time.
- The majority of heads and teachers lacked the competencies to carry out effective measurement and evaluation.
- Overally, heads and teachers are very much aware of the significant role played by measurement and evaluation during the teaching and learning process.

RECOMMENDATIONS

In light of the findings of this study, the researchers would like to make some recommendations.

- There is need for the Ministry of Primary and Secondary Education to come up with a blue print for guiding primary schools on effective ways of measuring and evaluating the learning of pupils in schools.
- Heads and teachers should be assisted to use continuous assessment to augment the use of summative evaluation.
- The Provincial and District Education offices should carry-out in-service workshops for heads and teachers on measurement and evaluation to enable them to effectively implement it in schools.
- Schools should be encouraged to utilize the cluster structure to share ideas on best practices on measurement and evaluation.
- External supervisors from within the Ministry of Primary and Secondary Education should periodically visit primary schools to provide expert guidance to heads and teachers on measurement and evaluation.

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TEACHERS' PERCEPTIONS ON THE CAUSES AND EFFECTS OF HIGH RATE TEACHER-TURNOVER OF MATHEMATICS AND SCIENCE TEACHERS IN RURAL SECONDARY SCHOOLS – A CASE STUDY OF NKAYI DISTRICT

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ABSTRACT: It is an indisputable fact that expert teachers are perhaps the most fundamental resource for improving student learning. Therefore, the need for the retention of qualified teachers particularly in specialist areas cannot be overemphasized. In many developing countries, Zimbabwe included, teacher turn-over has been a problem especially since the outbreak of HIV/AIDS where during the early 1990s, a large number of professionals, teachers included, succumbed to the epidemic in large numbers. Other factors like retirement and resignations have also played a role towards teacher turn-over. However, the most common form of teacher turn-over is whereby qualified teachers leave poor rural schools to better schools particularly in urban areas. Thus, most rural schools fail to attract qualified mathematics and science teachers and resort to using the unqualified and under qualified teachers thereby creating a dilemma, where the least prepared teachers teach the most educationally vulnerable children. As a result, the pass rate of pupils in rural secondary schools at public examinations, particularly in mathematics and science is consistently low. This study draws on a quantitative inquiry to investigate teachers' perceptions on the causes of high-turnover of mathematics and science teachers from rural secondary schools in Zimbabwean secondary schools. The study adopted the descriptive survey design. The target population comprised all secondary school teachers from Nkayi District in Matabeland North Province. The sample consisted of 120 teachers randomly sampled. All the information was collected through a questionnaire which largely had close-ended questions and two open-ended questions. The study revealed that the majority of teachers felt that poor conditions of service forced many mathematics and science teachers to leave rural secondary schools if not the teaching profession altogether. The high teacher turn over caused high failure rates in mathematics and science in the rural secondary schools. The study recommends that Government should allocate more resources to rural schools in order to improve the working conditions of teachers. The study also recommends that there should be a specific rural allowance for mathematics and science teachers to attract and retain more expert teachers in these subject areas.

KEYWORDS: Teachers, Rural secondary schools, Turn-over, Mathematics, Science, District.

INTRODUCTION

The quality of the education system is limited by the quality of its teachers (Vegas, et.al., 2012). According to Hanushek (2013) high quality teachers obtain measurable student learning results, have long-lasting positive impacts on their students' lives, and are irreplaceable. These teachers are irreplaceable because students who learn from them, instead of a low-performing teacher, gain between five and six months of additional learning, and have greater chances of passing (TNTP, 2012). Strong teachers, therefore, are essential for bringing out the best in students which makes the retention of good teachers a top priority for schools and education systems.

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Teacher turn-over causes profound strains in schools in that it destabilizes administrative, academic as well as professional standards. The administrative problem is two fold. Firstly, heads of schools fail to recruit new teachers and secondly, having to put up with ever orienting new teachers in their schools. Another face of the administrative problem is that learners were left unattended when a replacement teacher was not yet found. Learners would come to school only to spend the greater part of the day playing around the school premises. It also means that other teachers will be overloaded by managing classes for those teachers who have left before they are replaced. However, as Guin (2012) states, the most telling impact of high rate teacher turn-over is on learner performance. In Zimbabwe, most schools especially in rural areas have lost experienced highly qualified teachers, only to receive late replacements by inexperienced under qualified university graduates or temporary teachers thereby compromising the quality of instruction that pupils receive. It is on account of the above information that this study sought to explore Zimbabwean teachers' perceptions regarding causes of high-teacher turn-over of mathematics and science teachers in rural secondary schools.

LITERATURE REVIEW

Teacher supply differs by country and in nations where teaching is an attractive profession, schools have little trouble with staffing (Cooper and Avarado, 2006). Other countries, however, struggle to find teachers for certain subjects or for high needs areas (Cooper and Alvarado, 2006). According to Schleider (2012) it is not enough to simply ensure that classrooms are filled by teachers; schools need quality teachers who can produce high levels of student achievement. Interestingly, Ingersoll (2011) argues that some turnover is good for schools. Teachers who do not help students learn should leave the classroom. Unfortunately, weak teachers are not the only ones who exit through teaching's "revolving door" (Ingersoll, 2011:499). High quality teachers are among those most likely to leave, yet they are the teachers that schools struggling to improve student achievement need most (Johnson, et. al., 2005).

Phillips and Schewisfurth (2007) state that significant financial, social, instructional, organizational, and human capital costs of teacher turnover warrant prioritizing the problem of high quality teacher turnover on policy agendas. Johnson, et. al (2005) allude to differences in student achievement between classrooms to affirm the importance of individual teacher quality. In a study of employee turnover, Khatri, et. al (2001) in Waititu (2010) state that three groups of factors influence employee turnover, namely: demographic, uncontrollable and controllable factors. Demographic factors include age, gender, education, tenure, income level, managerial and non-managerial positions. Uncontrollable factors are the perceived alternative employment opportunity and job-hopping. Controllable factors include pay, nature of work, supervision, organizational commitment, distributive justice and procedural justice (Khatri et.al, 2001 in Waititu, 2010: 22).

The consequences of teacher turnover and attrition are too ghastly to contemplate. Smith (1999:58) posits that the impact of turnover is by way of increased costs to the organization, broadly categorized as separation, replacement, recruitment selection, induction and training costs. Ingersoll (2011: 2) postulates that staffing problems are created when employees leave the organization and have to be replaced, especially since teacher turn-over is highest among new teachers mostly within the first five years. Teacher attrition disrupts schooling. This is especially so when teachers leave the profession during the academic year or whilst engaged in critical projects in school (Ingersoll, 2011). According to Ingersoll (2011:4) turnover influences the performance and effectiveness of the school since the school as an organization has production processes requiring extensive interaction among educators and is, therefore, prone to suffer when subjected to high rates of turnover. Consequently, turnover disrupts the quality of school cohesion and performance (Mgadla, 2003).

As Mgadla (2003) postulates, the effects of teacher turn-over necessitates the management thereof. A number of measures have been taken to address teacher turnover in various countries. Among others, aggressive recruitment drives, lowering of standards for enrty into teaching, provision of allowances as incentives have been employed (Mgadla, 2003). A multiplicity of reasons are advanced for teacher turnover. Santiago (2001) in Mgadla (2003) cites an ageing teaching workforce and the possible retirement thereof, low salaries and demands for even complex teaching abilities. On the other hand, Duffrin (2009) cites working conditions as the major reason especially among teachers leaving within the first five years. The biggest cost of teacher turnover is student achievement (TNTP 2012). The reason that students do not have equal access to great teachers is not because there is a shortage of quality teachers; but rather, schools fail to retain their best teachers (Cooper and Alvarado, 2006). As the TNTP (2012) observes, when "irreplaceables" leave the teaching force, they create job openings that get filled by poorer quality teachers.

According to Cooper and Alvarado (2006) allowing less qualified candidates to fill vacancies left by high quality teachers contributes to the de-professionalisation of teaching which may pose organizational costs by damaging school quality and stability. The public may negatively interpret this "revolving door" as an indication of teachers' lack of commitment

(Ingersoll, 2011). Most importantly, as Phillips and Schweisfurth (2007) argue, replacing high quality teachers with weaker teachers results in missed student learning opportunities, which pose an adverse human capital cost to the nation.

Johnson, et.al. (2005) claim that schools are able to retain teachers by offering them both intrinsic and extrinsic rewards and by meeting teachers' standards for acceptable working conditions. Teachers leave when schools fail to outweigh negative working conditions, like school safety or a comfortable classroom. According to Johnson, et. al (2005) there are nine working conditions that influence teachers work. These are colleagues, community support, facilities, governance, principal, professional expertise, resources, school culture, and time. Of all the conditions that teachers consider important for work, conditions that are social in nature are paramount for teacher satisfaction (Johnson, et.al. 2005).

Ladd (2011:237) calls school leadership and collegiality "central" to any consideration of working conditions for teachers. The relationship between these elements is hierarchical because the quality of school leadership largely defined as the principal's effectiveness, determines the levels of teamwork and trust among teachers (Ladd, 2011). According to Cooper and Alvarado (2006) school leaders have direct and indirect control over organizational characteristics, like school culture, teacher autonomy, leadership and support, all of which are commonly reported factors influencing teacher turnover. Many of the "irreplaceables" who left their schools reported that school leadership had made no effort to persuade them to stay (T.N.T.P).

STATEMENT OF THE PROBLEM

The need to retain qualified teachers, especially, specialist teachers cannot be overemphasized. The quality of learning that pupils receive depends upon the quality of the teachers providing instructional guidance to these pupils. This study sought to investigate the causes of teacher turnover of mathematics and science teachers through the lens of teachers.

PURPOSE OF THE STUDY

The study sought to find out what teachers felt were the major causes of high-teacher turnover of mathematics and science teachers from rural secondary schools so as to suggest mitigatory measures to minimise the problem.

RESEARCH QUESTIONS

1. Why do mathematics and science teachers leave schools?
2. How do schools cope with the successive loss of mathematics and science teachers?
3. How does the loss of mathematics and science teachers affect the learners?
4. What measures can the Government and schools put in place to curb the high turnover of science and mathematics teachers?

SIGNIFICANCE OF THE STUDY

The significance of the study is premised on the fact that it attempted to unveil the underlying causes and effects of high rate teacher turn-over not only in the schools under study, but in Zimbabwe at large so that practical measures can be taken to stop the problem. The research hopes to bring awareness to the problem of mathematics and science teachers' exodus so that authorities can come up with policies that will curb this scourge. The study also hoped that findings would assist in the retention of maths and science teachers in rural schools so as to enable rural pupils to learn effectively in these two critical subjects for their own individual development and for national development.

DELIMITATION OF THE STUDY

The researchers delimited the study to the perceptions of teachers on the major causes and effects of high-rate teacher turnover of science and mathematics teachers in Zimbabwean rural secondary schools using a sample of 120 teachers made up of 70 females and 50 males. Other stakeholders like heads of schools, parents bodies, education officers and pupils were outside the purview of this study.

RESEARCH METHODOLOGY

The study used the quantitative research paradigm and employed a survey research design. According to Colgan (2011) the descriptive survey design looks with intense accuracy at the phenomenon of the moment and then describes precisely what the researcher sees. The questionnaire was used as the instrument for collecting data. As Barbie (2013) observes, the questionnaire increases reliability because of its greater impersonality. However, as Anderson (2011) postulate, its major weakness is that it may invite people to lie and answer questions vaguely. This was mitigated through the pilot testing of the questionnaire. The sample consisted of 120 respondents made of 70 female and 50 male teachers. The study employed simple random sampling because as Blumberg (2008) argues, it permitted every teacher to have an equal chance of participating in the study. The researchers used a questionnaire which largely had close-ended questions and two open-ended questions. Close-ended questions enabled the researchers to collect predetermined respondents opinion regarding the studied phenomena (Kumar, 2008). Researchers were able to obtain the actual perceptions of the respondents regarding the phenomenon of mathematics and science teachers' high turnover in secondary schools from the respondents' open-ended free responses.

DATA COLLECTION AND ANALYSIS

As highlighted in the above section, data were gathered by means of a questionnaire which was largely made up of close-ended questions and a few open-ended questions. The questionnaire was chosen because as Cohen and Manion (2012) observe, it has the ability to reach many respondents who live at widely dispersed addresses and preserves anonymity which encourages greater honesty. However, the questionnaire as Anderson (2011) argues, generally has a low response rate and is inflexible in that it does not allow ideas or comments to be explored in-depth and many questions may remain unanswered. The researchers personally distributed the questionnaires to the schools where the respondents worked. The same method was used to collect the completed questionnaires. Data generated produced descriptive statistics around the variables under study. These statistics were computed and inferential implications from them derived and recorded.

FINDINGS AND DISCUSSION

The study set out to explore teachers' perceptions on the causes of high rate turnover of mathematics and science teachers in rural secondary schools in Zimbabwe. This section is presented in two parts, namely, presentation and discussion of data.

PRESENTATION OF DATA

Table 1: Composition of sample by gender (N=120)

Sex	**Frequency**	**Percentage**
Male	50	42
Female	70	58
Total	**120**	**100**

Table 1 above shows that there were more female respondents than male ones. The datum was considered statistically significant to the extent that it confirmed that most schools in Zimbabwe had more female teachers than male ones.

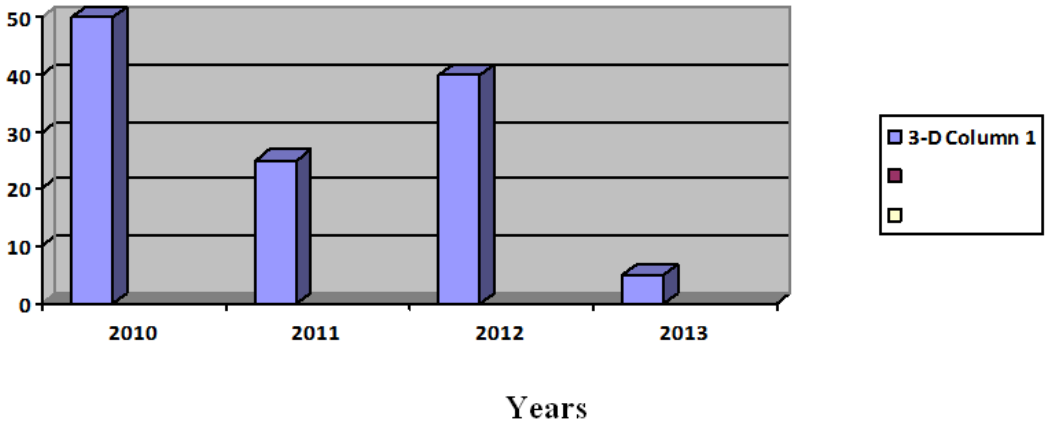


Figure 1: Mathematics and science teachers who left my school between 2010 and 2013 (N=120)

Figure 1 above shows that 42% of the respondents indicated that mathematics and science teachers left their schools in 2010; 21% indicated that their schools lost mathematics and science teachers in 2011; 33% of the respondents' schools lost mathematics and science teachers in 2012 and 4% indicated that their schools lost mathematics and science teachers in 2013. This information reveals that schools continue to lose mathematics and science year-in-year-out.

Table 2: How would you describe the rate at which your school loses mathematics and science teachers (N=120)

Rate	Frequency	Percentage
Extremely high	73	61
Very high	35	29
High	3	3
Low	2	2
Very low	0	0
Not sure	6	5
Total	**120**	**100**

Table 2 reveals that the majority of teachers indicated that the incidence of mathematics and science teachers leaving their schools was extremely high (61%), those who indicated that it was very high stood at 29% and a few (2%) felt that it was low and 5% indicated that they were not sure about this information.

Table 3: Time taken by my school to replace a mathematics or science teacher who has left the school (N=120)

Time taken	Frequency	Percentage
Within one month	0	0
After one month	0	0
Within one term	5	4
After one term	5	4
Within one year	10	9
After one year	5	4
More than one year	95	79
Total	**120**	**100**

The information on table 4 above shows that the replacement of mathematics and science teachers takes considerable time. The figures above reveal that it takes a year for a teacher to be replaced.

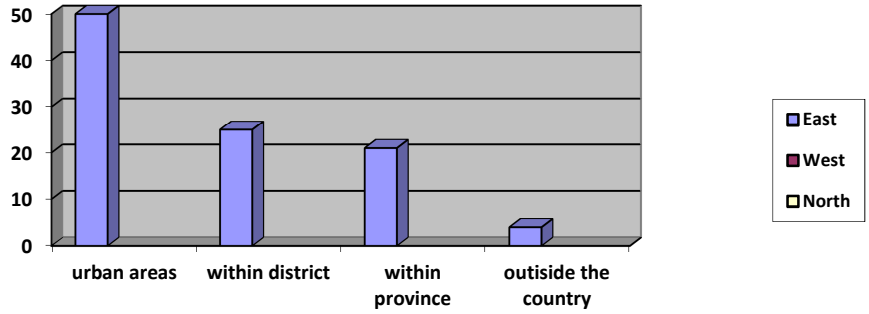


Figure 2: Destinations of mathematics and science teachers on leaving my school

The information on figure 2 above shows that the majority of respondents (50%) indicated that most of the mathematics and science teachers who left their schools went to urban centres within Zimbabwe, 25% of these teachers transferred to schools within the district, another 21% transferred to schools within the province. Those who indicated that teachers left for other countries were 4% of the sample.

The questionnaire had two open-ended questions which bolstered data from the close-ended questions. The first question wanted to find out from the respondents what they thought were the major causes of high rate teacher turn-over in their schools. A number of reasons were put forward. The most common included the following:

- Teachers with higher qualifications especially in specialist areas like mathematics, science and practical subjects have more opportunities elsewhere; and as a result are likely to leave faster to other stations.
- In subject areas where there is work overload as a result of shortages of teachers, teachers are likely to leave for better schools where the teacher-pupil ratio will be normal.
- Young teachers who grew up in urban areas are not used to the rural environment.
- Copying with students who had very weak foundations on difficult subject areas also frustrates teachers and this forces them to leave rural schools.
- The general school climates in most of the schools do not motivate teachers to stay for longer periods.
- Leadership styles also tend to stifle initiative and innovativeness with teaching methods and this drives teachers away as well as lack of resources.
- The second question sought to find out from the respondents what they believed to be the results of high teacher-turnover. Again, a number of issues were raised. The major issues highlighted included the following:
- Poor results at public examinations by pupils in maths and science because they might remain without a qualified teacher for a long time.
- The sudden transfer of maths and science teachers brought about work overload for those teachers who remained since they had to teach those classes whose teachers had left the school.
- Some parents may transfer their children to other schools where there are teachers in these subject areas.
- It increases conflict between teachers and the administration as some teachers may refuse to teach extra loads.

DISCUSSION

Information from the study revealed that mathematics and science teachers continue to leave rural secondary schools without any signs of abating. Every year all the schools one way or the other, lose a mathematics or science teacher. This situation profoundly compromises the quality of education that pupils in rural areas receive. As Hanushek (2013) argues, high quality teachers obtain measureable student learning results, have long-lasting positive impacts on their students' lives and are irreplaceable. These teachers are irreplaceable because students who learn from them, instead of from a low-performing teacher, gain between five and six months of additional learning and have greater chances of passing. Strong teachers, therefore, are essential for bringing out the best in students.

Findings also indicate that in most of the schools it took at best a term for schools to find a replacement for mathematics and science teacher who would have left and at worst, a whole year. The implications of this finding are that pupils left by these teachers lose in terms of concepts, and coverage of the syllabus is thoroughly compromised. This situation also affects

the overall staffing in the school since teachers have to be reassigned to accommodate classes left by the teacher who transferred. This also affects the time-tabling which should be re-done at a high cost in terms of time and labour. This is corroborated by observations by Ingersoll (2011) who postulates that staffing problems are created when teachers leave the organization and have to be replaced. It is therefore; very clear that teacher turn-over disrupts schooling. This is especially so when teachers leave the profession during the academic year or whilst engaged in critical projects in school, like preparing classes for final public examinations. According to Ingersoll (2011) turnover influences the performance and effectiveness of the school since the school as an organization has production processes requiring extensive interactions among educators.

The study also revealed that copying with students who had weak foundations for "difficult" subject areas like mathematics and science, frustrated teachers, particularly the young ones who are inexperienced. Mathematics and science teaching begins from primary school. Concepts in these subject areas should be well grounded from the very formative cognitive stages of children so that at secondary schools these are developed rather than started.

Findings also reveal that some teachers leave schools due to work overloads as a result of large class sizes and high number of periods. In subjects like mathematics and science, schools struggle to recruit qualified teachers and as a result the few qualified teachers available have to take all classes including for those teachers yet to be recruited. This, affects the morale of these teachers, and as a result, they would rather transfer to schools where the classloads are normal. As Johnson, et.al (2005) posit, teachers leave when schools fail to outweigh negative working conditions like school safety or a comfortable classroom.

The study also shows that the leadership styles and general school climates tend to stifle initiative and innovativeness of teachers in terms of teaching methods and this does not motivate teachers to stay for longer periods in these schools. As Ladd (2011) observes, school leadership and collegiality is central to any consideration of working conditions for teachers. The relationship between these elements is hierarchical because the quality of school leadership largely defined as the principal's effectiveness, determines the levels of teamwork and trust among teachers. According to Cooper and Alvarado (2006) school leaders have direct and indirect control over organizational characteristics like school culture, teacher autonomy, leadership and support, all of which are commonly reported factors influencing teacher turnover.

Findings also indicate that high rates of teacher turnover in mathematics and science contribute towards poor results of pupils at public examinations. The sudden transfer of maths and science teachers brought about work overload for those teachers who remained since they had to teach those classes whose teachers had left in addition to their own workload. This situation has a potential to create conflict between teachers and the administration team as some teachers may refuse to take the extra loads. This is in congruence with findings by Guin (2012) who states that, the most telling impact of high rate teacher turnover is on learner performance. Teacher turn-over causes profound strains in schools in that it destabilizes administrative, academic as well as professional standards. The administrative problem is two-fold. Firstly, heads of schools toil to recruit new teachers and secondly, having to put with ever orienting new teachers in their schools. Another face of the administrative problem as postulated by Guin (2012) is that learners were left unattended when a replacement was not yet found. Learners would come to school only to spend the greater part of the day playing around the school premises.

CONCLUSIONS

Given the background of the above findings the researchers make the following conclusions:

- Both theoretical and empirical data in this study converge on the fact that most rural secondary schools in Zimbabwe are losing mathematics and science teachers at an alarming rate.
- It takes a long time for schools to find a replacement for a mathematics and science teacher who has left the school, thereby, adversely affecting the learning of pupils.
- Copying with students who had weak foundations in mathematics and science frustrated teachers; particularly the young and the inexperienced.
- Some mathematics and science teachers leave certain schools due to work overloads as a result of class sizes and high number of teaching periods and exercise books for marking.
- Leadership styles and school climates tend to stifle initiative and innovativeness of teachers.
- High teacher turnover in mathematics and science is a major contributory factor to poor results of pupils at public examinations in the two subjects.
- Teacher turn-over causes strains in schools in that it destabilizes administrative, academic as well as professional standards.
- Teacher turnover may force some parents to remove their high performing children to other schools, thereby reducing the number of students likely to perform well at public examinations in these schools.

RECOMMENDATIONS

In light of the findings of this study, the researchers would like to make some recommendations.

- A stimulating and supportive work environment should be created by school leaders in order to retain mathematics and science teachers.
- There should be an allowance for mathematics and science teachers who opt to be deployed in the rural secondary schools. This allowance would help retain teachers for mathematics and science and also help encourage prospective student teachers to specialise in mathematics and science thereby creating a large pool of these teachers in the employment market.
- The Government should implement alternative certification programmes to increase teacher-supply; for example, retraining teachers without science and mathematics on these subjects through open and distance learning.
- The Government should also provide bonuses for new recruits and stipends for teaching "in hard to staff areas".
- Employment of mathematics and science teachers from Zimbabwe by other countries should be formalized so that the Zimbabwean Government exports these professionals for a fee and the revenue so collected be channeled back to losing schools to benefit teachers who would opt to replace those went outside the country.
- The Government should provide grants for the training of mathematics and science teachers. This might encourage more students to take up mathematics and science in their studies at school.

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PERCEPTIONS OF TEACHERS ON CAUSES OF POOR PERFORMANCE OF PUPILS AT ORDINARY LEVEL PUBLIC EXAMINATIONS IN ZIMBABWEAN RURAL SECONDARY SCHOOLS: A CASE STUDY OF NKAYI DISTRICT

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ABSTRACT: Zimbabwe gained its independence in 1980, after almost 100 years of British colonial rule. The colonial era was built on white supremacy, racial segregation and oppression of the majority African population by the white minority. The first ten years of independence were committed to rectifying the social inequities brought by the former colonial regimes. The new government was committed to the creation of a socialist state, which was guided by the principles of social justice and equality. Education was declared a fundamental human right. It was regarded as a potent tool for social and economic transformation. As a result, the formal sector of the education system was expanded to unprecedented levels. Secondary schools increased from a paltry 197 in 1980 to 1502 by 1989, a sharp increase of 662%. Enrolments increased by over 200% across the whole system. The majority of the new secondary schools were built in the rural areas first as upper-tops, that is using nearby primary schools infrastructure to do their business and later constructed in independent sites. In spite of the noble idea of availing secondary school education to the majority of rural students who needed it, there is a widespread out cry across the country about the low performance of pupils from these schools at Ordinary Level Examinations. The majority of these schools produce 0% pass rates year-in year-out. In view of the above, this study set out to investigate the major causes of high failure rate in Nkayi Rural District Secondary Schools. The population constituted of the 650 secondary school teachers in the district. A total of 100 respondents selected using random sampling was used for the study. These were made up of 55 females and 45 male teachers. The research instrument used was the questionnaire which had both close-ended and open-ended questions. Descriptive statistical analysis was used to interpret data. The study revealed that teachers attributed pupils' high failure rate to lack of materials and equipment for teaching, inadequate supervision, teacher incompetency among others. The study recommends that the Ministry of Primary and Secondary Education should embark on a massive infrastructural development to provide adequate classrooms and specialist rooms for rural secondary schools. Teachers should be adequately motivated so as to boost their moral and parents should be encouraged to support the learning of their children.

KEYWORDS: Pupils, Ordinary Level, rural secondary schools, teachers, public examinations, poor performance.

INTRODUCTION

The Ordinary Level Examinations constitute a very significant component of Zimbabwe's education process as they determine the future employment prospects of the learners (Ndlela, 2012). It is the Ordinary Level Certificate that determines who proceeds to Advanced Level and who join tertiary education institutions like teacher training colleges, nursing schools and others (Jolibongo, 2012). It is therefore, not surprising that parents, teachers, students and government and other stakeholders attack greater significance to the Ordinary Level examinations. However, in spite of the importance of the Ordinary Level to Zimbabwe's education system the tendency of high failure rate particularly in rural secondary schools is a great cause for concern (Chikowore, 2013). Whilst the national average pass rate at 'O' Level since 1998 stands at 14.5%, the average of most rural districts is 4,2% (Chiwore, 2010). This means that most of the pupils at the rural secondary schools go there to prepare for failure after four years, a very painful reality indeed (Luphahla, 2012). Many reasons have been put

forward to explain this high failure rate by a number of experts and stakeholders. This study seeks to find out how the teachers who are at the core of this high failure rate perceive this phenomenon. Thus, the study set out to investigate the causes of perennial poor results at rural secondary schools from the teachers' point of view.

LITERATURE REVIEW

According to the Zimbabwe School Examinations Council (ZIMSEC) a student is considered to have passed 'O' Level if they obtain C grade or better in at least five subjects (Ndoro, 2012). Students who pass four or less subjects cannot proceed to Advanced Level, neither can they join tertiary institutions for professional training (Mujaji, 2012). A number of rural secondary schools fail to produce a single student with a full certificate. For example, in the Midlands Province of Zimbabwe in 2010, out of a total of 70 secondary schools, 19 recorded a 0% pass rate and the highest concentration of schools with 0% pass rate was Kwekwe Rural District, Mberengwa, Gokwe North and Gokwe South (Shumba, 2010). Bennell and Ncube (2009) state that the decline in performance of both sexes in the rural areas has been explained by the deteriorating quality of education provided. Adell (2012) argues that poor performance at rural high schools is an international problem that has been linked to the low socio-economic background of the learners. Munn (2009) argues that the school environment might also be the source of poor performance if learner support materials are not adequate. The arguments concerning lack of facilities and resources in rural based schools are always raised where there is serious under performance at these schools (Karande and Kulkami 2008). As Ralenala (2012) observes, rural schools often serve disadvantaged learners who are from families that are not educationally supportive.

According to Saiduddin (2011), education is one of the most important aspects of human resource development; hence poor school performance does not only result in learners having low self-esteem but also causes significant stress to the parents. According to Lipton (2007) rural people are the main source of their own difficulties by rapid population growth. However, Okafor (2006) believes that lack of equitable distribution of social amenities within urban and rural areas is the main reason for poor performance of pupils from rural secondary schools. Yet another dimension to this debate is brought to the fore by Harris (2013) who attributes poor performance of rural secondary pupils to lack of parental support. There is a correlation between parental support in homework activities and the performance of pupils. Students with parental support in homework achieved better than those without parental support even if those without parental support had a higher intelligence quotient (Harris 2013). Cooper (2009) also found that there was a positive correlation between high achievement and quality time spent on home work.

On the other hand, Timothy (2010) found that the amount of instructional time affected learner performance and ignoring this fact results in less informative accountability systems and lost opportunities for learning outcomes. Vundla (2012) states that the major causes of high failure rate in South African rural secondary schools include shortage of well trained teachers, inadequate teaching facilities, lack of funds to purchase necessary equipment, poor quality textbooks, large classes, poorly motivated teachers, lack of laboratories and libraries, poorly coordinated supervisory activities, interference of the school system by politicians, incessant transfers of teachers, automatic promotion of pupils, and lack of proper classrooms. Avital (2012) also discovered that attitude of rural pupils towards the school and its benefits negatively contributed towards their commitment to school work. A study by Ndebele (2008) in Plumtree district in western Zimbabwe found that most secondary pupils thought that it was better to cross either the Botswana or South African borders to come back in a few months driving good cars than concentrating on their education. This kind of negative attitude minimises concentration and commitment to academic work (Ndebele, 2008). Burmaster (2009) found that where pupils had no reason to be at school, they frequently absented themselves from lessons to do other things they thought would help them in life, like income generating activities.

STATEMENT OF THE PROBLEM

The study sought to investigate the factors that contribute to causes of high failure rate of pupils from rural secondary schools in Zimbabwe. Most of the schools in rural districts of Zimbabwe perform far below the national average in some cases failing to produce just one candidate with a full certificate. There is need therefore, to find out from the teachers what they think are the real causes of this unpalatable situation.

PURPOSE OF THE STUDY

The study sought to explore the causes of poor performance of pupils in schools of Zimbabwe.

RESEARCH QUESTIONS

The study sought to provide answers to the following research questions:

1. Do supervisors in rural secondary schools provide adequate instructional leadership for their teachers?
2. Does the lack of educational facilities affect performance of pupils in Ordinary Examinations?
3. How do teacher factors contribute towards the failure of pupils in rural secondary schools?
4. What are the attitudes of pupils of rural secondary schools towards education?
5. Of what significance is the role of parental support towards performance of pupils at Ordinary Level by their pupils?

SIGNIFICANCE OF THE STUDY

The importance of this study stems from the fact that if a cause of students' poor performance at Ordinary Level examinations in the rural secondary schools is revealed solutions to ameliorate these causes will be proffered. The study also envisages to sensitive major stakeholders in the school system about the need to improve teaching and learning conditions in rural secondary schools.

LIMITATIONS OF THE STUDY

In view of the small size of the sample and sub-samples used the findings of the study would have limited generalizability. The other limitation relates to the descriptive method that was employed in this study (Leedy, 2009). The other limitation relates to the descriptive method that was used in this study. According to Bogdan and Taylor (20011) the descriptive method lacks predictive power. The research may discover and describe "what is" but is unable to predict "what would be" (Arkava and Lane 2010). The other limitation is that respondents may give false responses thereby affecting the validity of the findings. The weakness could be mitigated through the use of triangulation of methods which this study employed in the form of close-ended questions and open-ended questions.

DELIMITATIONS OF THE STUDY

The researchers delimited the investigation to establishing the causes of the poor performance of rural secondary school's pupils at Ordinary level in Nkayi District in western Zimbabwe. Views from 100 teachers taking Ordinary level classes were used in the research. Perceptions from stakeholders like pupils, heads of schools, parents, Education Inspectors and other key stakeholders were outside the purview of this study.

RESEARCH METHODOLOGY

The study used the quantitative methodology and made use of a survey research design. According to Anderson (2011) the descriptive survey method looks with intense accuracy at the phenomenon of the moment and them describes precisely what the researcher sees. The questionnaire was the major instrument for collecting data. As Bell (2013) observes, the questionnaire increases reliability as an instrument of gathering data because of its greater impersonality. The population consisted of 650 secondary school teachers from Nkayi District in Matebeleland North Province of Zimbabwe. The sample consisted of 100 teachers of which 55 were female and 45 male.

DATA COLLECTION AND ANALYSIS

Data were gathered by means of a questionnaire, which was largely made up of close-ended questions and a few open-ended questions. All respondents were given the questionnaires by the researchers at their schools. The researchers also personally collected the questionnaires to increase on the rate of return of the instruments. Non-returns according to Phillips and Pugh (2010) introduce a bias in as much as they are likely to differ from respondents in many ways, thereby adversely affecting reliability and validity of the findings. Data collected from the questionnaires produced descriptive statistics around the variables under study. These statistics were computed and inferential implications from them deduced and recorded.

FINDINGS AND DISCUSSIONS

The study set out to investigate the causes of poor performance of pupils from rural secondary schools at Ordinary Level in Zimbabwe. This section is presented in two parts, namely, presentation of data and then discussion of the same data. Data presentation is in two parts: characteristics of respondents and data on perceptions of teachers on causes of poor performance of pupils from rural secondary schools at Ordinary Level examinations.

PRESENTATION OF DATA

Table 1: Composition of sample by gender (N=100)

SEX	Frequency	Percentage
Male	45	45
Female	45	55
Total	100	100

As table 1 reveals, 55% of the respondents were female and 45% were male. This is generally a fair distribution of respondents in the survey as the variance between the two sexes is not very significant.

Table 2: Composition of sample by professional qualifications (N=100)

Professional qualification	Frequency	Percentage
Certificate in Education	2	2
DiplomainEducation	50	50
Bachelor in Education	12	12
Non-teaching degree	20	20
Masters degree	3	3
Untrained	13	13
Total	100	100

Table 2 above shows that the majority of the respondents (67%) had professional qualifications. However, a significant number of the respondents (20%) had non-teaching degrees and another 13% were Advanced Level Certificate holders.

Table 3: Composition of sample by teaching experience (N=100)

Years	Frequency	Percentage
1-2	15	15
3-5	29	29
6-10	43	43
10-15	10	10
20 and above	3	3
Total	100	100

The table above, table 3, shows that the majority of respondents had less than ten years of teaching experience (87%). Those who had over ten years of teaching experience constituted 13% of the respondents.

Table 4: Responses on the statement: "Textbooks and other related equipment are adequate in my subject(s) area(s)".

Category of responses	Frequency	Percentage
Strongly Agreed	10	10
Agree	11	11
Disagree	25	25
Strongly Disagree	50	50
Not Sure	4	4
Total	100	100

The information on table 4 above shows that respondents in the majority of cases indicated that their subject areas did not have adequate textbooks and other related equipment to augment textbooks. These constituted 75% of the respondents. Those who felt that textbooks and other equipment were adequate constituted 21%, whilst 4% were not sure about the textbook situation.

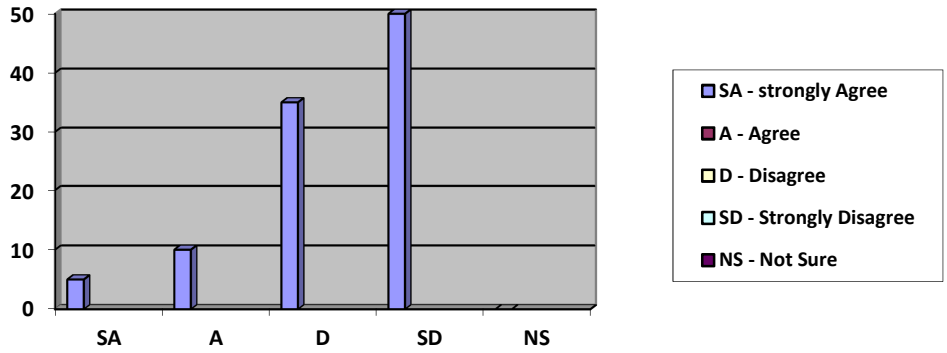


Figure 1: Responses to the statement: "Supervision by the head of Department and Head of School helps to guide me to be an effective teacher". (N=100)

As figure 1 reveals, 85% of the respondents disagreed with the statement that their school based supervisors (HOD and Head) helped to guide them to become more effective as teachers. Those who agreed with the statement were 15% of the respondents.

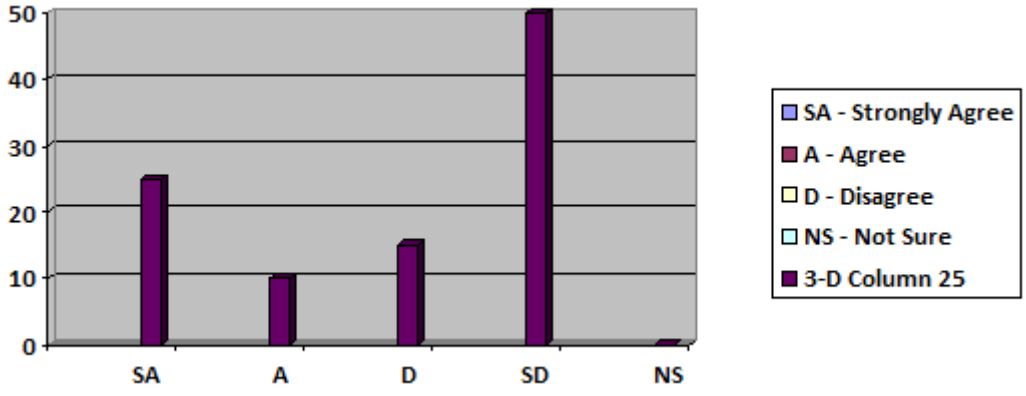


Figure 2: Responses to the statement: "I can confidently handle all topics in my subject areas". (N=100)

The information on figure 2 shows that the majority of respondents, 65% indicated that they were not confident with presenting all topics in their subject areas. Those who thought they could handle all topics confidently constituted 35%. Although a significant number of respondents held professional qualifications, it was discovered that most of them were deployed to teach subject areas they were not specialists in.

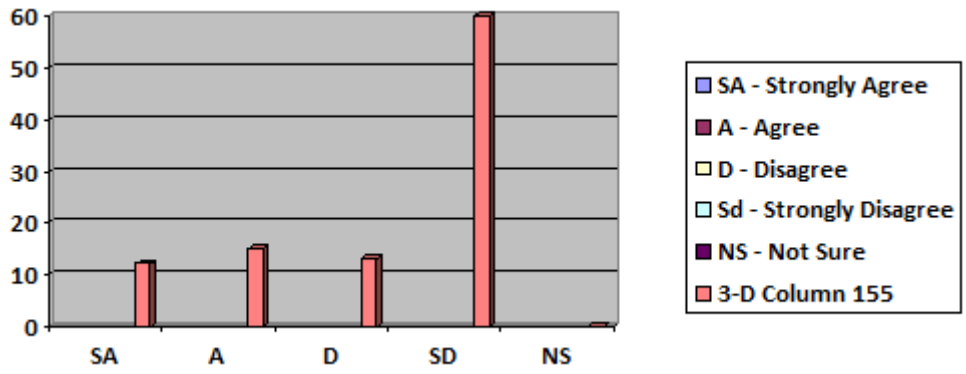


Figure 3: Responses to the statement: "Parents of my pupils support their children with their school work including homework". (N=100).

As figure 3 shows**,** the majority of respondents (73%) indicated that parents of their pupils did not support their children with their school work. Those who felt that their parents supported their children constituted 27% of the respondents.

Table 5: Responses to the statement: "Poor attendance of pupils affects my plans in the areas I teach". (N=100)

Category of responses	**Frequency**	**Percentage**
Strongly Agreed	55	55
Agree	26	26
Disagree	7	7
Strongly Disagree	12	12
Not Sure	0	0
Total	**100**	**100**

The information on table 5 above shows that the majority of the respondents (81%) agreed with the statement that absenteeism by pupils affected their teaching plans. Those who disagreed with the statement constituted 19% of the respondents.

The questionnaire had two open-ended questions which bolstered data from the close-ended questions. The first question sought to find out from respondents how big their classes were in terms of pupil population. The majority of respondents indicated that their classes ranged between 45 and 55 pupils for the Form 3 and Form 4 classes. A few respondents indicated that their classes ranged between 30 and 40 pupils per class.

The second question sought to find out whether given an option of another more lucrative job they would leave teaching. The vast majority indicated that they would leave their current job. In extension the majority indicated that they would even leave their school for a school that had better conditions than their current one.

DISCUSSION

The information from this study revealed that the majority of respondents were in possession of lower level professional qualifications of Certificate and Diploma in Education. This means that they possess relatively shallow content for their subject areas compared to those with degrees in their areas of specialisation. This observation tallies with findings from Vundla (2012) who discovered that the reason why pupils in rural secondary schools fail included largely a shortage of trained teachers among other causes. Properly qualified teachers as Timothy (2010) argues increase the amount of instructional time for learners and this positively affects their performance.

Findings also reveal that the majority of respondents indicated that their subject areas did not have adequate equipment and textbooks. Textbooks and other teaching/learning equipment are significant for high performance of pupils as Vundla (2010) discovered that the high failure rate in South African rural secondary schools was caused by inadequate teaching facilities, lack of funds to purchase necessary equipment and poor quality textbooks.

The study also revealed that most respondents felt that their school based supervisors were not doing enough in terms of guiding them to become professionally effective as teachers. Supervision is key to the professional development of teachers. As Miles (2008) states, effective leaders visit classrooms to discover what is happening in classrooms. They collect data through formal observations and instruments and use that data to help teachers with their teaching methodology.

The information from the study revealed that most respondents were not confident with presenting some of the topics in their subject areas. This is because most of them were deployed to teach subject areas they had not trained for. For example, a teacher who had specialised in Geography or History at a teacher training college, would find him/herself asked to teach Mathematics or Science for example because of shortages in these areas.

The findings also reveal that the majority of teachers in the study felt that parents of their pupils did not support their children on their school work particularly on home work. This tallies with Bush's (2009) observation that home background and community values can mar or make effective learning. Ralenda (2012) corroborates Bush (2009)'s observation when he argues that rural schools often serve disadvantaged learners who are from families that are not educationally supportive.

Evidence from the study also reveals that the vast majority of respondents indicated that there was rampant absenteeism by their pupils. Avital (2012) argues that attitude of rural pupils towards the school and its benefits negatively contribute towards their commitment to school work. Burmaster (2009) found that where pupils had no reason to be at school, they frequently absented themselves from lessons to do other things they thought would help them in life. According to Umameh (2011) there is need for genuine attitudinal change as it may bring about interest and positive attitudes towards the school work.

The study also reveals that the majority of respondents indicated that class sizes in their schools were relatively high. The majority were teaching Ordinary Level classes with above 40 pupils yet the stipulated class size is 30. This affects the teacher-pupil ratio which determines the quality time a teacher spends with his/her pupils. The larger the class, the less time the teacher spends with individual children, thereby affecting their learning (Bush, 2009).

Most teachers also indicated that given the opportunity of a greener pasture emerging they would not hesitate to leave their job. The majority also indicated that they would also quickly transfer to a better school if a vacancy arose at that school. This revelation tallies with observations by Vundla (2012) who found that one of the major causes of high failure in rural secondary schools was the incessant transfers of teachers to escape from poor conditions of service.

CONCLUSIONS

Given the background of the above findings, the researchers make the following conclusions:

- Most of the teachers under study are in possession of lower level professional qualifications that provide them with the barest minimum survival skills in the classrooms.
- Most of the schools do not have adequate and relevant textbooks and equipment necessary for effective teaching and learning.
- The supervision process in the schools is not adequate to promote the professional growth of teachers so as to enhance the performance of pupils.
- Most of the teachers lacked confidence in delivery of lessons in some subject areas because they were allocated to teach areas they were not specialists in.
- Parents were not providing adequate support for their children on school based activities particularly on homework.
- Most students did not take learning time seriously as they frequently absented themselves from school without good reasons.
- Class sizes in the schools in rural areas were quite way above the stipulated class enrolments thereby compromising the quality of education received by the pupils.
- Most teachers were willing to transfer to better schools particularly in urban areas or any other schools with better conditions of services.

RECOMMENDATIONS

In light of the findings of the study, the researchers would like to make some recommendations.

- The Ministry of Education should encourage teachers who possess the Certificate in Education and Diploma in Education qualifications to upgrade their qualifications by joining universities to obtain degrees. Teachers should have adequate content on the various subjects they teach so as to easily simplify it for their students. There should be regular staff development sessions for those without teaching qualifications.
- Schools should prioritise the acquisition of relevant textbooks and equipment in their budgets so that every pupil has access to a textbook even to take home for homework.
- School based supervisors should hold properly planned supervision sessions for the professional growth of teachers. Heads, Deputy Heads and Heads of Departments ought to continuously guide the teachers during the teaching / learning process.
- Teachers should be allocated subject areas they specialised in so as for them to properly guide pupils instead of asking them to teach areas they did at Ordinary or Advanced level and passed with C grades. This lowers the quality of teaching standards in the schools. If a teacher specialised to teach History and Geography, they should teach these two and not other subjects like Science or Ndebele.
- Schools through the School Development Committees should encourage parents to provide support to their children on their school work.
- Heads of schools, teachers and parents together should not tolerate absenteeism by pupils as it costs them a lot of learning time thereby affecting their performance negatively.
- Schools should adhere to the stipulated class sizes in order to promote high quality contact between the teachers and individual pupils.
- The government should work towards improvement of conditions of service for teachers serving in rural areas so that there is teacher stability which will promote the necessary experience required for guiding pupils, particularly for public examinations.

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AN INVESTIGATION INTO THE CONTRIBUTION OF PRIVATE COLLEGES TO THE PROVISION OF EDUCATION IN ZIMBABWE'S SECONDARY SCHOOL- SECTOR LEARNER'S ATTRIBUTIONS

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ABSTRACT: Demand for education in most developing countries (Zimbabwe included) is very high whereas the corresponding supply is low. Since education is a public service it inevitably implies that governments should wholly provide this service to all citizens who require it. However, due to financial constraints, the governments are unable to meet the educational demands for their populations. This, therefore, gives private players the chance to augment the efforts of the governments. The study was carried out in Harare Province. The study draws on a quantitative inquiry on the role played by private players in the provision of secondary education in Zimbabwe. A total of 200 respondents were used of which 110 were female and 90 were male. These were students enrolled by the four colleges that were sampled for the study. The study revealed that the teacher-pupil ratio was higher than that stipulated by regulations, most students enrolled for less than five subjects, there was shortage of textbooks, there was little participation in sports, teachers were not competent in most subject areas and most pupils were dissatisfied with the education they were receiving from these colleges. The study recommends that the Ministry of Primary and Secondary Education should closely monitor the operations of private colleges so as to ensure that they adhere to regulations regarding minimum standards on provision of secondary education. Teachers in private colleges should attend in-service courses to help them with their professional conduct.

KEYWORDS: Private colleges, Province, Secondary education, Students, Developing countries.

INTRODUCTION

According to Komba and Yohana (2013) education is recognised as the foundation of societies' economic developments as it facilitates the acquisition of the skills and attitudes necessary to facilitate innovation and hence raises national productivity. Education is the most powerful catalyst for poverty reduction and similarly, educational deprivation is equally a powerful cause of poverty (Yohana 2013; Rose et. al 2008; Avenstrup 2006; Shi and Quheng, 2007). Therefore, the importance of education to any nation dictates that governments cannot escape their responsibility of educating their citizens (Komba and Yohana 2013). However, the reality on the ground reveals that governments do not have adequate financial resources to wholly fund education provision for their citizenry, thus the involvement of the private players (Pessoa, 2008).

In Zimbabwe, the involvement of private colleges in the provision of secondary education is prescribed in Section 54 of The Education Act (1996) which stipulates that the operation of private colleges involves the offering of tuition only to students who would have completed the prescribed primary education period or would have attained the age of sixteen years whichever comes first (Bowora, 2008). As a result of this legal provision for the establishment of private colleges, a number of individuals and organisations have opened secondary schools across the country to accommodate those students who fail to get places at formal schools due to a number of reasons (Mpofu, 2010). It is on account of this information that

this study set out to investigate the way how private colleges conduct their business in their quest to provide secondary education to their students.

LITERATURE REVIEW

Private schools, also known as independent schools or non-state schools, are not administered by local, state or national governments, thus, they retain the right to select their students and are funded in whole or in part by charging their students tuition, rather than relying on mandatory taxation through public funding (Hein 2004). In the United Kingdom and several other commonwealth countries including Australia and Canada, the use of the term is generally restricted to primary and secondary educational levels (Mpofu 2010). Private education in North America covers the whole gamut of educational activity, ranging from pre-school to tertiary level institutions (Hein 2004). As Burns (2010) observes, most developing world countries follow either the United Kingdom model or the North American model on their private school structure.

In Zimbabwe as Bowora (2009) posits, private colleges were initially a phenomenon associated with rich people in the central business districts of major towns and cities. However, currently, private colleges have mushroomed in high density residential areas. Some of these colleges operate in unsuitable sites for educational business (Magura, 2010). As a result of the high number of these private colleges all over the towns, they are now under the spotlight (Dhliwayo, 2009). As Maponga (2001) observes since 2000, there has been a general decline in the quality of service offered by the mainstream educational system. Private colleges have been established as a result of the deterioration in public education standards due to a number of factors which include general economic decline, brain drain, lack of motivation amongst teachers among other factors (Sisimayi, 2008).

Shumba (2008) applauded private colleges for offering education services to a number of children who could not be accommodated in the government and council run schools because of overcrowding.The nation should not overlook the service provided by private colleges during 2008 when the mainstream education system was faced by total collapse (Mhunga, 2009).

However, as Dube (2009) found out, the Zimbabwe Child Rights activists are accusing these private colleges of profiteering as desperate parents lose patience with strikes by disgruntled teachers and the plummeting standards in government schools. According to Mhandu (2010) some private colleges have children learning in overcrowded conditions. In some cases, children as young as twelve years are exposed to adults as there is no age limit because most of the private colleges operate from rented premises, there is little or no long term investment which the owners put in place (Munyoro, 2010). This implies that their operations would be on makeshift bases hence they end up short-changing the students. As Bowora (2009) observed, equipment for laboratories is usually not acquired, textbooks are usually in short supply and permanent developments like the construction of additional classrooms and administration offices are often not done.

According to Ahmed (2013) in the Northern Nigerian town of Kano, over 80 private nurseries, primary and secondary schools were shut down in 2013 alone and a further, 52 suspended for violating Kano State's education law. Ahmed (2013) quotes Baba Abubakar Umar, the chairman of the Kano State Task Force on Private Schools who stated that, "the situation is quite pathetic; so many schools are operating without government consent, by extension without any kind of formal approval from the Ministry of Education. For example, some private schools are located near sites that negatively affect pupil behaviour-like under high tension cables, or near market places. Hajia Tabawa Abdusalam, the owner of Badar Primary School and Secondary School and the chairperson of the National Association of Proprietors of Private Schools in Kano as quoted by Ahmed (2013) said we are running private schools in Kano State, but some of us are not following the guidelines and the rules for operating a private school. These standards have to do with the teaching and learning environment, qualification of teachers, and the proprietor must have the quality to administer a private school (Ahmed, 2013).

According to Burns (2010), most of the students who learn in community and non-formal colleges possess some characteristics which are negatively associated with education. Such students include those who work as baby minders or domestic workers, part-time students without good results as well as those who struggle financially (Burns, 2010). To this end, the weaknesses which they possess negatively affect their preparedness to learn. With these students in the same class with other students who are not as disadvantaged as them would in turn affect the performance of these others.

STATEMENT OF THE PROBLEM

The study sought to investigate the role played by private colleges in the provision of secondary school education in Zimbabwe. Mainstream secondary schools cannot accommodate all the children who want to pursue their secondary school

studies, as a result private schools have mushroomed all over the country to fill that gap. There is need, therefore to investigate what actually takes place in these colleges.

PURPOSE OF THE STUDY

The study sought to investigate the role played by private colleges in the provision of secondary school education for those children who cannot be accommodated in mainstream secondary schools.

RESEARCH QUESTIONS

The study sought to provide answers to the following research questions:

1. What are the general class sizes obtaining in private colleges?
2. Is the location of the private colleges conducive for effective learning?
3. How does the curriculum offered by private colleges look like?
4. Are there adequate learning materials availed for students in the private colleges?
5. Are teachers properly qualified for teaching various subjects in the colleges?

SIGNIFICANCE OF STUDY

The importance of the study stunned from the fact that it sought to explore the role played by private colleges in the provision of secondary school education. It was hoped that the research would contribute immensely towards a better understanding of the operations of private colleges. There have been mixed perceptions on whether the private colleges are positively contributing to quality education in Zimbabwe or not. The study is likely to provide critical information to governments, policy-makers, non-governmental organisations, donors, communities, parents and other key stakeholders.

LIMITATION OF THE STUDY

Administrators of private colleges would not naturally want a study of this nature carried out in their colleges because of the sensitive nature of the subject. Secondly, in view of the small size of sample and sub-samples used, the findings of this study therefore will have limited generalizability. It has to be pointed out that attitudes about an issue are essentially subjective and cannot be measured accurately. In other words, attitudes have no universally recognised and accepted scales of measurement, and measures that were used in this study cannot be considered to be very accurate.

DELIMITATION OF THE STUDY

The study was confined to one province; which is Harare Province, which also houses Zimbabwe's capital city. It was concerned with the role played by private colleges in the provision of secondary education. The respondents were pupils learning at the private colleges. Teachers, parents and government were outside the purview of this study.

RESEARCH METHODOLOGY

The study employed quantitative methodology. Quantitative research was chosen for its ability to enable this study's findings to be generalised to other provinces in the country (Dlumberg, 2008). The quantitative methodology was also found useful in this study because it enabled the researchers to investigate 200 pupils' perceptions on the role private colleges plays towards the provision of secondary education.

The study settled for the survey research design. The use of survey research design enabled the researchers to gather widespread perceptions of respondents in regard to the studied phenomenon (Lawson and Lovell 2010). The study used simple random sampling and purposive sampling to select 200 students. The researchers used a questionnaire with closed-ended questions. Close-ended questions enabled the researchers to collect predetermined respondents opinions regarding the studied phenomenon (Khumar, 2008).

DATA COLLECTION AND ANALYSIS

Data were gathered by means of a questionnaire which was made up close-ended questions. The questionnaire was chosen because as Borg and Gall (2009) observe, it has the ability to reach many respondents who are at widely dispersed addresses and preserves anonymity which encourages greater honesty. However, Borland (2011) argues, the questionnaire generally has a low response rate and is inflexible in that it does not allow ideas or comments to be explored in-depth and many questions may remain unanswered. The researchers personally distributed the questionnaires to be selected respondents at their colleges. The same method was used to collect the collected questionnaires. The questionnaire produced descriptive statistics around the variables under study. These statistics were computed and inferential implications from them derived and rewarded.

FINDINGS AND DISCUSSION

The study sought to explore the contributions made by private colleges in the provision of secondary education in Zimbabwe. This section is presented in two parts namely, presentation of data and discussion.

PRESENTATION OF DATA

Table 1: Profiles of respondents by gender (N=200)

Sex	Frequency	Percentage
Male	90	45
Female	110	55
Total	200	100

As table 1 reveals, 45% of the respondents were male and 55% were female. The datum was considered statistically significant to the extent that it confirmed the wide-held hypothesis that more pupils in Zimbabwean private colleges are girls.

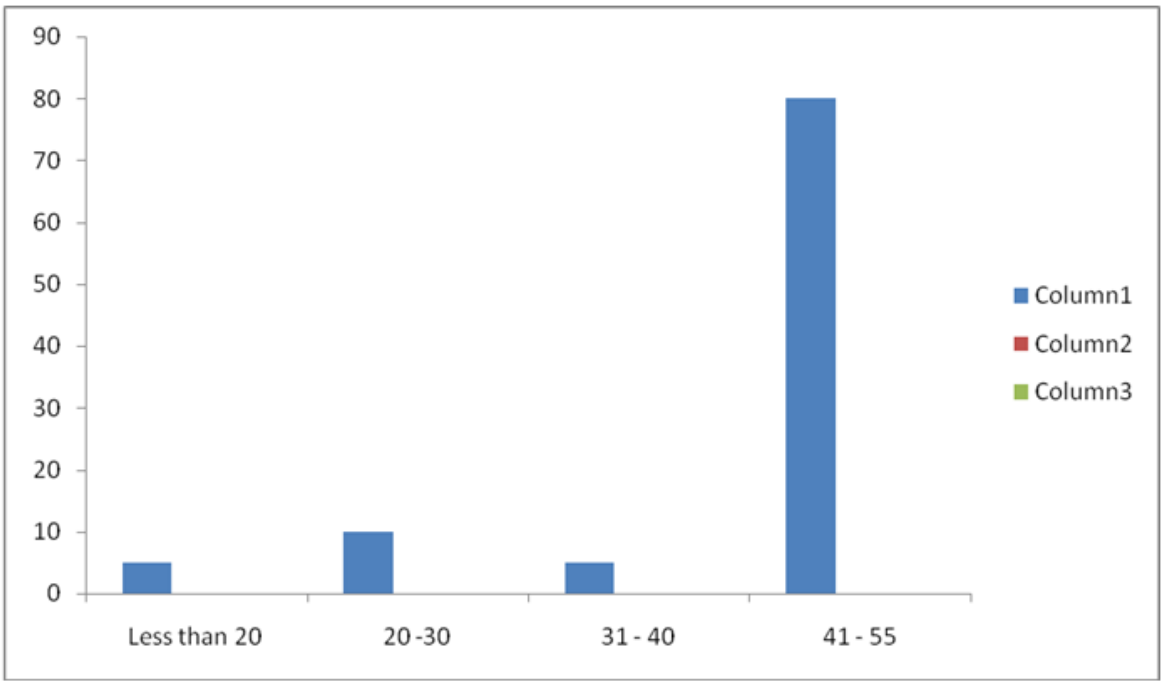


Figure 1: Number of pupils per class (N=200)

Figure 1 above shows that 80% of the respondents indicated that there were between 41 and 55 pupils in their classes. The 31-40 class sizes constituted 5% and the 20-30 constituted 10% and a few had classes of less than 20 pupils.

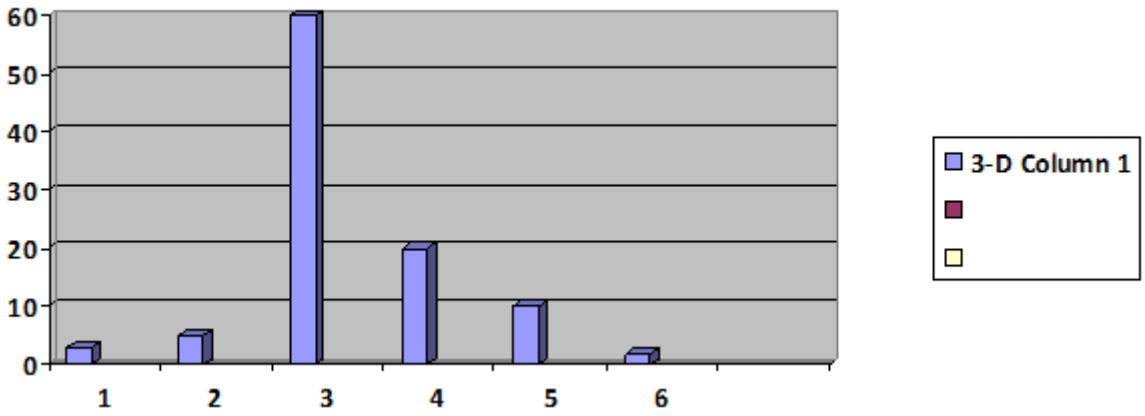


Figure 2: Number of subjects enrolled for by each pupil (N=200).

The figure above shows that over 88% of the pupils had registered for less than five subjects. Those registered five subjects and above were only 12% of the respondents.

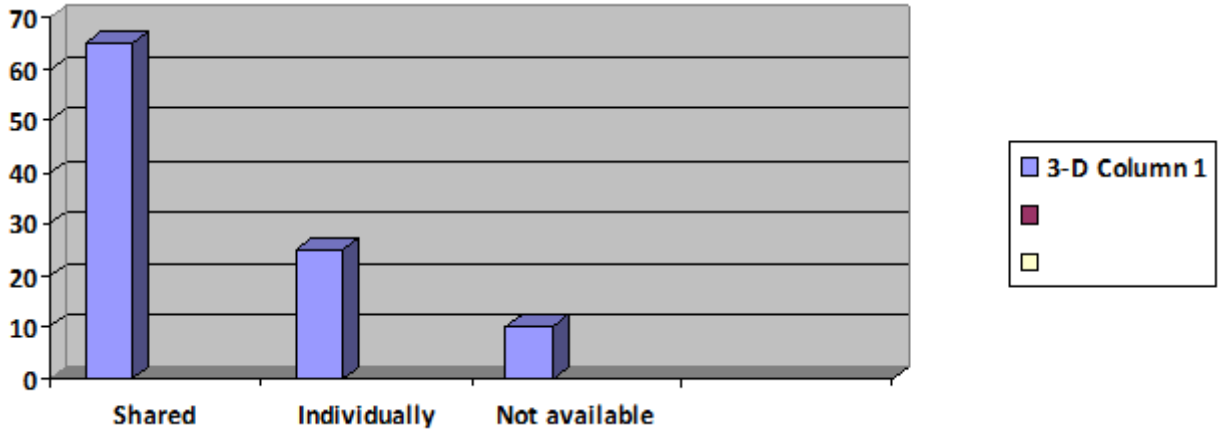


Figure 3: Distribution of textbooks for registered subjects amongst pupils (N=200).

The information on figure 3 reveals that the majority of respondents indicated that they were sharing textbooks. They constituted 65% of the sample respondents. Those who were not sharing constituted 25% and those who indicated that they did not have textbooks constituted 10% of the respondents.

Table 2: Responses to the question: "Teachers provide adequate support during the teaching/learning process" (N=200)

Category of responses	Frequency	Percentage
Strongly Agree	38	19
Agree	14	7
Disagree	48	24
Strongly Disagree	80	40
Not Sure	20	10
Total	200	100

Table 2 above reveals that the majority of respondents strongly disagreed with the statement that their teachers were providing adequate support during the learning/ teaching process. They constituted 40%. Those who disagreed were 24% of the respondents. Those who strongly agreed and agreed constituted 26% of the respondents. Respondents who indicated that they were not sure constituted 10% of the respondents.

Table 3: Responses to the statement: "The classroom environment was always good for our learning" (N=200).

Category of responses	Frequency	Percentage
Strongly Agree	20	10
Agree	22	11
Disagree	50	25
Strongly Disagree	100	50
Not Sure	8	4
Total	200	100

Table 3 above shows that the majority of the respondents (75%) indicated that their classroom environment was not always good for their learning. Those who indicated that it was always good constituted 21% of the sample respondents. Only 4% indicated that they were not sure about the question.

Table 4: Responses to the statement: "Teachers are always absent from school leaving us to do work alone" (N=200).

Category of response	Frequency	Percentage
Strongly Agree	80	40
Agree	50	25
Disagree	44	22
Strongly Disagree	26	13
Not Sure	0	0
Total	200	100

Table 4: Table above reveals that the majority of the respondents (65%) agreed with the statement that their teachers were always absent from work. Those who disagreed constituted 35% of the sample respondents.

Table 5: Responses to the question: "Which sporting activities do you take part in at your college" (N=200).

Category of respondents	Frequency	Percentage
Football	70	35
Netball	59	29
Volleyball	5	3
Athletics	15	8
Tennis	2	1
Basketball	0	0
Handball	0	0
Darts	0	0
None	48	24
Total	200	100

Information on table 5 above reveals that the majority of respondents indicated that they participated in football (35%) and netball (29%). A few indicated that they participate in volleyball (5%), athletics (15%) and tennis (2%). A significant (24%) of the respondents indicated that they did not participate in any sporting activity.

DISCUSSION

Data from the study reveal that the majority of the respondents were girls or female. This shows that there are more girls in most private colleges than there are boys. These findings tally with observations made by Burns (2010) who stated that most of the students who learn in community and non-formal colleges possess some characteristics which are negatively associated with education. Such students include most girls who dropped-out from mainstream school through pregnancy or those who work as babyminders.

Findings also indicate that respondents revealed that class sizes in their colleges were quite high. The majority were in classes with more than 40 pupils. This correlates with findings from Mhandu (2010) who found that some private colleges had children learning in overcrowded conditions far above the stipulated class size of 33 for forms 1 and 2, and 30 for forms 3 and 4.

Data also shows that most respondents indicated that they registered for less than five (5) Ordinary Level subjects which are required for a full certificate at 'O' level according to Zimbabwean standards (Bowora 2008). Perhaps, this explains the high failure rate which characterise the 'O' level results of the colleges studied. With this kind of situation it means that students would be having a lot of time in which they are not occupied.

The information from the study indicates that the majority of respondents revealed that they were sharing textbooks. Only a few had individual textbooks. This tallies with observations from Bowora (2007) who found that equipment for laboratories is usually not acquired, textbooks are usually in short supply and permanent developments like the construction of additional classrooms and administration offices are not often done.

Data discerned from the study shows that the majority of the respondents indicated that their teachers did not provide adequate support during the teaching learning process. As Dube (2009) argued, some of these private colleges have been accused of profiteering through hiring unqualified teachers who lack all the basic competencies of the teaching profession.

Findings also revealed that the majority of the respondents indicated that their classrooms did not provide conducive environments for effective learning. This observation tallies with the observations made by Mhandu (2010) who stated that some private colleges had children as young as twelve years who were exposed to adults as there is no age limit. In addition Ahmed (2013) states that some private colleges are located near sites that negatively affect pupil behaviour, for example under high tension cables or near market places.

Data also shows that respondents indicated that they did not partake in any sporting activity within their colleges. This means that some of these colleges do not address all the aspects of the Zimbabwean secondary school curriculum which views sports as a significant component.

CONCLUSIONS

Given the background of the above findings, the researchers make the following conclusions:

- Most of the pupils in private colleges are females who find themselves in these colleges because of a number of reasons.
- Most of the pupils register for less than five subjects instead of the five that constitute the standard expected in Zimbabwe at Ordinary level.
- Private colleges do not have adequate textbooks for pupils they have enrolled. Pupils share textbooks and in some extreme cases, pupils had no single textbooks.
- Some of the teachers employed by private colleges did not provide adequate support to the learners. This could be as a result of lack of competence in the various subject areas.
- Classroom conditions in some colleges did not provide conducive environments for effective learning.
- Private colleges in most of the cases provided sporting disciplines like football and netball. A few however, did not provide any sporting disciplines to their pupils.

RECOMMENDATIONS

In light of the findings of this study, the researchers would like to make some recommendations.

- The government should constantly monitor developments at private colleges since most of the students are girls who dropped out from mainstream schools who are likely to negatively influence younger pupils at private colleges.
- Private college owners should adhere to stipulated class sizes if ever they want to promote quality education for their pupils.
- Pupils should be encouraged to register five or more subjects to increase chances of these pupils obtaining full ordinary level certificates.
- There is need to staff develop teachers so that they are equipped with competencies that will help them professionally guide their pupils.

- Private colleges' authorities should make sure that pupils learn under conducive classroom environments for effective learning to take place. Colleges should not be sited near market places where there is noise.
- Private colleges are commended for providing sporting activities for their pupils. However, they are encouraged to motivate all pupils to partake in sporting activities.

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ESTIMATION OF TECHNICAL EFFICIENCY OF WHEAT FARMING IN KHYBER PAKHTUNKHWA, PAKISTAN: A STOCHASTIC FRONTIER APPROACH

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ABSTRACT: This study determined technical efficiency of wheat farmers in Khyber Pakhtunkhwa, Pakistan. Data from 300 wheat growers were collected through multistage stratified random sampling technique. Maximum likelihood estimation technique was applied to estimate stochastic frontier Cobb-Douglas production function to estimate the level of technical efficiency in wheat farming. Results showed that explanatory variables i.e., land under wheat crop, labor, chemical fertilizer, and tractor plough were statistically significant. The estimated elasticity for these variables indicated that a one percent increase in land under wheat crop, labor, chemical fertilizer and tractor plough would raise the wheat yield by 0.126, 0.248, 0.081, 0.226 and 0.066 percent respectively. The coefficient of farm yard manure was found insignificant. The estimated value of technical efficiency ranges from 39 to 94 per cent, with an average of 64 per cent. This means that if an average farmer opts to attain the technical efficiency level of its most efficient counterpart, then wheat yield could be increased by 32 per cent. Similarly the most technically inefficient farmer could enhance wheat yield by 58 per cent. Farmers' age, farming experience, farmer' education and land under wheat crop were major determinants of technical inefficiency. The relationship between farmers' age and technical inefficiency was positive and statistically significant implied that technical efficiency decreases with the increase in the farmers' age. The coefficient of farming experience was negative but statistically insignificant. The coefficient of farmers' education was negative and statistically significant which implied that inefficiency decreases with increase in the farmers' education in the study area. The relationship between technical inefficiency and land under wheat crop was positive suggesting that those farmers with relatively large farm size under wheat crop are technically inefficient but the coefficient is insignificant. It is suggested the use of more labor and tractor plough hours would increase wheat production in the country. Government of Pakistan should focus on formal as well as informal education in the country. Government should also encourage educated and young people to participate in agriculture particularly wheat growing.

KEYWORDS: Wheat, technical efficiency, stochastic frontier production function, Khyber Pakhtunkhwa, Pakistan.

1 INTRODUCTION

Wheat (Triticum aestivum L.) is the major food crop of larger part of Pakistan's population. Self-sufficiency in wheat is of immense important for sustainable food security since it is the key component of Pakistanis' diet. It contributes 3.1 per cent to GDP and 15 per cent to value added in food products [1]. Wheat production in Pakistan was 25.2138 million tons in 2010-11. The productivity of wheat which was 2553 kg/hectare in 2009-10 has increased to 2833 kg/hectare in 2010-11. In Khyber Pakhtunkhwa, the third ranked wheat producer province after Punjab and Sindh, in the year 2010-11 area under wheat was 724.500 thousand hectares, production 1155.800 thousand tons and productivity 1595 kg/hectare [2].

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It is evident that food production in Pakistan grows at slower rate as compared to demand for food because population of Pakistan grows at the higher rate of 1.9 per cent. Through increasing productivity, especially of small farmers who are majority in Pakistan and putting emphasis on major wheat growing districts, food availability can be secured [3].

Productivity of agriculture sector can be accelerated by improving efficiency or introducing new technology or both. Improvement in efficiency is an appropriate option to increase the agriculture productivity in short run because adoption rate of new technology in Pakistan is very low [4]. In order to achieve sustained growth in agriculture, efficiency and productivity differentials have to be reduced by improving the management skills of the farming communities, knowledge, education and development of infrastructure [5][6]. In this backdrop, efficiency measurement of agricultural production is an important scenario in developing countries.

Farrell (1957) [7] proposed that economic efficiency can be divided in to two components, technical and allocative efficiencies. The term technical efficiency of a farm is its ability to produce the largest possible potential output from existing set of inputs and existing technology while allocative efficiency refers to the ability of a firm to produce at a given level of output using the least cost combination of inputs. A measure of producer's performance is one of the important tools for policy purposes and the concept of economic efficiency provides a theoretical base for such measure. Growth in agricultural sector and promoting productivity are effective tools for economic development. Wheat productivity growth is one of the important determinants of long-term economic growth and real per capita income growth which in turn are crucial factors of living standard and well being of the society. Enhanced productivity leads to improved returns to the producers as well as to labor and enables larger consumption of goods and services per person including health, education and other community services.

Very little analytic research has been carried out on technical efficiency of Pakistan's wheat crop e.g., [8][9][10][11][4]. Thus there is an intense need to carry out a comprehensive study on technical efficiency of Pakistan's wheat crop. It is anticipated that this study will help farmers to identify factors that affect wheat growers' technical efficiency and determining the opportunity for increasing output. The present investigation aims to estimate and examine technical efficiency of various resources used in the production process of wheat crop in Khyber Pakhtunkhwa, Pakistan.

2 DATA AND METHODOLOGY

This study was carried out in Khyber Pakhtunkhwa Province of Pakistan. The population for this study consisted of total number of wheat growers in Khyber Pakhtunkhwa Province. Data from 300 wheat growers were collected through multistage stratified random sampling technique. In the first stage Peshawar, Charsadda and Mardan districts were purposively selected, since these are major wheat producing and highly irrigated districts of Khyber Pakhtunkhwa Province. Peshawar, Charsadda and Mardan have 92%, 88% and 71% irrigated area under wheat, respectively, during 2008-09. Similarly, these districts produced 83.55 thousand tons, 86.38 thousand tons and 99.01 thousand tons of wheat, respectively, during 2008-09 [12]. In the stage second out of these three districts, one tehsil from each district was randomly selected. In 3rd stage, from each selected tehsil two union councils were selected randomly. In stage four from each selected union council one village was randomly selected. A pilot survey was carried out for collection of data on yield of wheat (kilogram per hectare) from 60 respondents, 10 respondents from each village. Using the following formula, the required sample size was determined [13]:

$$n = (S * Z_{\alpha/2} / e)^2 \quad (1)$$

Where;

n	=	Sample size
S	=	Std. Dev. of wheat yield (kilograms per hectare)
	=	441
Z (α/2)	=	1.96; the value of standard normal variate at 95% confidence level
e	=	Sampling error
e	=	50
n	=	298.84 ≈ 300

100 respondents from each district were selected applying proportional allocation sampling technique. List of wheat growers in each village were prepared with the help of halqa patwari of that village [13]:

$$n_i = n/N \times N_i \quad (2)$$

Where;

n_i = Sample growers in each village
n = Total sampled growers
N_i = Population of wheat growers in each village
N = Population of wheat growers in each District

Primary data for the current study were collected through well structured questionnaire during 2009-10, while secondary data were collected from various published and unpublished sources. An interview schedule was prepared in the light of study objectives. The primary data regarding wheat yield, inputs used in the production process and other factors involved in the production process were collected from 300 randomly selected wheat growers.

Literature reveals that econometric method is widely used to estimate technical efficiency of firms e.g., [14]-[18]. According to econometric method stochastic frontier production model is estimated. Stochastic frontier analysis was developed by Aigner, Lovell and Schemidt (1977) [19] and Meeusen and Van Den broeck (1977) [20] also called composed error model. Their work was independently based upon the measure of technical efficiency by Farrell in 1957 [7]. For the present study, assuming a suitable production function, we define the stochastic production frontier as follows:

$$Y_i = f (X_i, \beta_i) \quad (i = 1,2 ,---------- n) \tag{3}$$

$$Y_i = \beta_i X_i + \epsilon_i \quad (i = 1,2 ,---------- n) \tag{4}$$

Where Y_i is the output obtained by ith grower, X_i is the inputs applied by ith grower, β_i are the parameters and ϵ_i is the composed error term for ith grower consisting of ν_i and μ_i. ν_i is symmetric ($-\infty < \nu_i < \infty$) and covers the random (stochastic) effects which are beyond the control of farmers i.e., weather, breakdowns and natural disasters etc. ν_i is assumed to be independently and identically distributed as $N (0, \sigma^2_v)$ [21]. μ_i depicts farm specific technical inefficiency. It estimates the shortfall of output (Y_i) from its maximum possible output given the stochastic frontier [$f (X_{ij}, \beta) + \nu_i$] [19]. u_i is independently and half normally distributed i.e. u_i - [$N (0, \sigma^2_u)$]. The disturbance ν_i and μ_i are assumed to be independent of each other. The term ν_i and μ_i are also assumed to be independent of physical inputs X_i. Stochastic frontier production model separates technical inefficiency effects from effects of those factors, which cannot be controlled by the farmers.

Present study estimated technical efficiency within the framework of Cobb-Douglas stochastic frontier production function. Cobb-Douglas production functional form has been utilized because of its ease of interpretation and estimation as follows:

$$\ln Y_i = \beta_0 + \sum_{i=1}^{n=7} \beta_i \ln X_i + \epsilon_i \tag{5}$$

Where;

Y_i = Yield of wheat grains in kilograms per hectare
X_1 = Land under wheat crop in hectares
X_2 = Number of labor days (man days) per hectare
X_3 = Chemical fertilizers in kilograms per hectare
X_4 = Number of tractor plough hours per hectare
X_5 = Farm yard manure in kilograms per hectare
X_6 = Dummy for Peshawar District i.e., 1 if Peshawar District, 0 otherwise
X_7 = Dummy for Charsadda District i.e., 1 if Charsadda District, 0 otherwise
ϵ_i = Composed error term
ln = Natural log
β_0 = Intercept
β_i = Parameters to be estimated

The stochastic frontier model was estimated by using maximum likelihood estimation (MLE) method. The basic idea of the ML principle is to choose the parameter estimates (β, σ^2_ε) to maximize the probability of obtaining the data. Therefore maximum likelihood estimation technique was used to estimate the stochastic frontier production model given as under:

$$\ln L = n/2 \ln [\pi/2] - n/2 \ln \sigma^2 + \sum^n_{i=1} \ln [1 - F [\varepsilon_i \sqrt{\gamma} / \sigma \sqrt{(1-\gamma)}]] - 1/ 2 \sigma^2 \sum^n_{i-1} \epsilon^2_i \tag{6}$$

Where;

$\epsilon_i = Y_i - X_i\beta$ (7)

σ^2_v and σ^2_u are variances of v and u respectively,

$\sigma^2_\varepsilon = \sigma^2_v + \sigma^2_u$ (8)

$\gamma = \sigma_u^2/(\sigma_u^2 + \sigma_v^2)$ (9)

F = Cumulative density function

Technical inefficiency model is expressed as follows:

$\mu_i = \delta_0 + \delta_1 Z_{1i} + \delta_2 Z_{2i} + \delta_3 Z_{3i} + \delta_4 Z_{4i} + \omega_i$ (10)

Where;

μ_i = Farm specific technical inefficiency
Z_{1i} = Age of ith grower (years)
Z_{2i} = Farming experiences of grower (years)
Z_{3i} = Education of ith grower (years)
Z_{4i} = Land under wheat crop of ith grower (hectares)
ω_i = Random error normally distributed with mean 0 and constant σ^2
δ_0 and δ_i are the parameters to be estimated

For estimating individual farmers' technical efficiency the following formula was applied:

$TE_i = Y_i / Y_i^*$ (11)

Where;

Y_i = Output obtained by ith wheat grower
Y_i^* = Output obtained by wheat grower operating at frontier
TE_i = Technical efficiency of ith grower (ranges between 0 and 1)

For estimating individual farmers' technical efficiency the following formula was applied:

$TI_i = 1 - TE_i$ (12)

$TI_i = 1 - [\, Y_i / Y_i^* \,]$

Where;

TI_i = Technical inefficiency of ith wheat grower (ranges between 0 and 1)

3 RESULTS AND DISCUSSION

The management practices and input use are likely to be influenced by various socio-agro-economic factors such as age of the farmer, educational level of the farmer, farming experience, access to information etc. These factors influence farmers to adopt any technology fully or partially. It is possible to attain a higher yield of different crops by adopting modern practices and the yield gaps can be minimized in this way [22]. Socioeconomic characteristics of farmers provide useful information to the researchers. The salient features of the wheat growers of the research area pertaining to their age, educational level, farming experience, and land under wheat crop are given in table 1.

Table 1 Socio-economic characteristics of the sampled respondents in the study area

Variables	Mean	Std. Dev.	Minimum	Maximum
Age	45.61	9.47	20.00	68.00
Farming Experience	24.11	9.26	5.00	50.00
Farmers' Education	5.61	5.44	0.00	16.00
Area (hectares)	1.67	1.09	0.10	6.07

Source: Survey Data; 2009-10

Table 2 Maximum likelihood estimates of the stochastic frontier production function in the study area

Variables	Parameters	Coefficients	Std. errors	t-ratios
Constant	β_0	5.820	0.187	31.122**
Ln Land under wheat	β_1	0.126	0.029	4.344**
Ln Labor	β_2	0.248	0.040	6.200**
Ln Chemical fertilizer	β_3	0.081	0.034	2.382*
Ln Tractor plough	β_4	0.226	0.043	5.256**
Ln FYM	β_5	-0.001	0.0012	-0.833
Technical inefficiency model				
Constant	δ_0	-9.822	2.244	-4.377**
Farmers' age	δ_1	0.090	0.049	1.836*
Farming experience	δ_2	-0.010	0.044	-0.227
Farmers' education	δ_3	-0.198	0.067	-2.955*
Land under wheat	δ_4	0.116	0.933	0.124
Peshawar dummy	δ_5	-4.526	2.083	-2.170*
Charsadda dummy	δ_6	-2.312	0.941	-2.460*
Sigma-U	σ_u	0.087		
Sigma-V	σ_v	0.041		
Gamma $(\sigma_u^2/\sigma_u^2 + \sigma_v^2)$	.γ	0.820		
Mean T E	X_{mean}	0.640		
Minimum T E	X_{min}	0.380		
Maximum T E	X_{max}	0.940		

*** and * indicates significance at 0.01 and 0.05 probability respectively,*
Source: Author's estimates from survey data, 2009-10.

Farmers' age is an important socioeconomic factor for adopting or rejecting a new technique or practice. Average age of farmers in the study area was 45.61 years ranging from 20 to 68 years with standard deviation of 9.47. Farming experience is also considered as one of the socioeconomic characteristics that affect farmers' decision regarding input use and other farm practices. Average experience of farmers in all the study area was 24.11 years ranging from 5 to 50 years with standard deviation of 9.26. Education plays an important role in the behavior formation, improving specific skills, rational use of scarce resources amicable to production [23]. Average level of education in all the study area was 5.61 years ranging from 0 to 16 years with the standard deviation of 5.44. Land under wheat crop operated by the farmers affects technical efficiency of the farmers. Average land under wheat crop in all the three districts was 1.67 hectares ranging from 0.10 to 6.07 hectares with standard deviation of 1.09 hectares.

According to the Log Likelihood Ratio (LR) test two models were estimated and then these models were compared. The formula for the LR test statistic is as follows:

$$\text{LR statistic} = 2 [\ln H_0 / \ln H_1] = - 2 [\ln H_0 - \ln H_1] \quad (13)$$

Where $\ln H_0$ denotes the log likelihood of the model when it is assumed that inefficiency is absent. And $\ln H_1$ the log likelihood of the model when it is assumed that inefficiency is present. If LR statistic is significant, then we reject the null hypothesis of no technical inefficiency. As our calculated LR statistic (40.46) is greater than tabulated χ^2 (12.59), so reject the null hypothesis of no technical inefficiency.

The estimated elasticities for the explanatory variables and efficiency levels of wheat growers are presented in table 2. Results show that explanatory variables i.e., land under wheat crop, labor, chemical fertilizer, and tractor plough were statistically significant. The estimated elasticity for these variables indicated that one percent increase in value of land under wheat crop, labor, chemical fertilizer and tractor plough would raise the wheat yield by 0.126, 0.248, 0.081, 0.226 and 0.066 percent respectively. The coefficient of farm yard manure (FYM) was found insignificant. The estimated value of technical efficiency ranges from 39 to 94 per cent. with an average of 64 per cent implies that if an average farmer opts to attain the technical efficiency level of its most efficient counterpart, then wheat yield could be increased by 32 per cent. Similarly the most technically inefficient farmer could enhance wheat yield by 58 per cent. Estimated value of γ (0.82) implies that 82 per cent of the total variation in wheat productivity was due to technical inefficiency of wheat growers.

Estimated value of LR test (40.76) was statistically significant, which follows Chi-square distribution. The estimated dummy variables for both, Peshawar and Charsadda, districts were found to be statistically significant at 5 per cent α; implies that technical efficiencies of the sample farmers are different from each others and also from the sample farmers of district Mardan.

The estimated coefficients of the explanatory variables for the technical inefficiency function are represented in the lower part of table 2. The relationship between farmers' age and technical inefficiency was positive and statistically significant implied that technical efficiency decreases with the increase in the farmers' age. The coefficient of farming experience was negative but statistically insignificant at all level of significance. The coefficient of farmers' education was negative and statistically significant. This means that inefficiency decreases with increase in the farmers' education in the study area. The relationship between technical inefficiency and land under wheat crop was positive suggesting that those farmers with relatively large farm size under wheat crop are technically inefficient but the coefficient is insignificant.

Comparing the mean technical efficiency of this study with other studies revealed that the mean technical efficiency is not far from the findings of [8][24][25] with the mean technical efficiency of 68, 67, and 67 % respectively. The average technical efficiency recorded from this study is higher than the one recorded by [9][26][27] with an average technical efficiency of 43, 53 and 51% respectively. Similarly the average technical efficiency recorded from this study is higher than the one recorded by [28][29][30][22] with an average technical efficiency of 84, 73, 89, and 84% respectively.

Figure 1 shows the frequency distribution of individual farmers of District Peshawar, Charsadda and Mardan and all three Districts. Average technical efficiency of wheat producers of District Peshawar, Charsadda and Mardan were 0.62, 0.64 and 0.67 respectively. The lowest efficiency ratio for Peshawar, Charsadda and Mardan Districts were 0.34, 0.39 and 0.42 respectively. Results further revealed that 42 percent of District Peshawar farmers lied between 0.61-0.70 in the efficiency ratio, while 39 percent of District Charsadda farmers lied between 0.61-0.70 in efficiency rating and Mardan (37%) farmers efficiency rating ratio ranging from 0.61-0.70.

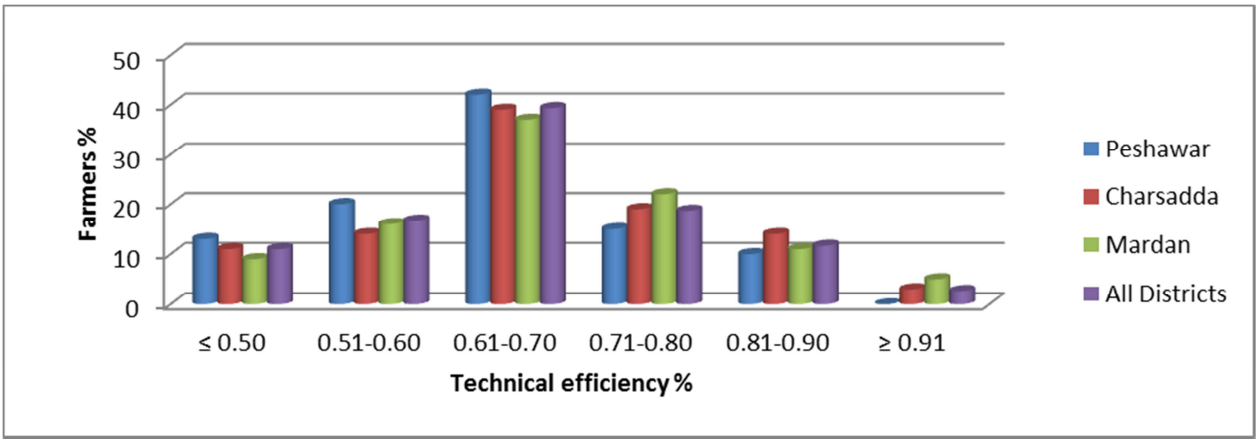


Figure 1 Frequency distribution of technical efficiency of wheat growers in the study area

4 CONCLUSION AND RECOMMENDATIONS

Stochastic frontier CDPF was used to estimate the level of technical efficiency in the study area. Major determinants of efficiency are land under wheat crop, labor, chemical fertilizer and tractor plough and FYM. Results indicated that one percent increase in value of land under wheat crop, labor, chemical fertilizer and tractor plough would raise the wheat yield by 0.126, 0.248, 0.081, 0.226 and 0.066 percent respectively. The coefficient of farm yard manure was found insignificant. The estimated value of technical efficiency ranges from 39 to 94 per cent. with an average of 64 per cent implies that if an average farmer opts to attain the technical efficiency level of its most efficient counterpart, then wheat yield could be increased by 32 per cent. Similarly the most technically inefficient farmer could enhance wheat yield by 58 per cent. Estimated value of γ (0.82) implies that 82 per cent of the total variation in wheat productivity was due to technical inefficiency of wheat growers. Major determinants of technical inefficiency were farmers' age, farming experience, farmer' education and land under wheat crop in hectares The estimated coefficient of farmers' age and technical inefficiency was positive and statistically significant implied that technical efficiency decreases with the increase in the farmers' age. The

coefficient of farming experience was negative and statistically insignificant at all levels of significance. The coefficient of farmers' education was negative and statistically significant. This means that inefficiency decreases with increase in the farmers' education in the study area. The relationship between technical inefficiency and land under wheat crop was positive suggesting that those farmers with relatively large farm size under wheat crop are technically inefficient but the coefficient is insignificant. This concludes that wheat output in the study area may be increased considerably from available inputs and techniques of production. An increase in the employment of labor would increase the production of wheat. Tractor plough increased wheat production implying that wheat producers should apply more tractor hours to fully prepare the soil for wheat cultivation. This would increase wheat production in the country. As technical efficiency increases with the increase in the level of education, therefore, government needs to focus on formal as well informal education in the country. Encouragement of educated and young people to participate in agriculture is also a good policy option for boosting up wheat productivity in the country.

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Isolation and characterization of lineage-IV *Peste des Petits Ruminants* (PPR) virus strains from Pakistan

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ABSTRACT: A total of 62 Peste des Petits ruminants (PPR) outbreaks in sheep and goat flocks were investigated in Pakistan during 2005-2007. The presence of PPR virus (PPRV) was confirmed by clinical picture, necropsy examination, Ic-ELISA, virus isolation and RT-PCR. Of 397 tissue samples, 65% tested positive by Ic-ELISA. Six PPR virus isolates were obtained through cell culture on VERO or GKC cell from 61Ic-ELISA positive samples identified by characteristic CPEs and confirmed by testing the cell culture supernatant by Ic-ELISA and RT-PCR using PPRV specific F gene based primers. The sequence data of F gene from 6 isolates was analyzed for identities and a phylogenetic tree was generated based on 372bp F gene sequences of PPRV. The isolates were clustered into lineage 4 along with other Asian isolates. The recent isolates and a previous isolate from Pakistan (PAK-2004) were found to be monophyletic having close relationship with an Indian isolate (IND-PON).

KEYWORDS: PPR, isolation, Pakistan, phylogenetic analysis, Ic-ELISA.

1 INTRODUCTION

Peste des Petits Ruminants (PPR) is an "acute, highly contagious and frequently fatal viral disease of sheep, goats and wild small ruminants" [1]. The disease is characterized by fever, muco-purulent ocular and nasal discharges, necrotizing and erosive stomatitis, severe enteritis and pneumonia leading to death [2]. PPR is a trans-boundary animal disease (TAD) of significant economic importance [3], ranking among the top ten diseases affecting small ruminants [4]. It has been described as the most important single cause of morbidity and mortality in small ruminant in Nigeria [5]. The causal agent, PPR virus (PPRV), is an enveloped ribonucleic acid virus of the genus *Morbillivirus* of family *Paramyxoviridae*[6]. The disease was first reported in Cote d'Ivoire in 1942 [7]. At present, it is endemic across the Sub-Saharan Africa, Morocco, Arabian Peninsula, Middle East, Turkey, Iran, Iraq, Pakistan, India, Bangladesh, Nepal, Tajikistan and Kazakhstan in Central Asia and Tibet, China [8-12]. The disease was first recorded in Pakistan during 1991 [13]. However, there are limited reports, which have attempted to document the prevalence and demonstrated continuing activity of PPRV in the country [14-16]. Bearing in mind the impact of PPR in the background of subsistence farming, the present study was conducted with the objective to isolate and characterize local PPR virus strains circulating among small ruminants population of Pakistan with special emphasis on monitoring the changes in virulence.

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2 MATERIALS AND METHODS

2.1 OUTBREAKS REPORTING

A total of 62 suspected PPR outbreaks reported by transboundary animal diseases (TAD) officers in their respective regions were investigated during 2005-2007. Each reported outbreak flock was examined for collection of data and samples.

2.2 CLINICAL EXAMINATION

The affected or "morbid" animals were defined as those showing anorexia, depression and an elevated body temperature over 104ºF. Animals were examined for the presence of clinical signs of PPR i.e. fever, discharges (ocular and nasal), erosive/necrotic mouth lesions, bronchopneumonia and diarrhea. Clinical examination of the affected animals was carried out in each affected flock and clinical signs were recorded.

2.3 NECROPSY EXAMINATION

The post mortem examination was conducted in those flocks where one or more dead animals were available. During necropsy, particular attention was given for evidence of discharges from the nostrils and eyes, diarrhea and gross pathological lesions in the oral mucosa, respiratory tract and alimentary tract. The gross pathological lesions were recorded.

2.4 SAMPLE COLLECTION

A total of 397 tissue samples were collected from dead goats and sheep at the time of necropsy using aseptic procedures. These included lungs, spleen and lymph nodes (mesenteric, bronchial, retropharyngeal and mesenteric lymph nodes). Each sample was marked with a unique identifier with date, and place. The samples were transported to the laboratory in cold condition. In the laboratory, the samples were stored at -70^{o}C till further processing.

2.5 SAMPLE ANALYSIS

The presence of PPRV antigens in the tissue samples was considered as evidence of PPRV infection in affected animals. The tissue samples (n=397) collected at necropsy were examined using an immune-capture ELISA (Ic-ELISA) kit (BDSL, France). Each of the tissue sample was processed to make a slurry and was tested by Ic-ELISA using the standard protocol [17].

The optical densities of the samples were measured at 492nm with an automated ELISA reader Immunoscan plus (Flow laboratories) using ELISA Data Interchange (EDI) software [18]. The samples with percent positivity (PP) value greater than 18% were considered positive.

2.6 ISOLATION AND PROPAGATION OF PPRV

Two types of cell culture were used to obtain PPR virus isolates *viz*. primary goat kidney cells (GKC) and Vero cells (African Green Monkey Kidney Cells). A total of 18 tissue samples (lungs, spleen and lymph nodes), that tested positive for PPRV antigen by Ic-ELISA, were inoculated onto primary GKC [19, 20]. The remaining 43 tissue samples that tested positive for PPRV antigen by Ic-ELISE, were processed and inoculated onto Vero cells [9, 20]. The control flask was inoculated with sterile phosphate buffer saline (PBS) only. The inoculated cell cultures were observed twice daily (morning and evening) under an inverted microscope for the appearance of cytopathic effects (CPEs). A sample was considered negative for PPRV if no CPEs were observed within 12 days post inoculation. In flasks, where CPEs developed within 12 days, the supernatant was harvested when 80% of the cells showed specific CPEs. The isolates thus obtained on GKC were adapted to grow on Vero cells by propagating for three passages. However, in case of Vero cells where there were no CPEs, the inoculated cultures were subjected to freezing and thawing three times to disrupt the intact cells (blind passages) and 1 ml of this suspension was added to a new 25 cm^2 flask of confluent monolayer of Vero cells. A sample was considered negative if no CPEs were observed after five blind passages.

2.7 PPR VIRUS IDENTIFICATION

The virus isolates were identified by characteristic CPEs observed on GKC and Vero cells and the presence of PPR virus was confirmed by testing the cell culture supernatant using Ic-ELISA. The isolates were catalogued on the basis of outbreak location and year of isolation. All the six isolates were lyophilized and are available in Animal Health Laboratories repository. The six PPR virus isolates obtained on cell culture and 46 field samples collected during PPR outbreaks reported during 2005-07 that tested positive by Ic-ELISA were confirmed using RT-PCR. The field samples comprised of ocular and oral swabs (18) and tissue samples (28) (lungs 7, Spleen 4 and lymph nodes 17). The PPR virus specific RNA from isolates and tissue and swab samples was extracted using an RNeasy kit (Qiagen GmbH, Hilden, Germany) according to manufacturer'sinstructions. A negative control was included to detect any possible contamination of reagents. The extracted RNA was eluted in 40 µl of nuclease-free water and stored at -70°C until use. The purity and quantity of the RNA was determined using Nanodrop (Nano Drop 1000, Thermo scientific, Wilmington, DE, USA). Vaccinal virus (Nigeria 75/1) was used in one step RT-PCR as control to confirm the successful extraction of RNA [11]. One step RT-PCR was performed to amplify extracted RNA by using PPR virus specific primers based on highly conserved sequences within F gene of PPR virus Forsyth and Barrett (1995).

2.8 SEQUENCING

The PCR products from the agarose gel was purified using Wizard® SV Gel and PCR clean-Up System kit (Promega Corp. Madison, WI, USA) according to the manufacturer's instructions. Sequencing was performed using the Dye Terminator Cycle Sequencing GenomeLab™ DTCS Quick Start Kit (Beckman Coulter, USA) following manufacturer's instructions. Approximately 100ng of purified PCR product was used as template with 5 pM of a single sequencing primer. The reactions were capillary electrophoresed on the CEQ™ 8000 Genetic Analysis System (Beckman Coulter, USA). For all sequencing reactions specific primers were used to sequence both the strands.

2.9 SEQUENCE ANALYSIS

The sequence data was compiled manually with the help of Blast 2 sequences (Tatusova and Madden, 1999; at http://www.ncbi.nlm.nih.gov/blast/bl2seq/wblast2.cgi), for both the strand separately for each isolate. The nucleotide sequences from both the strands were complementary aligned to each other. In this way a consensus sequence from one isolate was determined. The sequencing data was submitted in the Gene Bank.

2.10 PHYLOGENETIC ANALYSIS

The sequences of F gene of PPRV isolates were obtained from the nucleotide data base in the GenBank updated till 18-01-2010 and used for analyses. The sequences were aligned in ClustalW Sequence Alignment program using ClustalW 1.6 matrix for DNA alignments [21] in the Molecular Evolutionary Genetics Analysis Program (MEGA) version 4.0.1 [22] and only those parts which were aligned with the sequences of isolates sequenced in this study, were used further for phylogenetic analysis. Phylogenetic Neighbor-Joining (NJ) analysis was carried out using Maximum Composite-likelihood model with uniform rates among the sites; the 1000 bootstraps replicates were used to evaluate the significance of generated tree.

3 RESULTS

3.1 CLINICAL OBSERVATIONS

The clinical examination of affected animals indicated depression, pyrexia (39°C - 41.6°C), swollen lips, conjunctivitis, catarrhal ocular and nasal discharges along with cough and diarrhea. Almost all the affected animals appeared dehydrated. The animals examined in early stages of disease showed an erosive and necrotic lesion on lower gums just beneath the insertion of incisors. Similar lesions were also noted on the inner side of the lips, cheek papillae, dorsal surface of the tongue and hard palate.

3.2 NECROPSY OBSERVATIONS

The postmortem examination of carcasses showed sunken eyes, rough and dehydrated/dry skin with soiling of hindquarter. The internal examination revealed pneumonic lungs, hemorrhages on mucosal surfaces of abomasum and large intestine (caecum and colon) and inflamed lymph nodes, especially mesenteric lymph nodes.

3.3 DETECTION OF PPRV ANTIGEN

Of 397 samples tested, 258 were found positive for PPR virus with a positive percentage 64.99%.

3.4 VIRUS ISOLATION AND IDENTIFICATION

A total of six cytopathic PPR viruses (PPRV) were isolated from six different outbreaks using primary GKC and Vero cells. The PPRV isolates were identified by the characteristic CPEs induced by PPRV on both cell types (Table 1). Of these, two isolates were obtained of the 18 samples inoculated on primary GKC. The CPEs were observed on day 5 post-inoculation and onward. The CPEs included cell rounding, retraction, vacuolation, and formation of small syncytia. Of 43 samples inoculated on Vero cells, four PPRV isolates were obtained. Of these, one isolate was obtained after single blind passage while three isolates were obtained after two blind passages. The CPEs on Vero cells included cells of increased refractivity, rounding and detachment from the surface, clumping into grape like clusters and the appearance of fine spindle cells with elongated processes. The PPRV was harvested when 80% of the cells showed CPEs. The control flasks did not show any CPEs and the monolayers remained intact during the observation period. The cell culture supernatant of each isolate was tested positive by Ic-ELISA confirming that CPEs were induced by PPRV. The percent positivity values ranged between 78 to 133% (Table 1).

3.5 PHYLOGENETIC ANALYSIS

The sequences were submitted to GeneBank under accession numbers GU980858, GU980859, GU980860, GU980861, GU980862, GU980863, GU980864, GU980865, GU980866, GU980867 and GU980868**.** The results of the sequence analysis indicated that all the present study isolates of PPRV from 4 different provinces/ regions of Pakistan fall into lineage 4 (Figure 1). The nucleic acid sequences analysis of 372 F gene sequences of PPRV revealed identity among the 11 field isolates of the present study and previous isolate from Pakistan (Pak 2004) ranging between 100-98.8%. The sequence identities among recent isolates and two other previous isolates (Pak-Shah-Pk07 and Pak-Fsd-Pk07) ranged between 99.7- 96%. The identity score between recent isolates and a closely related Indian isolate (IND-PON) was 99.1- 97.8%. The identity scores between isolates from Pakistan and isolates from India, Turkey, China, Iran, Nigeria and Cote d Ivoire ranged between 99.1- 92%, 97.8- 96.6%, 97.8- 96.3%, 98.1-97.2%, 94.4- 91.6% and 89.8- 87.9% respectively (Table 2). The phylogenetic tree of PPRV isolates from Pakistan is shown in figure 2.

4 DISCUSSION

The current study was undertaken to isolate PPR virus circulating in small ruminant's population and monitor the changes in virulence of PPR virus involved in the outbreaks occurring in different parts of the country. The presence of PPRV virus in these outbreaks was demonstrated by clinical picture, necropsy examination, Ic-ELISA and virus isolation and RT-PCR.

The Ic-ELISA is an effective test for diagnosis of PPR from field samples and identification of PPRV in cell culture supernatant. A higher positive percentages or PI found in this study have been reported previously using Ic-ELISA in nasal secretions of clinically affected goats [23]. The monoclonal antibody based Ic-ELISA is now accepted as an alternative of virus isolation for diagnosis of Rinderpest virus (RPV) and PPRV by Office Internationale des Epizooties [24] for being simple, rapid, highly specific and sensitive assay [25].

Initially, primary GKC were employed for the isolation of PPRV from the field samples to increase the sensitivity of this technique. Later, Vero cells were preferred because of their continuity and lesser chances of contamination. The Vero cells also proved suitable for the isolation of PPRV. CPEs observed in this study due to PPRV on Vero and GKC were initial cell rounding, detachment from the surface, retraction, vacuolation and multinucleate syncytia formation. Other studies also reported similar findings[19, 20, 26].The six PPRV isolates obtained on primary GKC and Vero cells were confirmed using Ic-ELISA that can detect as little as $10^{0.6}$ $TCID_{50}$/well of PPRV particles[24].

Despite detection of viral antigen in all the tissue samples processed for virus isolation, only six isolates of PPRV were obtained. This low success rate for the isolation of PPRV may be attributed to the fact that the samples were collected at the time of necropsy after disease had run its full course. Successful isolation of RP/PPRV depends on various factors including the phase of the disease during which samples were collected from donor animals [27]. The samples collected during the infectious period i.e. in febrile phase are ideal for the isolation of RPV/PPRV and the titers of infectious virus decline exponentially after fever has regressed [20]. The isolation of PPRV using Vero cells is reported to be difficult since it requires one or more blind passages to become tissue culture adapted even from very fresh clinical samples or isolated virus [20, 28].

Moreover, PPRV is difficult to isolate from infected animals despite detection of PPRV antigen by Ic-ELISA in tissue samples [17].

The RT- PCR using primers based on highly conserved sequences within F gene of PPRV proved suitable for diagnosis and/or confirmation of the PPRV isolates obtained on cell cultureand effectively tracked the changes in virulence of PPR virus. The assay described by Forsyth and Barrett, (1995) has extensively been used for the specific diagnosis and molecular epidemiological studies of PPR virus [8, 9, 29].

High sequence variability's found in RNA viruses [10, 30] necessitate the need to carry out molecular epidemiological studies focusing on sequence identities and distances among local field isolates and isolates of different geographic origin. The phylogenetic analysis revealed that lineage 4 PPRV is circulating in Pakistan. These results are in agreement with those reported earlier [8, 9, 11, 29]. The data also suggested that two strains of PPRV are circulating among small ruminants population in Pakistan. The existence of two viral subgroups among lineage 4 PPRVs circulating in Asian countries has already been reported [29]. The most related sequences to those of Pakistani isolates originated from India. This clearly is indicative of cross border transmission of PPRV infection into Pakistan. The border between Pakistan and India was used to be porous and there was frequent movement of livestock prior to the fencing of border by India. It was revealed during field investigations that sheep and goats were brought from India for trade purposes during shortage of mutton in Pakistan and also before Eid festival. The cross border transmission of PPRV was held responsible for the introduction of PPR in Tibet, China [11]. However, the Indo-Pakistan subcontinent was swept across by an epidemic of lineage 4 PPRV during 1993-95 [8, 10, 31]. With this common history the sequence identities and close genetic relationship among PPRV isolates can be expected.

It is evident from the phylogenetic analysis that source of PPR outbreaks in south of Punjab province and upper Sindh province is from central Punjab (Faisalabad). The isolates from these regions were found 100% similar to a previous isolate (PAK-2004). The most likely source of PPR outbreaks in Azad Jammu and Kashmir (AJK) was from northern Punjab. These further inter and intra provincial spread of PPR virus within the country may also be attributed to the animal movement. The prevailing production systems for small ruminants in Pakistan are traditional and extensive. Majority of the farmer's have very smallholdings with livestock production varying in three broad areas *viz.* canal irrigated areas, arid/ semi-arid areas and desert areas where crop production is not possible. There have been four main systems namely nomadic (44%), semi migratory transhumant (38%), sedentary and/or household (18%) [32]. All of these systems require a lot of stock movement in search of pastures and water. It can be speculated that the transhumant stock movement may had contributed to the transmission of PPRV from central Punjab into south of Punjab and upper Sindh. Likewise the nomadic and transhumant movement from northern Punjab to summer alpine pastures may possibly be held responsible for the transmission of PPR virus into AJK.

During the course of this study it was observed that PPR outbreaks exhibited two different epidemiological and pathological trends in the country. The first trend was seen in case of epidemic outbreaks where the affected animals presented classical clinical signs (acute form) of disease. The affected animals were dying within two weeks' time with a mortality rate of 50- 70%. Such trend was seen during 2005-06 in south Punjab and upper Sindh. The second trend was observed during the following years i.e. in 2006-07 especially in north of Punjab and AJK where the outbreaks of PPR were less explosive in terms of severity of clinical signs and mortality. The duration of disease was longer and many of the affected animals recovered. Such changes in virulence of PPR virus were depicted in sequence analysis of F gene of the isolates e.g. PAK- Att-07-NARC5, PAK- FJg-07-NARC4 and PAK- Mzd1-07-NARC where these isolates varied in identity ranging between 99.1-98.8% from the virulent virus PAK- Veh- 05-NARC1 and PAK- KP1- 06-NARC1. These changes are indicative of immune pressure and greater weight of infection in the field. The genetic variations in F protein gene coupled with the epidemiological picture strongly suggest that PPR has established as an endemic infection in the country. This also elucidated the evolving nature of PPR virus.

5 CONCLUSION

Based on the results of the present study, it is concluded that lineage 4 PPR virus infection has established as an endemic infection in the country. Now, it constitutes a major threat to the small ruminant's production and food security in the region. This calls for a comprehensive strategy to improve the disease reporting and surveillance activities, farmers' awareness regarding sanitary prophylaxis for PPR and other TADs and further studies to understand epidemiology and pathogenesis of PPR in small ruminants to devise an optimal control strategy.

Table 1. Isolation and identification of PPR virus isolates using goat kidney cells (GKC) and Vero cells (Vero-76) based on cytopathic effects (CPEs).

Isolate	Cell Type	CPEs						PP (Ic-ELISA)
		Cell rounding	Detachment from Surface	Vacuolation	Syncytia formation	Clumping of cells	Cells with Elongated processes	
PAK-VEH-05/NARC1	GKC	+	+	+	+	-	-	94
PAK-ICT-06/NARC2	GKC	+	+	+	+	-	-	133
PAK-KP1-06/NARC3	Vero-76	+	+	-	-	+	+	78
PAK-FJg-07/NARC4	Vero-76	+	+	-	-	+	+	106
PAK-Att-07/NARC5	Vero-76	+	+	-	-	+	+	89
PAK-Mzd1-07/NARC6	Vero-76	+	+	-	-	+	+	121

PP = Percent positivity
Ic-ELISA = Immuno-capture Enzyme Linked ImmunoSorbant Assay
PAK = Pakistan
VEH = Vehari
ICT = Islamabad Capital Territory
KP1 = Khairpur
FJg = Fateh Jang
Att = Attock
Mzd1 = Muzaffarabad
NARC = National Agricultural Research Centre

Table 2. Percentage sequence identities of F gene sequences between PPRV isolates of different geographical origins

	Pakistan	India	Turkey	China	Iran	Nigeria	Cote d' Ivoire
Pakistan Lineage 4	100- 96.0	99.1-92.0	97.8-96.6	97.8-96.3	98.1-97.2	94.4-91.6	89.8-87.9
India Lineage 4	99.1-92	100-92.3	99.1-92.9	99.4-92.0	99.4-93.5	95-88.6	90.1-88.2
Turkey Lineage 4	97.8-96.6	99.1-92.9	99.4-98.1	97.2-96.9	99.1-98.8	94.4-92.5	89.1-88.5
China Lineage 4	97.8-96.3	99.4-92	97.2-96.9	100-99.7	97.5-97.2	93.8-92.5	88.8-88.5
Iran Lineage 4	98.1-97.2	99.4-93.5	99.1-98.8	97.5-97.2	100	94.1-93.2	89.4
Nigeria Lineage1	94.4-91.6	95.0-88.6	94.4-92.5	93.8-92.5	94.1-93.2	97.8-90.4	97.8
Cote d' Ivoire Lineage 2	89.8-87.9	90.1-88.2	89.1-88.5	88.8-88.5	89.4	97.8	90.4-91.9

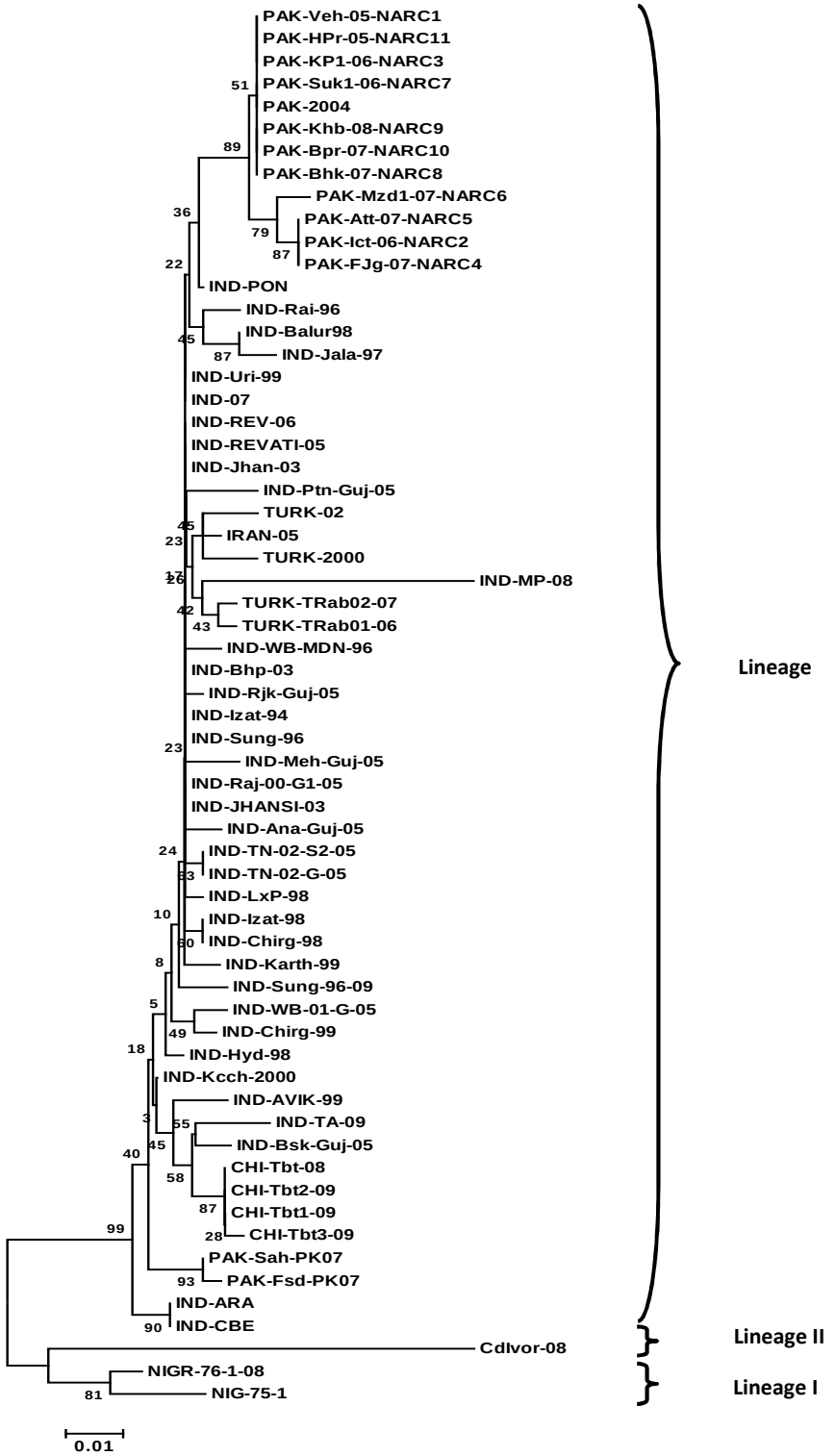


Fig. 1. Unrootedneighbor joining phylogenetic tree based on 372 bp partial sequence of F gene of PPRV detected in Pakistan and other isolates. Bootstrap values are shown on the branches. Bar indicates substitution per site.

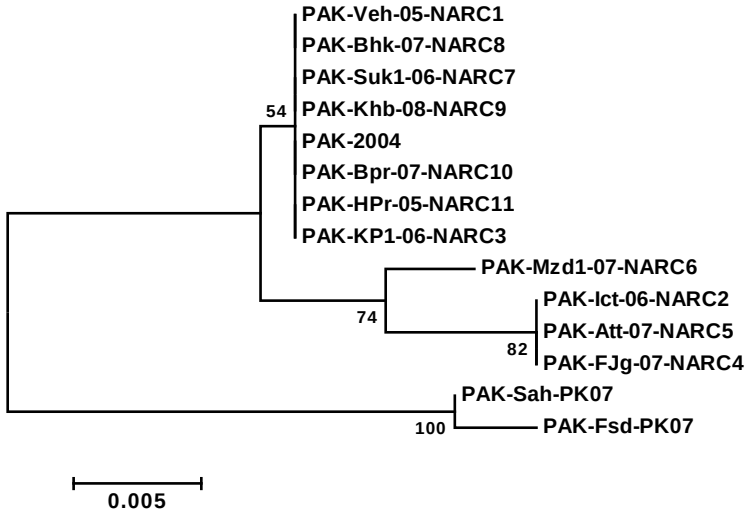


Fig.2. Phylogenetic relationship based on 372 bp partial sequence of fusion (F) gene of Pakistani isolates of PPRVs.

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Five Point Predictor-Corrector Formulae and Their Comparative Analysis

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ABSTRACT: This paper is mainly analytical and comparative. Here I have proposed three new forms of predictor-corrector formulae for solving ordinary differential equation of first order and first degree. These predictor-corrector formulae have derived by taking the general forms of predictor-corrector. These formulae approximate the value of dependent variable based on five initial value of independent variable by predictor formula and then improve that initial crude value of dependent variable by corrector formula. A comparative analysis among proposed three predictor-corrector formula with Milne's predictor-corrector formula and Adam-Moulton's predictor-corrector formula by means of comparing with exact value of dependent variable have expressed as relative error. Finally, conclusive discussions have narrated.

KEYWORDS: ODE, predictor-corrector formula, general form, particular form, comparative analysis, relative error, accuracy.

1 INTRODUCTION

Considering the initial value [4] problem

$$y' = \frac{dy}{dx} = f(x,y);\ y(x_0) = y_0 \qquad (1)$$

If the function $f(x,y)$ is continuous in the open interval $a < x < b$ containing $x = x_0$, there exists a unique solution [5] of the equation (1) as$y_r = y(x_r)$; $r = 1,2,3, \ldots\ldots\ldots$The solution is valid for throughout the interval $a < x < b$. It is required to determine the approximate values of y_r for the exact solution $y = y(x)$ in the given interval for the value $x = x_r = x_0 + rh$; $r = 1,2,3, \ldots\ldots\ldots$

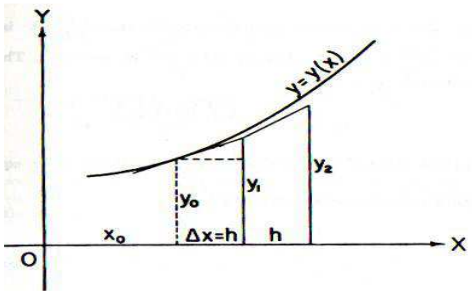


Figure-(1)

Corresponding Author: Mahtab Uddin

Now deriving a tangent line equation for (1), from above figure

$$\frac{\Delta y}{\Delta x} \approx tan\theta$$
$$or, \Delta y \approx \Delta x(tan\theta)$$
$$or, y_1 - y_0 \approx h(\frac{dy}{dx})_0$$
$$or, y_1 \approx y_0 + hf(x_0, y_0) \quad (2)$$

After starting with the initial valuey_0, an approximate value of $y_1 = y_1^{(1)}$ is computed from the relation given by (2) as

$$y_1^{(1)} \approx y_0 + h(\frac{dy}{dx})_0 = y_0 + hf(x_0, y_0)$$

Substituting this approximate value of y_1 in (1) for getting an approximate value of $f(x, y)$ at the end of the first interval as:

$$(\frac{dy}{dx})_1^{(1)} = f(x_1, y_1^{(1)})$$

Now the improved value of Δy is obtained by using the Trapezoidal rule [6,7] as

$$\Delta y \approx \frac{h}{2}[f(x_0, y_0) + f(x_1, y_1^{(1)})]$$

Then the second approximation for y_1 is now

$$y_1^{(2)} \approx y_0 + \frac{h}{2}[f(x_0, y_0) + f(x_1, y_1^{(1)})]$$

Substituting this improved value of $y_1^{(1)}$we get the second approximate value of $f(x, y)$ as

$$(\frac{dy}{dx})_1^{(2)} = f(x_1, y_1^{(2)})$$

Then the third approximation for y_1 is now

$$y_1^{(3)} \approx y_0 + \frac{h}{2}[f(x_0, y_0) + f(x_1, y_1^{(2)})]$$

Continuing this process, we can find

$$y_1^{(n)} \approx y_0 + \frac{h}{2}[f(x_0, y_0) + f(x_1, y_1^{(n-1)})] \quad (4)$$

Then the next approximation for $y_1$is obtained as

$$y_1^{(n+1)} \approx y_0 + \frac{h}{2}[f(x_0, y_0) + f(x_1, y_1^{(n)})] \quad (5)$$

This process is applied repeatedly until no significant change is produced in two consecutive values of y_1.

The above process is applied for the first interval and same manner can be hold for the next intervals also. Then the general formula takes the following form

$$y_{m+1} \approx y_m + hf(x_m, y_m) \tag{6}$$

$$y_{m+1}^{(n+1)} \approx y_m + \frac{h}{2}[f(x_m, y_m) + f(x_{m+1}, y_{m+1}^{(n)})] \tag{7}$$

The value of y_{m+1} will be determined using (6) and is to be substituted on right hand side of (7) for giving a better approximation of y_{m+1}. This method of refining an initial crude estimate of y_{m+1} by means of a more accurate formula is known as predictor-corrector [1] method. In the above (6) is called the predictor formula and (7) is called the corrector formula for obtain y_{m+1}.

The predictor-corrector method is a multi-step, iterative and self-correcting [8] process to the value of dependent variable by means of some initial value of independent variable.

In the above process the predictor-corrector method is used for a single initial value problem but that method is applicable for several initial value [3] problems.

2 DERIVATION

2.1 DERIVATION OF PREDICTOR FORMULAE

The general linear predictor formula [2] which involves the information about the function and its derivative at the past four points together with the value of the at the given point being computed as

$$\begin{aligned} y_{n+1} &= A_0 y_n + A_1 y_{n-1} + A_2 y_{n-2} + A_3 y_{n-3} + A_4 y_{n-4} \\ &\quad + h[B_0 y_n' + B_1 y_{n-1}' + B_2 y_{n-2}' + B_3 y_{n-3}' + B_4 y_{n-4}'] \end{aligned} \tag{8}$$

Above equation contains ten unknowns. Suppose it holds for polynomials up-to degree five. Hence take $y(x) = x^n$; $n = 0,1,2,3,4,5$. Let the space between the consecutive values of x be unity. i.e. taking $h = 1$.

Now putting $h = 1$ and $y(x) = 1, x, x^2, x^3, x^4, x^5$ successively in (8), obtain as

$$\begin{aligned} 1 &= A_0 + A_1 + A_2 + A_3 + A_4 \\ 1 &= -A_1 - 2A_2 - 3A_3 - 4A_4 + B_0 + B_1 + B_2 + B_3 + B_4 \\ 1 &= A_1 + 4A_2 + 9A_3 + 16A_4 - 2B_1 - 4B_2 - 6B_3 - 8B_4 \\ 1 &= -A_1 - 8A_2 - 27A_3 - 64A_4 + 3B_1 + 12B_2 + 27B_3 + 48B_4 \\ 1 &= A_1 + 16A_2 + 81A_3 + 256A_4 - 4B_1 - 32B_2 - 108B_3 - 256B_4 \\ 1 &= -A_1 - 32A_2 - 243A_3 - 1024A_4 + 5B_1 + 80B_2 + 405B_3 + 1280B_4 \end{aligned} \tag{9}$$

Here six equations with ten unknowns. Introducing three assumptions as followings

For first assumption taking A_0, A_1, A_2 & A_3 as parameter, then (9) gives

$$\begin{aligned} A_4 &= 1 - A_0 - A_1 - A_2 - A_3 \\ B_0 &= \frac{1}{720}[2125 - 224A_0 + 27A_1 + 8A_2 + 19A_3] \\ B_1 &= \frac{1}{360}[-875 - 512A_0 - 189A_1 - 16A_2 - 53A_3] \\ B_2 &= \frac{1}{30}[125 - 16A_0 - 27A_1 - 8A_2 + 11A_3] \\ B_3 &= \frac{1}{360}[-125 - 512A_0 - 459A_1 - 496A_2 - 323A_3] \\ B_4 &= \frac{1}{720}[475 - 224A_0 - 243A_1 - 232A_2 - 251A_3] \end{aligned} \tag{10}$$

Since A_0, A_1, A_2 & A_3 are arbitrary, choosing $A_0 = A_1 = A_2 = A_3 = 0$. Then from (10) get the followings

$$A_4 = 1, B_0 = \frac{425}{144}, B_1 = -\frac{175}{72}, B_2 = \frac{25}{6}, B_3 = -\frac{25}{72}, B_4 = \frac{95}{144}$$

To get a predictor formula substituting these values in (8), as follows

$$y_{n+1}^p = (1)y_{n-4} + h[\left(\frac{425}{144}\right)y_n^{'} + \left(-\frac{175}{72}\right)y_{n-1}^{'} + \left(\frac{25}{6}\right)y_{n-2}^{'} + \left(-\frac{25}{72}\right)y_{n-3}^{'} + (\frac{95}{144})y_{n-4}^{'}]$$

$$or, y_{n+1}^p = y_{n-4} + \frac{h}{144}[425y_n^{'} - 350y_{n-1}^{'} + 600y_{n-2}^{'} - 50y_{n-3}^{'} + 95y_{n-4}^{'}] \quad (11)$$

For second assumption taking A_0, A_1, A_3 & A_4 as parameter, then (9) gives

$$A_2 = 1 - A_0 - A_1 - A_3 - A_4$$
$$B_0 = \frac{1}{720}[2133 - 232A_0 + 19A_1 + 11A_3 - 8A_4]$$
$$B_1 = \frac{1}{360}[-891 - 496A_0 - 173A_1 - 37A_3 + 16A_4]$$
$$B_2 = \frac{1}{30}[117 - 8A_0 - 19A_1 + 19A_3 + 8A_4]$$
$$B_3 = \frac{1}{360}[-621 - 16A_0 + 37A_1 + 173A_3 + 496A_4]$$
$$B_4 = \frac{1}{720}[243 + 8A_0 - 11A_1 - 19A_3 + 232A_4] \quad (12)$$

Since A_0, A_1, A_3 & A_4 are arbitrary, choosing $A_0 = A_1 = A_3 = A_4 = 0$. Then from (12) get the followings

$$A_2 = 1, B_0 = \frac{237}{80}, B_1 = -\frac{99}{40}, B_2 = \frac{39}{10}, B_3 = -\frac{69}{40}, B_4 = \frac{27}{80}$$

To get a predictor formula substituting these values in (8), as follows

$$y_{n+1}^p = (1)y_{n-2} + h[\left(\frac{237}{80}\right)y_n^{'} + \left(-\frac{99}{40}\right)y_{n-1}^{'} + \left(\frac{39}{10}\right)y_{n-2}^{'} + \left(-\frac{69}{40}\right)y_{n-3}^{'} + (\frac{27}{80})y_{n-4}^{'}]$$

$$or, y_{n+1}^p = y_{n-2} + \frac{h}{80}[237y_n^{'} - 198y_{n-1}^{'} + 312y_{n-2}^{'} - 138y_{n-3}^{'} + 27y_{n-4}^{'}] \quad (13)$$

For third assumption taking A_1, A_2, A_3 & A_4 as parameter, then (9) gives

$$A_0 = 1 - A_1 - A_2 - A_3 - A_4$$
$$B_0 = \frac{1}{720}[1901 + 251A_1 + 232A_2 + 243A_3 + 224A_4]$$
$$B_1 = \frac{1}{360}[-1387 + 323A_1 + 496A_2 + 496A_3 + 512A_4]$$
$$B_2 = \frac{1}{30}[109 - 11A_1 + 8A_2 + 27A_3 + 16A_4]$$
$$B_3 = \frac{1}{360}[-637 + 53A_1 + 16A_2 + 189A_3 + 512A_4]$$
$$B_4 = \frac{1}{720}[251 - 19A_1 - 8A_2 - 27A_3 + 224A_4] \quad (14)$$

Since A_1, A_2, A_3 & A_4 are arbitrary, choosing $A_1 = A_2 = A_3 = A_4 = 0$. Then from (14) get the followings

$$A_0 = 1, B_0 = \frac{1901}{720}, B_1 = -\frac{1387}{360}, B_2 = \frac{109}{30}, B_3 = -\frac{637}{360}, B_4 = \frac{251}{720}$$

To get a predictor formula substituting these values in (8), as follows

$$y_{n+1}^{p} = (1)y_n + h[\left(\frac{1901}{720}\right)y_n^{'} + \left(-\frac{1387}{360}\right)y_{n-1}^{'} + \left(\frac{109}{30}\right)y_{n-2}^{'} + \left(-\frac{637}{360}\right)y_{n-3}^{'} + (\frac{251}{720})y_{n-4}^{'}]$$

$$or, y_{n+1}^{p} = y_n + \frac{h}{720}[1901y_n^{'} - 2774y_{n-1}^{'} + 2616y_{n-2}^{'} - 1274y_{n-3}^{'} + 251y_{n-4}^{'}] \quad (15)$$

2.2 DERIVATION OF CORRECTOR FORMULAE

The general linear corrector formula [2] which involves the information about the function and its derivative at the past four points together with the value of the at the given point being computed as

$$y_{n+1} = a_0y_n + a_1y_{n-1} + a_2y_{n-2} + a_3y_{n-3} + a_4y_{n-4}$$
$$+h[b_{-1}y'_{n+1} + b_0y'_n + b_1y'_{n-1} + b_2y'_{n-2} + b_3y'_{n-3}] \quad (16)$$

Above equation contains ten unknowns. Suppose it holds for polynomials up-to degree five. Hence take $y(x) = x^n$; $n = 0,1,2,3,4,5$. Let the space between the consecutive values of x be unity. i.e. taking $h = 1$.

Now putting $h = 1$ and $y(x) = 1, x, x^2, x^3, x^4, x^5$ successively in (16), obtain as

$$1 = a_0 + a_1 + a_2 + a_3 + a_4$$
$$1 = -a_1 - 2a_2 - 3a_3 - 4a_4 + b_{-1} + b_0 + b_1 + b_2 + b_3$$
$$1 = a_1 + 4a_2 + 9a_3 + 16a_4 + 2b_{-1} - 2b_1 - 4b_2 - 6b_3$$
$$1 = -a_1 - 8a_2 - 27a_3 - 64a_4 + 3b_{-1} + 3b_1 + 12b_2 + 27b_3$$
$$1 = a_1 + 16a_2 + 81a_3 + 256a_4 + 4b_{-1} - 4b_1 - 32b_2 - 108b_3$$
$$1 = -a_1 - 32a_2 - 243a_3 - 1024a_4 + 5b_{-1} + 5b_1 + 80b_2 + 405b_3 \quad (17)$$

Here six equations with ten unknowns. Introducing three assumptions as followings

For first assumption taking a_0, a_1, a_2 & a_3 as parameter, then (17) gives

$$a_4 = 1 - a_0 - a_1 - a_2 - a_3$$
$$b_{-1} = \frac{1}{720}[475 - 224a_0 - 243a_1 - 232a_2 - 251a_3]$$
$$b_0 = \frac{1}{360}[-125 + 448a_0 + 621a_1 + 584a_2 + 637a_3]$$
$$b_1 = \frac{1}{30}[125 - 136a_0 - 117a_1 - 98a_2 - 109a_3]$$
$$b_2 = \frac{1}{360}[875 + 928a_0 + 981a_1 + 1064a_2 + 1387a_3]$$
$$b_3 = \frac{1}{720}[2125 - 2144a_0 - 2133\,a_1 - 2152a_2 - 1901a_3] \quad (18)$$

Since a_0, a_1, a_2 & a_3 are arbitrary, choosing $a_0 = a_1 = a_2 = a_3 = 0$. Then from (18) get the followings

$$a_4 = 1, b_{-1} = \frac{95}{144}, b_0 = -\frac{25}{72}, b_1 = \frac{25}{6}, b_2 = -\frac{175}{72}, b_3 = \frac{425}{144}$$

To get a corrector formula substituting these values in (16), as follows

$$y_{n+1}^{c} = (1)y_{n-4} + h[(\frac{95}{144})y_{n+1}^{'} + \left(-\frac{25}{72}\right)y_n^{'} + \left(\frac{25}{6}\right)y_{n-1}^{'} + \left(-\frac{175}{72}\right)y_{n-2}^{'} + \left(\frac{425}{144}\right)y_{n-3}^{'}]$$

$$or, y_{n+1}^{c} = y_{n-4} + \frac{h}{144}[95y_{n+1}^{'} - 50y_n^{'} + 600y_{n-1}^{'} - 350y_{n-2}^{'} + 425y_{n-3}^{'}] \quad (19)$$

For second assumption taking a_0, a_1, a_3 & a_4 as parameter, then (17) gives

$$a_2 = 1 - a_0 - a_1 - a_3 - a_4$$
$$b_{-1} = \frac{1}{720}[243 + 8a_0 - 11a_1 - 19a_3 + 232a_4]$$
$$b_0 = \frac{1}{360}[459 - 136a_0 + 37a_1 + 53a_3 - 584a_4]$$
$$b_1 = \frac{1}{30}[27 - 38a_0 - 19a_1 - 11a_3 + 98a_4]$$
$$b_2 = \frac{1}{360}[189 - 136a_0 - 173a_1 + 323a_3 - 1064a_4]$$
$$b_3 = \frac{1}{720}[-27 + 8a_0 + 19a_1 + 251a_3 + 2152a_4] \quad (20)$$

Since a_0, a_1, a_3 & a_4 are arbitrary, choosing $a_0 = a_1 = a_3 = a_4 = 0$. Then from (20) get the followings

$$a_2 = 1, b_{-1} = \frac{27}{80}, b_0 = \frac{51}{40}, b_1 = \frac{9}{10}, b_2 = \frac{21}{40}, b_3 = -\frac{3}{80}$$

To get a corrector formula substituting these values in (16), as follows

$$y_{n+1}^c = (1)y_{n-2} + h[(\frac{27}{80})y_{n+1}^{'} + \left(\frac{51}{40}\right)y_n^{'} + \left(\frac{9}{10}\right)y_{n-1}^{'} + \left(\frac{21}{40}\right)y_{n-2}^{'} + \left(-\frac{3}{80}\right)y_{n-3}^{'}]$$
$$or, y_{n+1}^c = y_{n-2} + \frac{h}{80}[27y_{n+1}^{'} + 102y_n^{'} + 72y_{n-1}^{'} + 42y_{n-2}^{'} - 3y_{n-3}^{'}] \quad (21)$$

For third assumption taking a_1, a_2, a_3 & a_4 as parameter, then (17) gives

$$a_0 = 1 - a_1 - a_2 - a_3 - a_4$$
$$b_{-1} = \frac{1}{720}[251 - 19a_1 - 8a_2 - 27a_3 + 224a_4]$$
$$b_0 = \frac{1}{360}[323 + 173a_1 + 136a_2 + 189a_3 - 448a_4]$$
$$b_1 = \frac{1}{30}[-11 + 19a_1 + 38a_2 + 27a_3 + 136a_4]$$
$$b_2 = \frac{1}{360}[53 - 37a_1 + 136a_2 + 459a_3 - 928a_4]$$
$$b_3 = \frac{1}{720}[-19 + 11a_1 - 8a_2 + 243a_3 + 2144a_4] \quad (22)$$

Since a_1, a_2, a_3 & a_4 are arbitrary, choosing $a_1 = a_2 = a_3 = a_4 = 0$. Then from (20) get the followings

$$a_0 = 1, b_{-1} = \frac{251}{720}, b_0 = \frac{323}{360}, b_1 = -\frac{11}{30}, b_2 = \frac{53}{360}, b_3 = -\frac{19}{720}$$

To get a corrector formula substituting these values in (16), as follows

$$y_{n+1}^c = (1)y_n + h[(\frac{251}{720})y_{n+1}^{'} + \left(\frac{323}{360}\right)y_n^{'} + \left(-\frac{11}{30}\right)y_{n-1}^{'} + \left(\frac{53}{360}\right)y_{n-2}^{'} + \left(-\frac{19}{720}\right)y_{n-3}^{'}]$$
$$or, y_{n+1}^c = y_n + \frac{h}{720}[251y_{n+1}^{'} + 646y_n^{'} - 264y_{n-1}^{'} + 106y_{n-2}^{'} - 19y_{n-3}^{'}] \quad (23)$$

2.3 PARTICULAR FORMS

The system of above predictor-corrector schemes can be expressed in particular form by putting $n = 4$ and then these reduce to the following system of predictor-corrector formulae

$$y_5^p = y_0 + \frac{h}{144}[425y_4^{'} - 350y_3^{'} + 600y_2^{'} - 50y_1^{'} + 95y_0^{'}]$$
$$y_5^c = y_0 + \frac{h}{144}[95y_5^{'} - 50y_4^{'} + 600y_3^{'} - 350y_2^{'} + 425y_1^{'}]$$

$$y_5^p = y_2 + \frac{h}{80}[237y_4^{'} - 198y_3^{'} + 312y_2^{'} - 138y_1^{'} + 27y_0^{'}]$$
$$y_5^c = y_2 + \frac{h}{80}[27y_5^{'} + 102y_4^{'} + 72y_3^{'} + 42y_2^{'} - 3y_1^{'}]$$

$$y_5^p = y_4 + \frac{h}{720}[1901y_4^{'} - 2774y_3^{'} + 2616y_2^{'} - 1274y_1^{'} + 251y_0^{'}]$$
$$y_5^c = y_4 + \frac{h}{720}[251y_5^{'} + 646y_4^{'} - 264y_3^{'} + 106y_2^{'} - 19y_1^{'}]$$

3 NUMERICAL EXAMPLES

Problem-1: $Solve\ \ y^{/} = \frac{dy}{dx} = x + y - 1\ \ at\ \ x = 1.00$

With initial values are $y(0.00) = 1.00000000$, $y(0.20) = 1.02140276$, $y(0.40) = 1.09182470$, $y(0.60) = 1.22211880$ & $y(0.80) = 1.42554093$.

The analytical solution is $y = e^x - x$

Problem-2: $Solve\ \ y^{/} = \frac{dy}{dx} = e^x + y\ \ at\ \ x = 1.25$

With initial values are $y(0.00) = 1.00000000$, $y(0.25) = 1.60503177$, $y(0.50) = 2.47308191$, $y(0.75) = 3.70475003$ & $y(1.00) = 5.43656366$.

The analytical solution is $y = (1 + x)e^x$

Problem-3: $Solve\ y^{/} = \frac{dy}{dx} = xy\ \ at\ \ x = 1.25$

With initial values are $y(0.00) = 2.00000000$, $y(0.25) = 2.06348682$, $y(0.50) = 2.26629691$, $y(0.75) = 2.64956952$ & $y(1.00) = 3.29744254$.

The analytical solution is $y = 2e^{\frac{x^2}{2}}$

Problem-04: $Solve\ \ y^{/} = \frac{dy}{dx} = \frac{x+y}{2}\ \ at\ \ x = 2.50$

With initial values are $y(0.00) = 2.00000000$, $y(0.50) = 2.6361016$, $y(1.00) = 3.59488508$, $y(1.50) = 4.96800007$ & $y(2.00) = 6.87312731$.

The analytical solution is $y = 4e^{\frac{x}{2}} - x - 2$

Problem-5: $Solve\ \ y^{/} = \frac{dy}{dx} = \frac{y}{1-x}\ \ at\ \ x = 0.50$

With initial values are $y(0.00) = 1.00000000, y(0.10) = 1.11111111, y(0.20) = 1.25000000, y(0.30) = 1.42857143$ & $y(0.40) = 1.66666667$.

The analytical solution is $y = \frac{1}{1-x}$

4 COMPARATIVE ANALYSIS OF NUMERICAL RESULTS

Problem No.	Exact value	New method I	New method II	New method III	Milne method	Adam-Moulton method
01	1.71828183	1.71832282 5th iteration $\|E_R\|$ = 0.002386%	1.71828428 4th iteration $\|E_R\|$ = 0.000143%	1.71828432 4th iteration $\|E_R\|$ = 0.000145%	1.71829032 5th iteration $\|E_R\|$ = 0.000494%	1.71830108 5th iteration $\|E_R\|$ = 0.0011203%
02	7.85327165	7.85469550 8th iteration $\|E_R\|$ = 0.018137%	7.85335930 5th iteration $\|E_R\|$ = 0.001116%	7.85336122 6th iteration $\|E_R\|$ = 0.001141%	7.85349775 6th iteration $\|E_R\|$ = 0.002879%	7.85377374 7th iteration $\|E_R\|$ = 0.006393%
03	4.36840162	4.37851870 10th iteration $\|E_R\|$ = 0.231586%	4.36917214 7th iteration $\|E_R\|$ = 0.017639%	4.36920791 7th iteration $\|E_R\|$ = 0.018457%	4.36946805 7th iteration $\|E_R\|$ = 0.024412%	4.37053870 7th iteration $\|E_R\|$ = 0.048921%
04	9.46137183	9.46211459 8th iteration $\|E_R\|$ = 0.007851%	9.46141668 5th iteration $\|E_R\|$ = 0.000474%	9.46141756 5th iteration $\|E_R\|$ = 0.000483%	9.46150093 6th iteration $\|E_R\|$ = 0.001365%	9.46166121 6th iteration $\|E_R\|$ = 0.003059%
05	2.00000000	2.00273381 7th iteration $\|E_R\|$ = 0.136691%	2.00025926 5th iteration $\|E_R\|$ = 0.012963%	2.00027429 5th iteration $\|E_R\|$ = 0.013715%	2.00032394 6th iteration $\|E_R\|$ = 0.016197%	2.00061350 6th iteration $\|E_R\|$ = 0.030675%

5 CONCLUSIONS

From above comparison table it is clear that among three new predictor-corrector formulae, second & third formulae give better accuracy and also can minimize the calculating time as it takes less number of iterations but the first one gives very poor result. It is yet to implement proposed formulae to the real world problems. Though new predictor-corrector formulae seem to be lengthy process of solving ordinary differential equations of first order and first degree, it has following advantages over previous methods. Such as; (i) the previous methods estimates the value of y respecting a given value of x by means of four initial conditions whereas the proposed predictor-corrector formulae estimate the value of y respecting a given value of x by means of five initial conditions, which is more logical, (ii) taking more decimal places in these formulae give better accuracy.

Thus it can be said that the second & third proposed formulae can be used to solve ordinary differential equations of first order and first degree with more accuracy and in shorter time than existing predictor-corrector formulae. Also, for less accuracy and much time consume the first one to be rejected obviously. Finally, by considering each of the formula for compare with exact value, it can conclude that the second new predictor-corrector formula is the best.

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QUALITATIVE ASSESSMENT OF WATER SAMPLES FROM MISCELLINOUS PROVINCIAL LOCALE OF PAKISTAN

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ABSTRACT: Two hundred potable water samples were garnered from myriad rustic areas of Pakistan. These were perceptible by fifty illustrative individually from Khyber Pukhtoonkhuwa (KPK), Punjab, Sindh and Baluchistan. From the bacteriological appraisal, it was corroborated that indispensible turfs of Pakistan such has Sindh and Khyber Pukhtoonkhuwa aqua founts was hexed with boisterous total colony counts i.e. (38%) and (40%) on average for samples enthralling >5700 bacterial count. Abiding preposterous intensity of fecal *E.coli, Enterococci*, *Streptococci* and other pathogens cardinally *Pseudomonas, Clostridia* pose inimical predicament by ameliorating recrudescence of water borne contagion. The deemed magnitude of sullied potable water is (52%) which according to World Health Organization (WHO), this grade of water is bacteriologically ominous and government and citizenry should apprehend worthwhile and optimistic approaches to cope the egregious circumstance of the country.

KEYWORDS: Potable water, Bacteriological, Pakistan.

INTRODUCTION

Water is pre-eminent and pertinent bounty of the Mother Nature. Humanity wields these quotidian resources to sustain oneself [1]. The terra firma of Pakistan is vapid and majority of strain depends on deliquescence of glaciers and annual rains for potable water. But faux adulteration of water had posed momentous ultimatum to esse on earth. Water resources are pared down per capita due to increasing population, capricious weather patterns and surplus exploitation of water. Provision of execrable quality of potable water have increased the morbidity rate of water borne illness including hepatitis, cholera, typhoid, gastro-enteric discomforts and cutaneous infections etc. According to UNICEF documentation mortality rate diahorreal illness is 2 million per annum which superintend for one third of demise [2]. Residuum of coliforms in potable water is crucial cause of water borne illness. In Pakistan, Nation Sanitation Policy and Natural Drinking water Policy ended in view to perk up water status in 2006 and 2009 at the expense of 4$ per capita. But execution of this convention remained debriefed, as annual ante is beneath the requirement. Appalling water standards is accountable for epidemics of oppressive water borne maladies. Guesstimated annually, three million natives are smote due to water borne afflictions [3]. Striking cataclysms in 2006 had surged over fundamental cities such as Peshawar, Karachi, Lahore and Faisalabad. Later on, Pakistan Council of Research in Water Resources surveiled quality of water from various quarters of Pakistan and the documented evaluation flaunted that pre-eminence of water from each substantial city was bacteriologically abysmal. The exposition declared tainted potable water reservoirs and possessed elevated level of coliforms, higher concentrations of iron and fluoride along with 73% turbidity. As claimed by United Nation Children's Fund investigation, approximately 20 - 40% children are hospitalized due to water borne illness and this condition may account for escalating mortality and morbidity rates which affects the daily wage and income of the family by procuring treatment for the ailments. According to Pakistan Supreme Court ordinance, ingurgitation of secure potable water is the quintessential prerogative of nation across the country [4].

The cardinal proposition of this research interpretation was to amass fifty potable water samples each from quotidian founts of the four provinces of Pakistan i.e. Khyber Pukhtoonkhuwa, Punjab, Baluchistan and Sindh. These samples were then analyzed for qualitative bacteriological atonements interrogating Total colony counts/ml, Total coliforms/ml, Presence of fecal *E.coli, Enterococci, Streptococci* and other micro-organism/ml.

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MATERIALS AND METHODS

SAMPLE COLLECTION

Fifty potable water from variegated provincial localities of Pakistan were tot up in 1000ml sample collector bottle. The collector bottles confine sodium thio-sulphide that aids to neutralize pH and maintain bacterial counts. Test samples included tap water, bore water, mineral water, tank water, spring water, well water, purified water from installed water purifiers and coolers, lake and river water from pertinent sectors of Khyber Pukhtoonkhuwa (KPK), Punjab, Sindh and Baluchistan. Clubbing together, two hundred water samples were put on to the bacteriological examination.

pH AND TEMPERATURE EXAMINATION

Speculated pH range for all the two hundred samples were 5.5 - 8.5 which was probed with aid of conventional comparator indicator strip. All the water samples were stowed at room temperature before prosecuting bacteriological examination.

BACTERIOLOGICAL EXAMINATION

Bacteriological examination of potable water samples were preceded via accessing total colony counts and identification of water borne micro-organisms.

a. TOTAL COLONY COUNT

Total colony counts of amassed water samples were scrutinized as per cited pour plate method [5]. 1ml water sample was subjected to autoclaved petri-plate. Then the water samples were spread commensurately with aid of sterilized spreader in the petri-plates. Then in laminar flow hood, prepared complex nutrient agar medium was poured over the water samples. Petri-plates were then left unperturbed at room temperature so that nutrient agar medium would gelatinize. Further the petri-plates were incubated at 37^{o}C for 24 hours in transpose position. At the end of incubation period, total bacterial counts were enumerated aiding digital colony counter.

b. IDENTIFYING MICRO-ORGAMNISMS

Identification of the water borne pathogens was scrutinized as per cited membrane filtration method [6]. 100ml water samples were filtered through cellulose ester membrane having pore size 0.45µm. After filtration, the membrane retained the bacteria on the surface eminently coliforms, fecal *E.coli, Enterococci, Streptococci* and other micro-organism such as *Pseudomonas* and *Clostridium* species. Cellulose membranes were then subjected to autoclaved bacterial selective medium extant in autoclaved petri-plates in a skyward position. Further the petri-plates were incubated at 37^{o}C for 24 hours. At end of incubation period, appeared bacterial colonies were enumerated on the basis of their perceptible color and morphology. Unwanted micro-organisms were either inhibited by composites present in selective medium or distinguished on basis of morphological traits.

RESULTS

KHYBER PUKHTOONKHUWA WATER SURVEY

From the evaluated result synopsized in (Table 1) and (Graph 1), it is apparent that potable water from circadian sources of Khyber Pukhtoonkhuwa (KPK) were indicted to be bacteriologically execrable due to the estimated samples holding higher total colony count i.e. >5700 was 20 out of 50 thus illustrating average of (40%), average presence of coliforms were (46%) for 23 isolated samples and average frequency of fecal *E.coli* were (30%) for 15 isolated samples which notifies alarming unsatisfactory water quality and escalating levels of water borne ailments specially in infants. Rare prevalence of fecal *Streptococci, Enterococci* (2%) and other organisms mainly *Pseudomonas* was inscribed.

Table 1: Tabular index proclaiming potable water recce of Khyber Pukhtoonkhuwa (KPK) precincts

SAMPLE NO.	KHYBER PUKHTOONKHUWA INVESTIGATIONS				
	TOTAL COLONY COUNT (CFU/ml)	TOTAL COLIFORMS (CFU/ml)	FECAL *E.COLI* (CFU/ml)	FECAL *STREPTOCOCCI/ ENTEROCOCCI* (CFU/ml)	OTHER ORGANISMS (CFU/ml)
1	1011	03	Isolated	-	-
2	<01	-	-	-	-
3	<01	-	-	-	-
4	>5700	-	-	-	-
5	<01	-	-	-	-
6	>5700	Numerous	Isolated	-	-
7	>5700	-	-	-	-
8	1325	-	-	-	-
9	>5700	25	-	-	-
10	1011	Numerous	Isolated	-	-
11	798	50	-	-	*Pseudomonas*
12	1410	25	-	-	-
13	370	15	Isolated	-	-
14	>5700	25	-	-	-
15	>5700	15	Isolated	Isolated	-
16	<01	-	-	-	-
17	<01	-	-	-	-
18	<01	-	-	-	-
19	<01	-	-	-	-
20	>5700	15	Isolated	-	-
21	17	-	-	-	-
22	>5700	-	-	-	-
23	>5700	6	Isolated	-	-
24	840	Numerous	-	-	-
25	1866	-	-	-	-
26	>5700	6	Isolated	-	-
27	02	-	-	-	-
28	940	-	-	-	-
29	>5700	60	Isolated	-	-
30	>5700	02	Isolated	-	-
31	>5700	02	Isolated	-	-
32	02	-	-	-	-
33	<01	-	-	-	-
34	>5700	-	-	-	-
35	>5700	13	Isolated	-	-
36	>5700	09	Isolated	-	-
37	08	-	-	-	-
38	03	-	-	-	-
39	<01	-	-	-	-
40	598	02	-	-	-
41	>5700	06	Isolated	-	-
42	>5700	09	-	-	-
43	121	15	Isolated	-	-
44	>5700	-	-	-	-
45	<01	-	-	-	-
46	<01	-	-	-	-
47	11	-	-	-	-
48	<01	-	-	-	-
49	1467	-	-	-	-
50	>5700	10	-	-	-

Key: (>5700) *denotes diabolical water sample that own exorbitant bacterial counts,*
(<01) *denotes veritable water sample that own few or no bacterial counts*

PUNJAB WATER SURVEY

From the results procured by Punjab potable water scrutiny, it was apparent that water quality in these regions at average moment was much same as Khyber Pukhtoonkhuwa's survey. Average of potable water samples that resides higher total colony count i.e. >5700 were (34%) for 17 observed samples, manifesting it as bacteriologically decrypted. Moderate prevalence of total coliforms was (34%) for 17 isolated samples and fecal *E.coli* (14%) for 7 isolated samples were computed. Rare to none fecal *Streptococci, Enterococci* (2%) and other organisms were observed. Results are synopsized in (Table 2) and (Graph 1).

Table 2: Tabular index proclaiming potable water recce of Punjab precincts

SAMPLE NO.	PUNJAB INVESTIGATIONS				
	TOTAL COLONY COUNT (CFU/ml)	TOTAL COLIFORMS (CFU/ml)	FECAL *E.COLI* (CFU/ml)	FECAL *STREPTOCOCCI/ ENTEROCOCCI* (CFU/ml)	OTHER ORGANISMS (CFU/ml)
1	2465	-	-	-	-
2	>5700	-	-	-	-
3	>5700	12	-	-	*Pseudomonas*
4	>5700	06	-	-	-
5	>5700	-	-	-	-
6	>5700	Numerous	-	-	-
7	<01	-	-	-	-
8	14	-	-	-	-
9	<01	-	-	-	-
10	48	-	-	-	-
11	13	-	-	-	-
12	1396	20	-	-	-
13	<01	-	-	-	-
14	1539	-	-	-	-
15	<01	-	-	-	-
16	1211	25	-	-	-
17	1368	25	-	-	-
18	<01	-	-	-	-
19	>5700	Numerous	-	-	-
20	<01	-	-	-	-
21	<01	-	-	-	-
22	16	-	-	-	-
23	484	-	-	-	-
24	03	-	-	-	-
25	>5700	50	-	-	-
26	>5700	-	-	-	-
27	53	24	-	-	-
28	<01	-	-	-	-
29	<01	-	-	-	-
30	>5700		-	-	-
31	>5700	Numerous	Isolated	-	-
32	>5700	02	-		-
33	641	-	-	-	-
34	08	-	-	-	-
35	1254	Numerous	Isolated	-	-
36	1054	30	Isolated	-	-
37	>5700	20	Isolated	Isolated	-
38	<01	-	-	-	
39	<01	-	-	-	-
40	741	-	-	-	-
41	<01	-	-	-	-
42	>5700	Numerous	Isolated	-	-
43	>5700	-	-	-	-
44	>5700	-	-	-	-

45	1140	-	-	-	-
46	>5700	-	-	-	-
47	>5700	02	Isolated	-	-
48	755	35	Isolated	-	-
49	570	-	-	-	-
50	71	-	-	-	-

Key: (>5700) *denotes diabolical water sample that own exorbitant bacterial counts,*
(<01) *denotes veritable water sample that own few or no bacterial counts*

SINDH WATER SURVEY

From Sindh water survey, we discerned that water from these sectors are also bacteriologically unsatisfactory and are insecure for consumption. Average total colony counts for water samples owing >5700 colony count was (38%) for 19 inspected samples, average of total coliforms was (58%) for 29 isolated samples, average persistence of fecal *E.coli* was (42%) for 21 isolated samples, average presence of other organisms such as *Clostridium* and *Pseudomonas* species was (8%) for 4 indicated samples. Results are synopsized in (Table 3) and (Graph 1). The awful water status from these areas poses a peril to health by inhabiting virulent organisms that are chief causative agents of gastro-intestinal illnesses.

Table 3: Tabular index proclaiming potable water recce of Sindh precincts

SAMPLE NO.	SINDH INVESTIGATIONS				
	TOTAL COLONY COUNT (CFU/ml)	TOTAL COLIFORMS (CFU/ml)	FECAL *E.COLI* (CFU/ml)	FECAL *STREPTOCOCCI/ ENTEROCOCCI* (CFU/ml)	OTHER ORGANISMS (CFU/ml)
1	>5700	20	Isolated	-	*Clostridia*
2	>5700	-	-	-	*Pseudomonas*
3	1140	Numerous	Isolated	-	-
4	>5700	-	-	-	-
5	>5700	Numerous	Isolated	-	-
6	>5700	45	Isolated	-	-
7	02	-	-	-	-
8	<01	-	-	-	-
9	58	02	-	-	-
10	741	80	Isolated	-	-
11	820	Numerous	Isolated	-	-
12	1197	Numerous	Isolated	-	-
13	>5700	25	Isolated	-	-
14	<01	-	-	-	-
15	02	-	-	-	-
16	>5700	Numerous	Isolated	-	-
17	427	01	-	-	-
18	370	25	Isolated	-	-
19	384	30	Isolated	-	-
20	<01	-	-	-	-
21	100	04	-	-	-
22	83	01	-	-	-
23	>5700	02	Isolated	-	-
24	584	06	Isolated	-	-
25	<01	-	-	-	-
26	<01	-	-	-	-
27	>5700	15	Isolated	-	-
28	>5700	-	-	-	-
29	1211	01	Isolated	-	*Pseudomonas*
30	<01	-	-	-	-
31	>5700	05	Isolated	-	-
32	>5700	02	Isolated	-	-
33	712	-	-	-	-
34	>5700	-	-	-	-
35	>5700	02	Isolated	-	-

36	>5700	Numerous	-	-	*Pseudomonas*
37	>5700	45	Isolated	-	-
38	<01	-	-	-	-
39	>5700	Numerous	-	-	-
40	441	-	-	-	-
41	<01	-	-	-	-
42	370	Numerous	-	-	-
43	<01	-	-	-	-
44	<01	-	-	-	-
45	<01	-	-	-	-
46	<01	-	-	-	-
47	<01	-	-	-	-
48	541	-	-	-	-
49	>5700	Numerous	Isolated	-	-
50	>5700	Numerous	Isolated	-	-

Key: (>5700) *denotes diabolical water sample that own exorbitant bacterial counts,*
(<01) *denotes veritable water sample that own few or no bacterial counts*

BALUCHISTAN WATER SURVEY

From regional water survey of Baluchistan sector, we perceive that in comparison to other provinces, the samples from these areas possessed less bacterial counts as notified (20%) on average for 10 isolated samples having colony counts observations >5700, (34%) for 17 isolated samples on average for total coliforms, (18%) for 9 isolated samples on average for regularity of fecal *E.coli.* Rare presence of other organisms mainly *Pseudomonas* and absence of fecal *Streptococci, Enterococci* was spotted. Results are synopsized in (Table 4) and (Graph 1). It is comparatively better result, but yet the elevated levels of coliforms and average bacterial counts contemplate this situation to be bacteriologically vulnerable as a whole.

Table 4: Tabular index proclaiming potable water recce of Baluchistan precincts

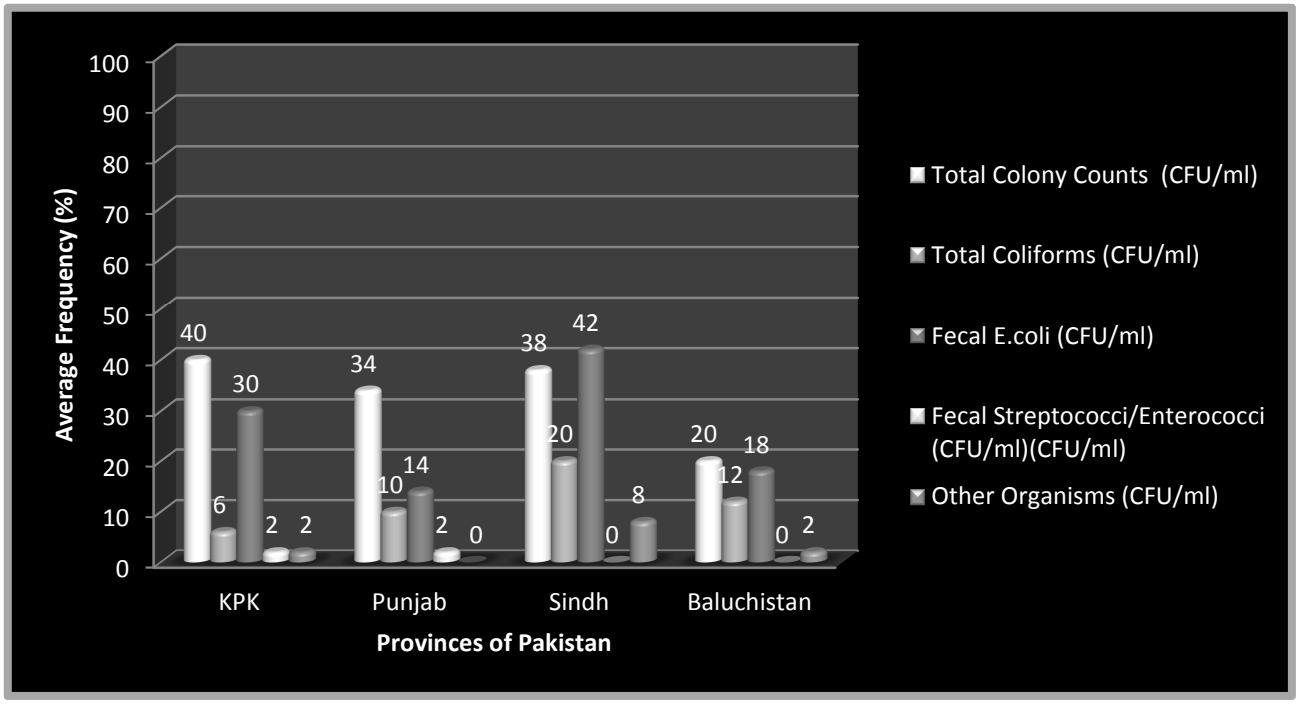
SAMPLE NO.	BALUCHISTAN INVESTIGATIONS				
	TOTAL COLONY COUNT (CFU/ml)	TOTAL COLIFORMS (CFU/ml)	FECAL *E.COLI* (CFU/ml)	FECAL *STREPTOCOCCI/ ENTEROCOCCI* (CFU/ml)	OTHER ORGANISMS (CFU/ml)
1	>5700	50	-	-	-
2	03	-	-	-	*Pseudomonas*
3	<01	-	-	-	-
4	<01	-	-	-	-
5	<01	-	-	-	-
6	<01	-	-	-	-
7	02	-	-	-	-
8	<01	-	-	-	-
9	1681	02	Isolated	-	-
10	270	-	-	-	-
11	<01	-	-	-	-
12	498	-	-	-	-
13	1524	-	-	-	-
14	66	-	-	-	-
15	<01	-	-	-	-
16	<01	-	-	-	-
17	>5700	Numerous	-	-	-
18	498	-	-	-	-
19	1396	09	Isolated	-	-
20	>5700	02	-	-	-
21	897	35	-	-	-
22	>5700	05	Isolated	-	-
23	>5700	Numerous	-	-	-
24	>5700	Numerous	Isolated	-	-
25	>5700	Numerous	Isolated	-	-

26	1410	Numerous	Isolated	-	-
27	02	-	-	-	-
28	<01	-	-	-	-
29	<01	-	-	-	-
30	01	-	-	-	-
31	01	-	-	-	-
32	>5700	-	-	-	-
33	<01	-	-	-	-
34	<01	-	-	-	-
35	1140	-	-	-	-
36	<01	-	-	-	-
37	01	-	-	-	-
38	01	-	-	-	-
39	812	09	Isolated	-	-
40	327	04	-	-	-
41	50	05	Isolated	-	-
42	>5700	02	-	-	-
43	812	02	-	-	-
44	<01	-	-	-	-
45	<01	-	-	-	-
46	<01		-	-	-
47	<01	-	-	-	-
48	<01	-	-	-	-
49	<01	-	-	-	-
50	>5700	Numerous	Isolated	-	-

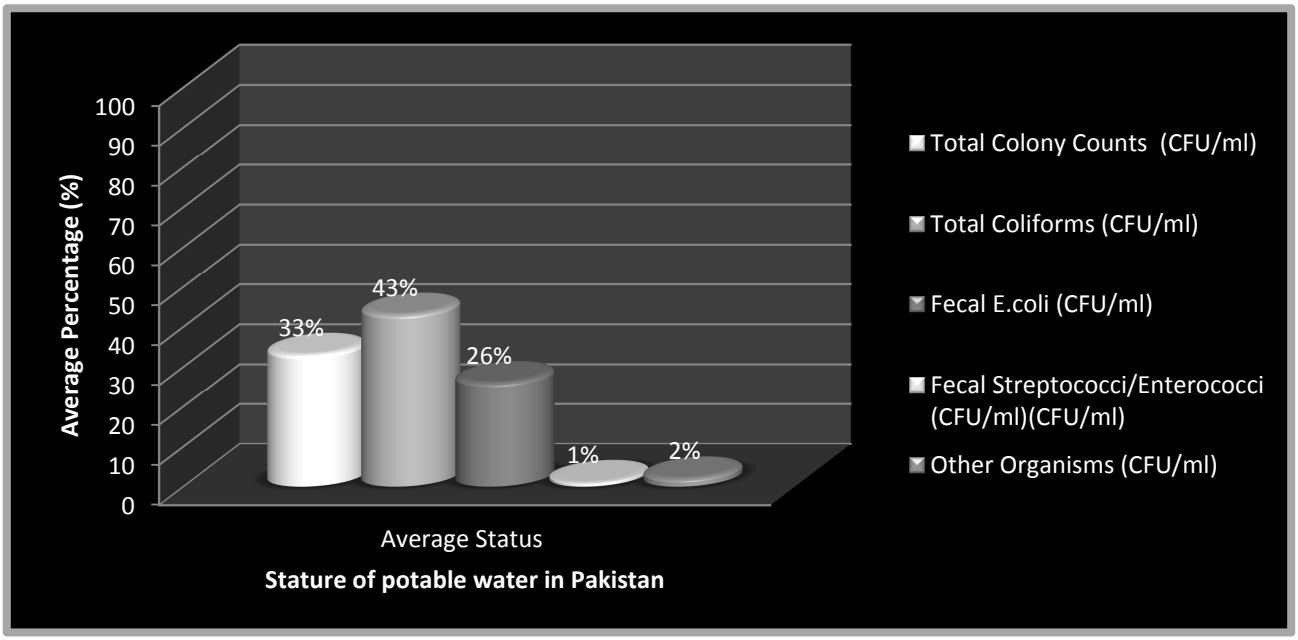
Key: (>5700) *denotes diabolical water sample that own exorbitant bacterial counts,*
(<01) *denotes veritable water sample that own few or no bacterial counts*

PROMINENCE OF WATER QUALITY IN PAKISTAN

Status of potable water quality has not changed much in these contexts. The bacteriological survey was conducted on daily consumed potable water from kaleidoscopic sources over the country. The results were then synopsized according to level of adulteration i.e. (52%) exclusively in cantonal sectors across Pakistan. From the result, we analyzed that there is no refinement in quality of water since past surveys. The current catastrophic environmental conditions and lack of advancement has upgraded the level of contamination and water borne maladies. Germane quarters of the country such as Sindh, Punjab and Khyber Pukhtoonkhuwa possess unreasonable bacterial counts which pose a life-threatening circumstance. Blustered expositions of epizootic water borne afflictions such as Dengue Shock Syndrome, Poliomyelitis, Typhoid fever, Cholera, Hepatitis A and E and assorted other cutaneous and gastric ailments are dominating. Escalating mortality and morbidity rates especially in juveniles are predominant. Bacteriologically these commonly consumed water sources are penurious and are debilitated for drinking due to revenant of torrent bacterial counts mainly fecal coliforms, pathogenic fecal *E.coli*, *Enterococci, Streptococci, Pseudomonas, Clostridium* and relatively some fungi. Bacteriological average stratum of country “Pakistan” are synopsized in (Graph 1), (Graph 2) which displays the bacteriologically one third inadmissible viaticum of water quality.



Graph 1: Graphical index epitomizing substandard potable water stature of Pakistan



Graph 2: Graphical index epitomizing average of one third abjected magnitude of potable water in Pakistan

DISCUSSIONS

According to the reports of research study conducted in 2006 – 2008 prototyped by the Health Service Academy, Ministry of Health and Government of Pakistan in collaboration to World Health Organization and UNICEF, it was evident that water quality was bacteriologically unsatisfactory and with having deplorable presence of fecal coliforms and *E.coli.* Along with this physiochemical nature of water was also accountable due to presence of higher proportions of toxic minerals and radioactive elements [7]. The quality of water was then accused to be unsound for partaking and mainspring of water borne epidemics. Water and Sanitation Extension Program (WASEP) evaluated that morbidity of diahorreal discomforts was (33%) which reciprocates in increasing rates of bairn mortalities [8]. Soaring water pollution through direct anthropogenic supremacy,

industrial and agricultural effluents require paramount centralization to improve quality of consumable water in Pakistan in response descending the graph of water borne infections [9, 10, 11].

CONCLUSION

From the research survey, we access that water quality from contradictory district regions on average had higher colony counts which according to World Health Organization is unsafe for drinking purpose. Inflated levels of fecal *E.coli, Enterococci* and coliforms in the water samples revealed that the provenances of these samples are contaminated animal manure and human excreta which are blameworthy for infestation of water borne infirmities. Therefore bona-fide water treatment plants and sewage plants must be engrafted to confront the impoverish water status of the Pakistan as according to ordinance it is cardinal right of the confederation to profit from good water quality. Natives must also be tutored to tackle situations predominantly in cataclysm by implementation of cheap disinfection sources such solar water disinfection, conventional boiling and chlorination.

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DETERMINATION OF CHANGE MATRIX AMONG THE LANDUSE/LANDCOVER TYPES IN JALINGO METROPOLIS, NIGERIA

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ABSTRACT: The study examined the changes in land use/land cover (LULC) in Jalingo between 1988 and 2006. Six LULC types were classified in the study area from Landsat TM image of 1988, Landsat ETM image of 1999 and NigSat image of 2006. The six LULC types were bareland, built-up, cultivation, shrubland, water body and wetland. The data were analyzed using thinning, overlay operations, calculation of the area in km^2 of the resulting LULC type and LULC change matrix. The software used in the analysis are ERDAS and ILWIS 3.2.The areas of bareland, cultivation, water body, shrubland and wetland have decreased by 1.53km^2 (1.6%), 19.22km^2 (71%),0.15km^2 (0.6%) 0.22km^2 (0.81%) and1.64km^2 (6.0%) from 1988 to 2006. Conversely, the area of built-up land has increased by 15.62km^2 (40.2%) during the same period. Built-up land lost 11.64 km^2 and gain 27.26km^2 from 1988 to 2006 with the highest contribution of 19.22km^2 (71%) from cultivated land. The study recommended among others, the need for appropriate legislations to be put in place to check indiscriminate sprawling. The study concludes that increase in the proportion of urban population is the principal driver of land use/land cover change in Jalingo town.

KEYWORDS: land use, land cover, change matrix, built up, jalingo.

1 INTRODUCTION

Recent analyses suggest that 83% of the earth's land surface has been affected by human settlement and activities, leaving only 17% in wilderness (WCS & CIESIN 2002). Urban areas are expanding, particularly in the developing world. UN population division estimates suggest that the world's population will become majority urban by 2030, in contrast the world was only 37% urban in 1970.

Though the extent of urban areas is not that large when compared with other land uses such as agriculture, or forestry, their environmental impact is significant. This is not only to the large concentrations of population that are found in cities, but because they are centres of political, cultural and economic influences, and are often the location of significant industrial activities. In the era of economic globalization, so-called "mega-cities" like New York, London, Sao Paulo and Singapore draw on resources and economic activities around the world to build the wealth and prominence (Schiller et. al. 2001).

According to Turner (2001), urban areas rely on vast hinterland for food, raw materials for industrial, energy, water supplies, construction materials, recreational areas, and myriads of other goods and services.

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In terms of urban impacts on the environment and land cover change, there are direct and indirect impacts. The direct impacts include human settlements, industrial and infrastructure land uses, and the expansion of these land uses into areas of natural or agricultural lands (Heilig 1999, Vincent et. al. 2002). Urban built up areas have direct impacts on the hydrological cycle. Because urban paved and built up land surfaces tend to absorb heat and to re-radiate it at night, they can also create heat Islands that affect plant physiology as well as the health and welfare of urban dwellers (Vincent et. al. 2002).

The indirect impact of urban areas on land use and land cover can be even more important. For example, cities expropriate water from large distances; in some cases, such as in the New York city water supply districts, this may have the effect of conserving large areas of land that might otherwise be developed, (Turner, 2001).

A significant indirect impact of urban areas is the need for sinks or dumping sites for the great volumes of waste they produce. Urban wastes can be solid, liquid or gaseous. Problems of solid waste disposal have become increasingly problematic as land fills have reached their maximum capacities. Cities generally have few solutions other than to truck their waste at great cost to distinct landfills, or to incinerate it. (Vincent et al, 2002).

Liquids waste, or sewage, are generally treated and released into water bodies. This can, under certain circumstances, result in completely dead water bodies in which rivers, lakes or bays can no longer sustain life due to an excess of biochemical oxygen demand (Kreimer et.al. 1993). In northern Europe, natural wetlands are often used to filter impurities from water during the latter stages of sewerage treatment. This builds on the natural characteristics of wetlands as nutrients (Folke et. al. 1997).

Atmospheric pollutants can have a significant impact on land use and land cover. Folk et al estimate that the CO_2 emissions of major cities alone would consume 95% of the carbon absorptive capacity of the world's forest. Another major problem is air pollutant impacts on natural vegetation and crops. Acid rain has been a documented problem that dames forest lands in eastern Europe and North America.

Urbanization pathways lead to different impacts on rural landscapes in the developed and developing world. In the developed world, large-scale urban agglomerations and extended peri-urban settlements of such large areas that various ecosystem processes are threatened (Chameides et. al. 1994)

Ecosystem fragmentation, however, in peri-urban areas may be offset by urban-led demands for conservation and recreational land uses. In a different vein, economically and politically powerful urban consumers tend to be disconnected from the realities of resources production and largely in attentive to the impacts of their consumption on distant locales.

STUDY AREA

Jalingo is located in north-eastern Nigeria. It became the capital city of Taraba State in 1991 following the creation of Taraba State from the defunct Gongola State. The city is bordered on the east by Yoro Local Government Area, on the north-west is Lau Local Government Area, and on the south is the Ardo-Kola Local Government Area. It is located at Latitude $8^{o}54''$N and Longitude $11^{o}22''$E (Figure 1.6.1.1 and 1.6.1.2). According to the 2006 population census, Jalingo has estimated population of 118,000 people. Jalingo occupies a total land area of 219.18km^2



Fig: 1: Map of Nigeria showing Taraba State

Source: Taraba State Ministry of Land and Survey, (2013).

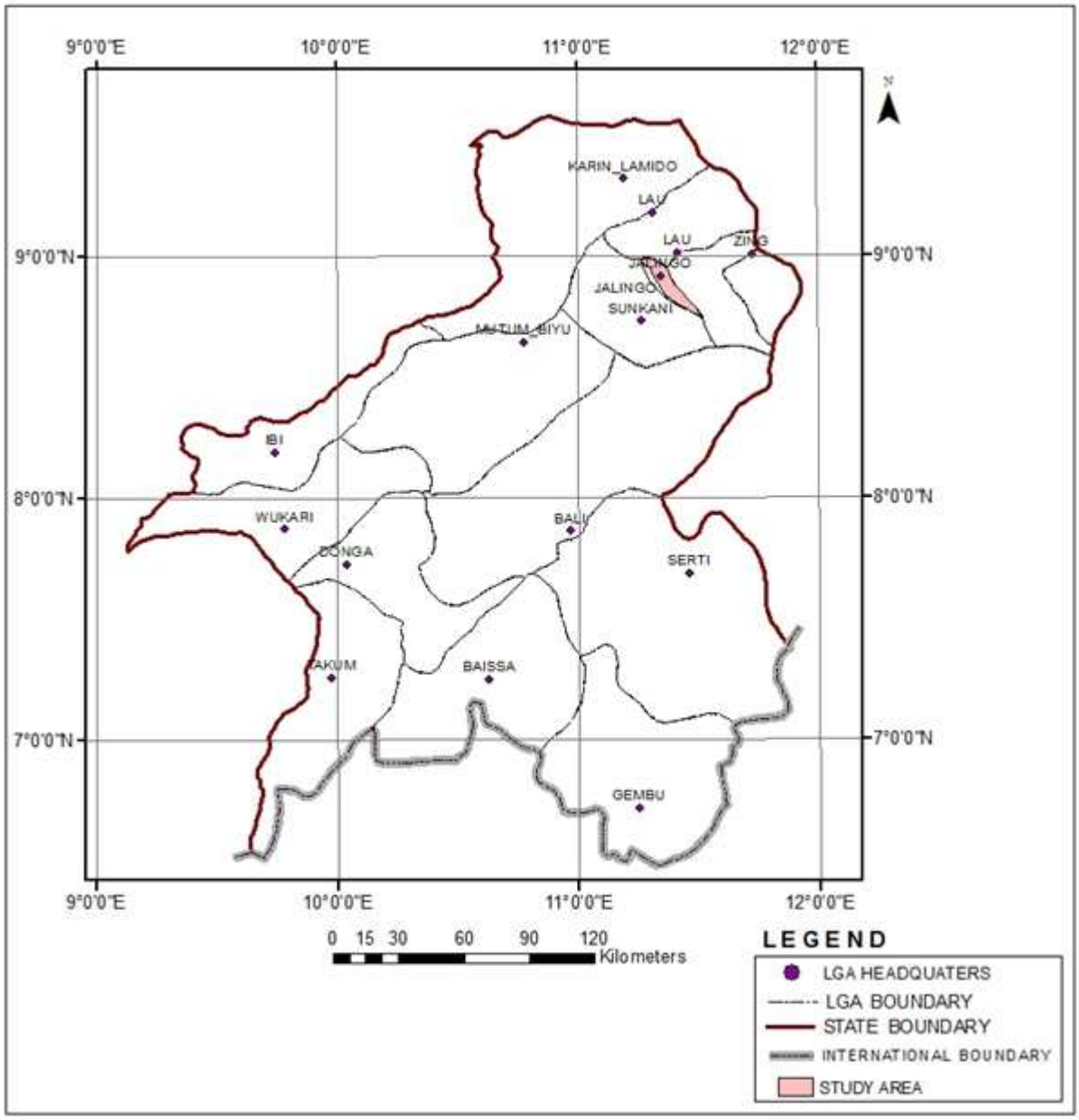


Fig: 2. Map of Taraba State showing study area (Jalingo)

Source: Taraba State Ministry of Land and Survey, (2013).

Jalingo town is blessed with vast plain land surrounded by mountains. It has very fertile soil which supports the various agricultural productions in the area. In the area of solid minerals, Jalingo is endowed with the following: feldspar, clay, quartzite, limestone, granite, marion, musconte, prite, lourmaline and zircon thereby making it a good climate for investment in ceramics, cement, burnt bricks and precious stone processing or production. In addition, due to the vast presence of precious stones, Jalingo is also a good place for the establishment of stone chips and stone crushing industries.

The climate of Jalingo is that of the tropical savanna (wet and dry). This is marked by rainy and dry seasons. Jalingo has temperature range of 18^{o}C (64^{o}F to 36^{o}C (96^{o}F) (1991-2007) and an annual rainfall of about 1,500mm with a single rainfall maxima in September. (Williams & Mary, 2007).The dry season experienced in the study area begins in November and lasts till March. It is characterized by northeasterly or the harmattan wind from Sahara Desert.

With the Northward movement of the Inter-Tropical Convergence Zone (ITCZ) over West Africa, heavy showers coming from convective clouds are experienced. Early onset of rain is experienced along the coastal area in January-February, April-

May in Central state and June-July in Northern parts of the country. (Williams and Mary, 2007).The vegetation of the Jalingo falls within the Guinea Savanna zone, which is characterized by tall grass and scattered tress.

Jalingo is surrounded by hills and mountains though with a vast plain land which supports the population of the area. There is a good drainage system in Jalingo. The town is traversed by two different rivers which banks support the cultivation of rice and sugar cane. (Figure3)

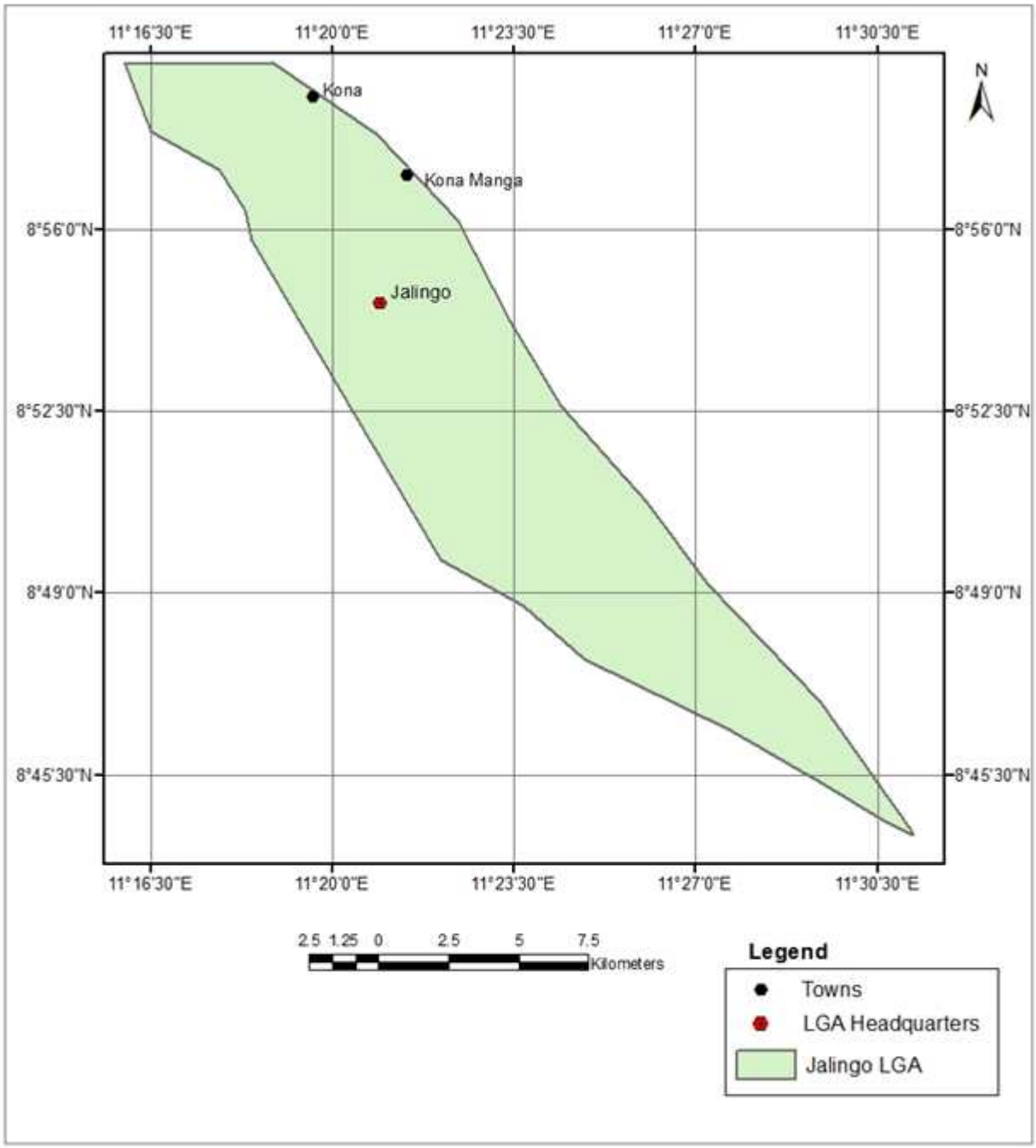


Fig. 3: Map of Jalingo L.G.A.

Source: Taraba State Ministry of Land and Survey, (2013).

The people of Jalingo are primarily engaged in farming which is supported by the vast fertile agricultural land of the area. As a result of its agriculture endowments, the area offers opportunities for cash and food crop production such as cashew,

mango, oranges, pineapple, palm oil, plantain, cassava, yam, soya beans, maize, and groundnut among others thus making the place very suitable for the establishment of juice processing industries as well as for cassava chips and starch production, oil mill, flour mill and so on. Other emerging socio-economic activity in the study area includes manufacturing, construction, commerce, transportation and so on.

DATA NEEDS/SOURCE

The data needed for this research work are the different land use/land cover types (in area square km) in Jalingo. NIGSAT 1 image of 5th July, 2006 was acquired from the National Center for Remote Sensing (NCRS) Jos, Nigeria. The satellite image was used for land use/land cover change detection and monitoring in the study area.

PROCESSING OF SATELLITE IMAGES

The raw satellite image NIGSAT1was first processed before usage. The image was rectified to a common Universal Transverse Mercator (UTM) coordinate system based on the topographical map of Jalingo. This converted the imagery format of North-East to South-West orientation to a topographical map format with North-South orientation.

METHOD OF CLASSIFICATION OF LAND USE/LAND COVER TYPES

Supervised classification method was used in this research work for the interpretation of satellite images. Supervised classification using maximum likelihood classifiers is a well established technique for the interpretation of satellite and airborne remotely-sensed images (Weng, 1999). Supervised classification has been developed for satellite image-processing where it has been applied to the classification of spectral layers. However, it can also be applied to other forms of remote sensing and has been used for the classification of interpolated acoustic reflectance data (Zhang et.al, 2004). It can also be used to convert different forms of data, not just 'spectral' values. For example classification can combine reflectance, depth (height), variability e.t.c. Although many of the variables may be correlated, supervised classification is a very versatile and statistically robust tool. However, to work well, the images should be distortion-free. This is often difficult to achieve with different degrees of distortion across an image. Distortion away from the nadir (the point on the sea floor directly under the remote sensing instrument) is a particular problem for many acoustic swath systems and is particularly noticeable where image strips have been mosaic together.

DERIVATION OF LAND USE/LAND COVER TYPES

Six land use/land cover types namely Bareland, Built-up lands, Cultivation, Shrubland, Water body, Wetland, were derived from the satellite image in conjunction with ground truthing using supervised classification method.

DATA ANALYSIS

To detect and analyze the changes in land use/land cover due to urbanization in the study area, satellite image of 2006 was used to investigate the temporal and spatial changes in land use/land cover due to urbanization in Jalingo town.

Five main methods of data analysis were adopted in this study as follow:

i. Image thinning
ii. Overlay operations
iii. Ground truthing
iv. Calculation of Area in sqrkm of the resulting land use/land cover types for each study year and subsequently comparing the results.
v. Intra changes among LULC

i. Image thinning

The first process in the analysis of satellite images is thinning. This is a process where the researcher carefully studies the images and removes the possible noise from them in order to get the correct picture of the area under study.

ii. Overlay operations

Overlay operations is concerned with the identification of the actual location and magnitude of change in a particular land use or land cover type. In this research, overlay operations was however limited to build-up since the major concern in the research is the impact of urbanization on other land use and land cover.

iii. Ground-truthing

Ground-truthing is a term used in remote sensing; it refers to information collected on location. Ground truth allows image data to be related to the real features and materials on the ground. The collection of ground truth data enables calibration of remote sensing data, and aids in the interpretation and analysis of what is being sensed. Examples include cartography, meteorology, analysis of aerial photographs, satellite imagery and other techniques in which data are gathered at a distance.

In this study, ground-truth was carefully done to ascertain the various land use/land cover types physically found in the study area so as to insure that the information reflected on the satellite image are true reflections of what is obtainable on the ground.

iv. Calculation of area in square of the resulting land use/land cover types

To calculate the area in km2 of the resulting land use/land cover types for each study year, a table was developed showing the area in km2 and the percentage for each year (1988, 1999 and 2006) measured against each land use/land cover type. The percentage change was calculated by dividing observed change by the sum of changes multiply by 100.

$$\text{Percentage change} = \frac{\text{observed change} \times 100}{\text{Sum of change (Opeyemi 2006)}} \quad (1)$$

Change matrix

To determine the intra changes among LULC types, changes among the six LULC types were assessed by determining the conversion of one land use/land cover type to another r(i.e, loss and gain in area km^2) among the six LULC types using LULC change matrix.

RESULT AND DISCUSSION

CLASSIFICATION OF LAND USE/ LAND COVER TYPES IN JALINGO, 1988-2006

A total of six land use / land cover (LULC) types were classified in the study area namely bareland (comprising of bare surfaces), built- up (comprising of roads, highways, buildings, and other paved surfaces), cultivation, (Comprising of cultivated farmlands), shrubland (comprising of grass and shrubs), water body (comprising of rivers, streams, open reservoir), and wetland (comprising of marshes). The LULC types in Jalingo are presented in table1 and figures 2 and 4.

In 1988, cultivation has the largest area of 171.35 km^2, representing 80.8%of the study area. Bareland occupied 7.38 km^2 representing 3.40%, while built-up has 8.95km^2, shrubland has 18.47km^2 representing 3.7%. Water body occupied 3.72km^2 representing 1.7%. Wetlands, on the other hand occupy 9.31km^2 representing 4.3% of the study area.

Table 1: Classification of land use/ land cover in Jlingo 1988, 1999 and 2006

LULC Types	1988 Area(km^2)	%	1999 Area (km^2)	%	2006 Area(km^2)	%
Bareland	7.38	3.40	0.97	0.4	6.3	2.9
Built-up	8.95	3.7	16.77	7.9	27.11	12.7
Cultivation	171.35	80.8	134.13	63.2	132.33	62.7
Shrubland	18.47	8.7	22.03	10.3	40.18	18.9
Water body	3.72	1.7	5.44	2.5	5.72	2.6
Wetland	9.31	4.3	40.24	18.9	7.54	3.5
TOTAL	219.18	100	219.18	100	219.18	100

Source: Author's research work

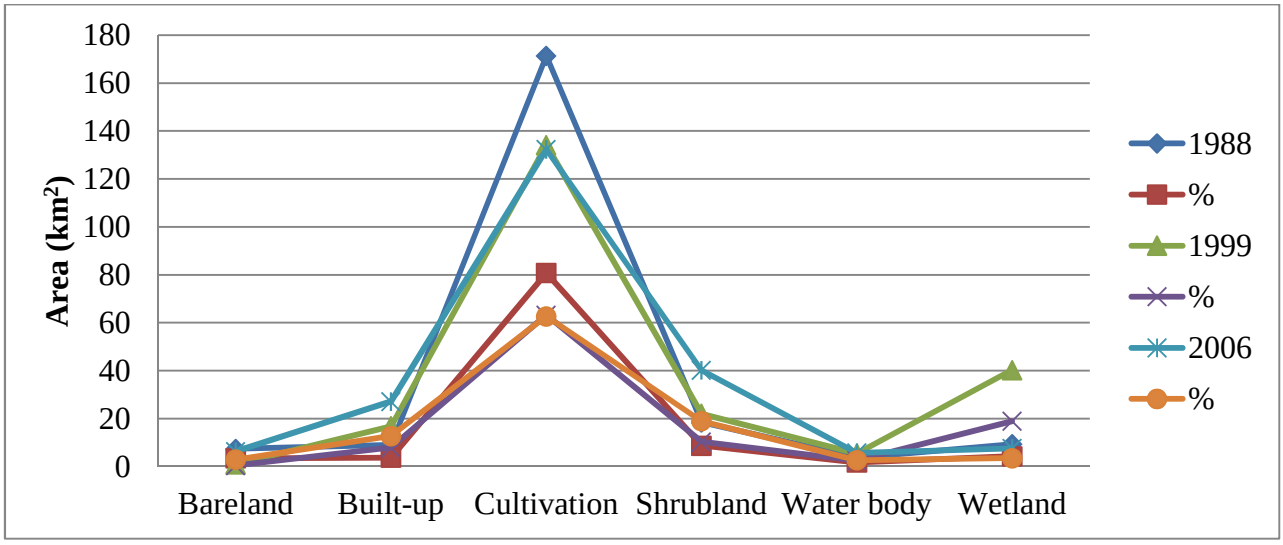


Figure 1: Graphical representation of table 4.2.1 above

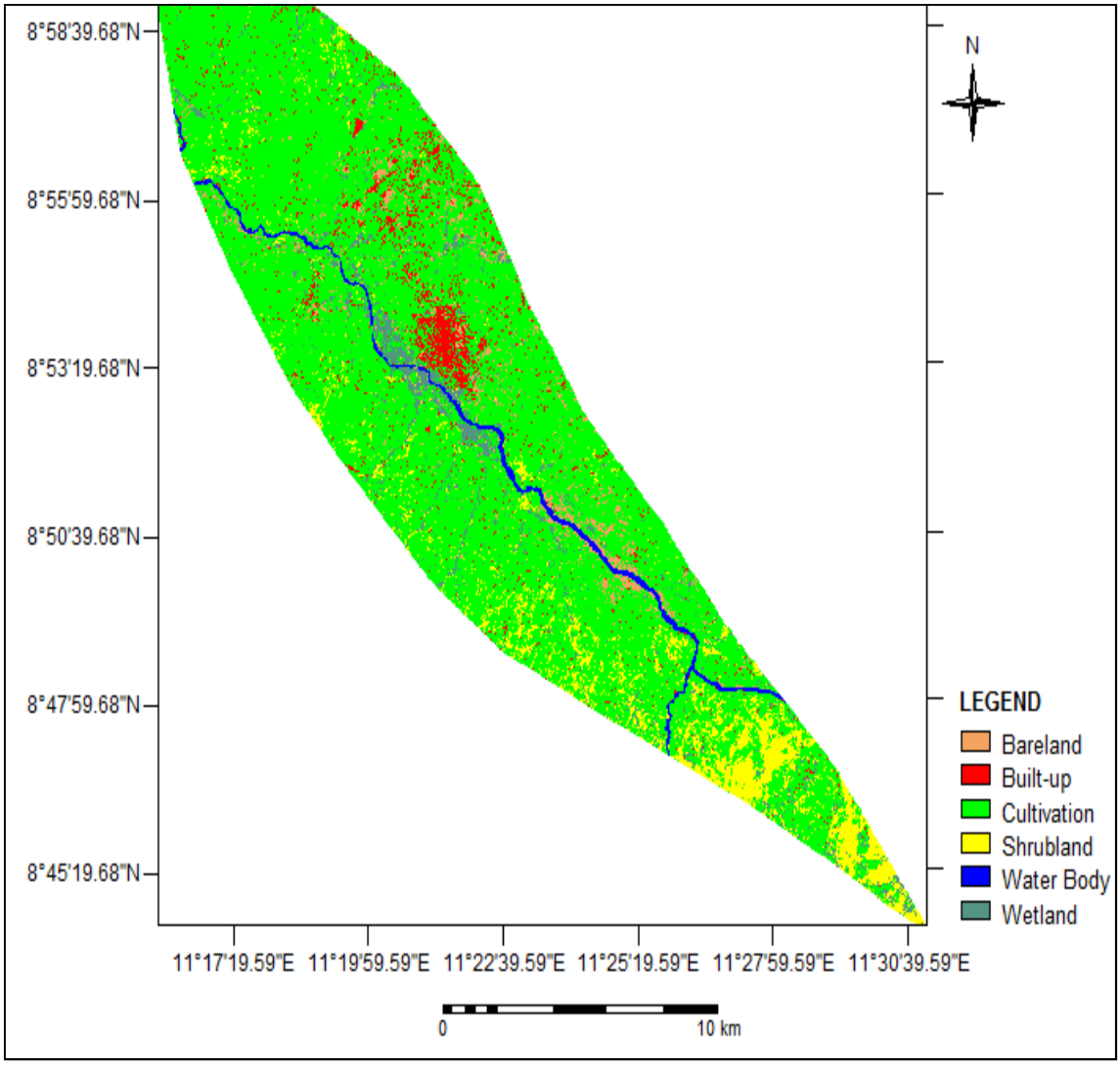


Figure 2: Land use/land cover in Jalingo, 1988.

Cultivation and bareland have the largest and least areas of 134.13km^2 and 0.97km^2 in 1999, representing 63.2% and 0.4% of the study area respectively. Built-up has 16.77 representing 7.9, while shrubland and water body have 22.03km^2 and 5.44km representing 10.3% and 2.5% of the study area respectively. Last but not the least, wetland occupy 40.24km^2, representing 18.9% (table 4.2.1 and figure 4.2.3).

In 2006, cultivation and water body still have the largest and least areas of 132.33km^2 and 5.72km^2, representing 62.3% and 2.6% of the study area respectively. Bareland and built-up occupy 6.3km^2 and 27.11km^2, representing 2.9% and 12.7% respectively. Shrubland and wetland on the other hand, have 40.18km^2 and 7.5km^2, representing 18.8% and 3.5% respectively (table 1 and figure 2).

The high percentage of bareland area in 1988 may be unconnected to the fact that then Jalingo was just a local government headquarter and hence less economic activities. Built- up was less in 1988 with only 3.7% of the study area. This may also be attributed to the same reason stated above. Cultivation in 1988 recorded the highest percentage of land area in Jalingo with 80.8%. This was because at that time Jalingo was more of a rural setting where farming is the main occupation of the populates. The low percentage of shrubland in Jalingo in 1988 could be attributed to the long period of drought witnessed that year. The drought affected the growth of grasses and shrubs in the area. Water body recorded the lowest percentage of land area in 1988 compared to other study years. It could be remembered that 1988 was a drought year in that part of the country. This could be responsible for the low percentage of water body observed that year. Wetland also has the lowest percentage of land area in 1988 compared to other study years. This may still be due to the long period of drought experienced that year.

In 1999, bareland reduced to 0.4% of the total land area in the study area. This was due to the expansion in size of the town. Jalingo was made state capital in 1991 and this of course, has influenced the growth of the town both in terms of population and city size. More bare lands were taken over by buildings and other economic activities as a result of the population growth. The percentage of built-up area in the study area increased to 7.9% in 1999 after the town had been made state capital in 1991. This was due to the boom in population of the town and the increase in economic and industrial activities. The percentage of cultivated land on the other hand decreased to 63.2% in 1999. This may be due to the fact that most of theagricultural land were bought over and converted to other economic uses to accommodate the increasing population. Apart from this, most of the people who got jobs with the state government then abandoned their farming occupation for civil service. Shrubland, in 1999 increased to 10.3%. This may be as a result of disengagement of many people from agriculture to other sector of the economy and the abandoned farmlands gradually turned to shrubland as time went on. In 1999, water body also increased to 2.5% as against 1.7% in 1988. This was due to the restoration of the rainfall being experienced in the area. Wetland also witnessed an increased in percentage of land area compared to 1988. This, the researcher believes was due to the restoration of the usual amount of rainfall of 1,500mm annually.

In 2006, however, bareland increased to 2.9% compared to 0.4% recorded in 1999. This may be as a result of bush burning and cutting down of shrubs for fuel. There was a dramatic increase in percentage of built-up area from 7.9% in 1999 to 12.7% in 2006. This attests to the fact that the government of Reverend Joly Nyame at that time embarked on city decongestion campaign in order to decongest the city centre. This, he did by building several housing estates in the outskirt of the town, relocation of giant projects such as the games village, specialist hospital and the air port to the outskirt of the town. Apart from all these, there was also increase in economic activities by private and corporate bodies in Jalingo town which resulted in the increase in built-up area. Cultivation in 2006 further decreased to 62.3% which shows more and more agricultural lands had been converted to built- up and other purposes. Also at this time, the city had started moving away from the traditional setting where farming seems to form the basis for living. The improvement in the welfare of workers could also attest to this as people are now engaging in other sectors of the economy which are more benefiting than farming. Another increase in shrubland was witnessed in 2006 with 18.9%. The same reason as in year 1999 above could be responsible for this. Water body, in 2006 witnessed an insignificant increase in the percentage of land area covered. The area had 2.6% of water body as against 2.5% obtained in 1999. This shows the annual rainfall of about 1,500mm usually witnessed in the area was maintained within the periods of 1999 and 2006. In 2006 however, the percentage of wetland in Jalingo reduced to 3.5%. This may be due to encroachment into the wetland areas as a result of population growth. Most of the wetlands, especially the ones around Mayo-Goi have been taken over by buildings while some parts of it have been converted to farmland for cultivation of crops such as rice and sugarcane. This may be the root cause of the serious floods that occurred in the area in the recent years.

CHANGE MATRIX AMONG LAND USE/LAND COVER TYPES

Changes among the six LULC types were assessed by determining the conversion of one land use/land cover type to another (i.e, lose and gain in area km^2) among the six LULC types using LULC change matrix. Since the concern in this research work is to determine the impact of built-up on other land use/land cover types, the researchers only focused on the losses of the other LULC types to built-up.

Cultivation, from 1988-2006, recorded the highest loss to built-up. It lost 19.22km^2, representing 71% to built-up. This, as earlier said, was due to the population boom in Jalingo after it was made state capital in 1991. Water body, on the other hand, had the least loss of 0.15km^2, representing 0.6% to built-up.

Table 1: Land use/land cover change matrix

LULC Types	Bareland (km^2)	Built-up (km^2)	Cultivati-on (km^2)	Shrub-land (km^2)	Water body (km^2)	Wetland (km^2)	Total loss (1988)
Bareland	0.65	1.53	4.41	1.47	1.21	0.90	10.17
Built-up	1.62	4.50	3.17	0.91	0.62	0.82	11.64
Cultivation	5.61	19.22	112.13	26.31	2.26	4.49	170.02
Shrubland	0.24	0.22	7.81	10.21	0.42	1.44	20.34
Water Body	0.22	0.15	1.70	0.17	3.35	0.87	6.46
Wetland	0.44	1.64	4.46	2.30	0.26	2.26	11.36
Total gain (2006)	12.58	27.26	133.68	41.37	8.12	10.78	233.79

Source: Author's research work.

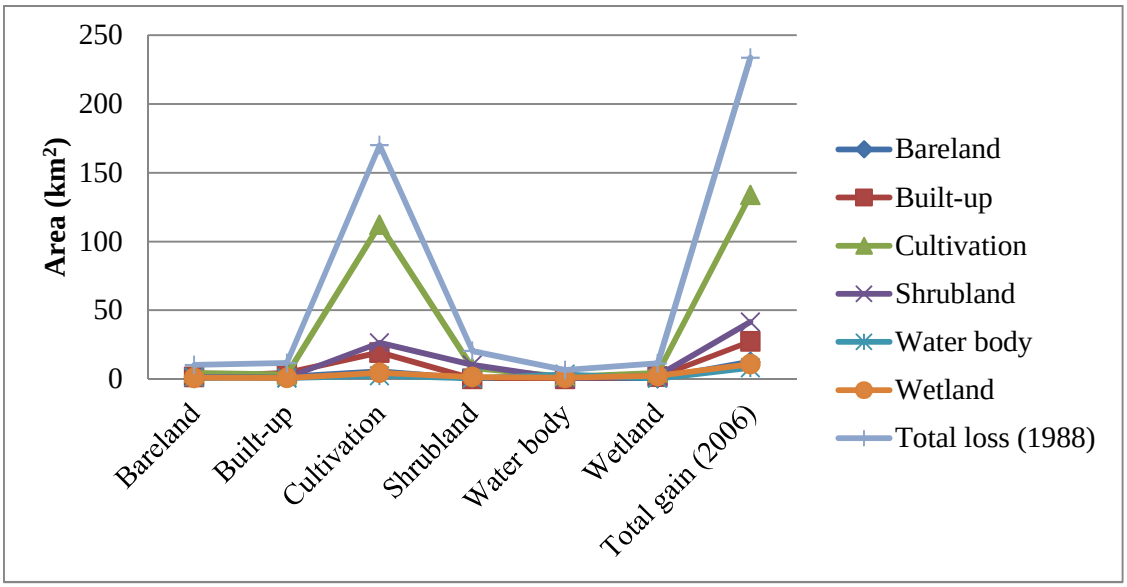


Figure 3: Graphical representation of the table 1 above.

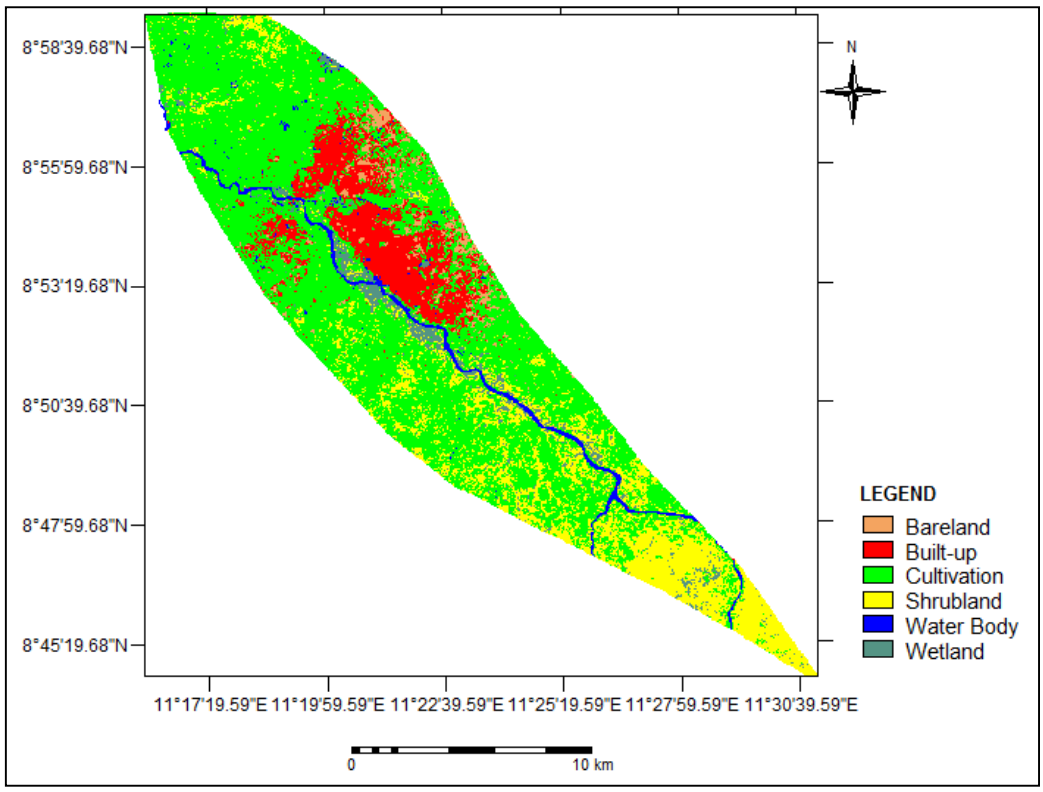


Figure 4. Land use/ land cover in Jalingo, 2006.

Bareland lost 1.53km^2, representing 5.6% to built-up within the study years. While shrubland lost 0.22km^2, representing 0.81%. Next to cultivation in the order of loss is the wetland which lost 1.64km^2, representing 6.0% to built-up. The reason for this, as advanced earlier was as a result of encroachment into the wetland in the study area. Large portion of the wetland was drained, refilled and taken over by buildings to accommodate the teaming population of the town.

CONCLUSION

This research work was carried out to determine the change matrix between land use/land cover(LULC) types in Jalingo town. The research was objectively done and the results proved that expansion in size of the town is the main cause of LULC change in Jalingo town within the period of 1988 and 2006.

The researchers therefore, call for more researches to be carried out in this area so as to come out with more recommendations to proffer better solutions to the problems of urbanization on LULC types in Jalingo town and Nigeria in general.

RECOMMENDATIONS

Having determined the change matrix in LULC types due to urbanization in Jalingo, the researchers hereby recommend the following measures to mitigate the impacts.

Development along flood plain, drainage channels, infrastructure easements and flood prone areas should be avoided. Development Control Authorities (e.g Town Planning and Capital Cities Development Authorities) should enter into partnership with private sectors to ensure that physical development legislations are strictly adhered to by developers.

There is need for appropriate legislations to be put in place to check indiscriminate sprawling. The relevant regulatory institutions and agencies should be empowered to monitor the level of compliance and met out appropriate sanctions.

Researches have shown that the best general way to protect areas of high diversity threatened by urbanization is to purchase those areas specifically for the purpose of conservation (Luck et al, 2004). Combating the threat of urbanization on surrounding land use/land cover is one of the greatest challenges facing conservationists and ecologists. It demands a thorough and often complicated process in which areas of high priority are identified, assessed, and either conserved or restored. These are the first steps in limiting the many ecological disturbances already caused by growing urbanization. Taking a more proactive stance towards conservation right now and in the near future, however, is the only way to assure those future generations in the services of nature we often take for granted.

With the above given recommendations, the researchers believe the impacts of urbanization on LULC will be mitigated if strictly adhered to.

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Influence of Drought Duration on Livestock Feeding Practices by Maasai Pastoralists in Kajiado County, Kenya

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ABSTRACT: Droughts manifested in the changes in frequency, duration and changes in rainfall patterns directly impact on livestock assets of pastoral households of which Maasai community in Kajiado County of Kenya exemplifies. The community is seasonally exposed to drought effects and has adjusted their livestock feeding practices to cope but knowledge gaps exists as to whether the adjusted feeding practices adequately aligns to the magnitude of change experienced, This study established the influence of drought duration on livestock feeding practices from sample of 136 households, selected using simple random sampling procedure. A large majority of the sampled households had noticed changes in the frequency of droughts (98.5 %), increased drought duration (97.8%), unpredictable onset and patterns of rains (99.3%) and longer droughts lasting 7 to 12 months on average. Despite noticing increased trends of changing and variable climate, a large majority of the sample households (87.5%) continues with traditional herd mobility in coping with drought effects and limited uptake of supplementary feeding, demonstrating non uptake of planned adaptation strategies, which poses threats to livestock assets of pastoral community. Urgent interventions is therefore advised for the Maasai community to include introduction and promotion of harvesting and storing natural hay for drought feeding, use of drought tolerant livestock breeds, targeted livestock off-take to reduce economic losses and construction of watering facilities in the area and regular desilting of existing water pans to ensure adequate water harvesting during the rains for watering livestock during drought periods.

KEYWORDS: Drought feeding, Climate variability, Herd mobility, Maasai community.

1 BACKGROUND

The Arid and Semi Arid Lands (ASALs) in Kenya are characterized by low rainfall amounts with erratic and unreliable timing associated with recurring droughts. Climate change is worsening drought effects, manifested in drying up of water pans supporting livestock assets managed under production system, characterized by mobility and flexibility to counter extreme environmental fluctuations. Although drought affects the country as a whole, its effects is felt most dramatically by the livestock based economies and livelihoods in the Kenyan ASAL areas ([28]).

Droughts in the ASALs has three distinguishing features: intensity, duration and spatial coverage ([26]) and does directly impact on the livestock assets of pastoral households [28]. According to ([12]), recurrent drought and climate change have over the years put additional strains on the already limited livelihood resources in the ASALs predominantly occupied by pastoralist and mobile communities. ([9]) reports that drought in Kenya has been the most common hazard encountered by households on a widespread level in ASAL areas where the government has declared five drought related national disasters between 1993 and 2011.

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Drought variability affects pastoralism by reducing carrying capacity of rangelands inducing changes in plant species compositions favourable to less palatable species and reducing availability of water for livestock use ([2]). Drought diminishes the primary production of crops and rangeland vegetation and the secondary production of livestock which depends on primary production ([3]).

Climate variability and traditional adaptation strategies have long been part of pastoral production systems. However, convergence of unprecedented levels of land use change coupled with increasing climate uncertainty is eroding the resilience of ecological and social systems alike ([19]). Hartmann and Sugulle (2009) reports that traditional knowledge and information systems have a prominent role in rangeland and livestock management because it is sensitive and comprehensive and can be adapted to changing conditions. Pastoralists can tell the change in droughts, rainfall patterns, distribution and intensity when comparing the present and the past.

Drought variability attributed to climate change has put sustainability of pastoralism which is the main livelihood for the Maasai community in Kajiado County under threat ([11])). The community has in the past developed elaborate traditional knowledge, natural resource management practices and cultural rituals ([13])). However, now more than ever the Maasai community is facing serious challenges such as diminishing natural resource base impacting on food security and poverty which are attributable to drought variability ([21]). The Maasai community has reported noticing changes in plant species composition with some plant species increasing while others declined. Working with the community, ([5])) noted that reduction in species composition and diversity was as a result of drought variability and not over grazing *per se*. This paper examined the influence of duration of droughts on livestock feeding practices of the Maasai pastoralists.

STUDY AREA

The study was conducted in Mailwa sub-location in Kajiado County, purposely selected because it is an ASAL area inhabited by Maasai pastoralists still practicing pastoralism in the face of challenges posed by drought variability, experiencing increased sub-division of communal grazing areas and immigration of other communities in search of land for settlement. The pastoralists keep mainly cattle, sheep and goats, camels and donkeys. The average annual rainfall ranges between 500 mm to 1250 mm. The rainfall pattern is bimodal with short rains between October and December; and long rains between March and May. The average annual potential evapotranspiration ranges from 1600 to 2200 mm which means that for the greater parts of the year there is a moisture deficit. Mailwa sub-location has a population of 2,130 and 437 households. The vegetation cover is open grassland, wooded grassland and bushed grassland. Wood and bush land makes this area suitable for pastoralism.

2 METHODS

DATA COLLECTION

A cross-sectional survey was conducted in August 2013 in Mailwa sub-location of Kajiado County which was purposively selected because the area is inhabited mainly by Maasai who practice pure pastoralism. The study targeted 437 household heads (295 male and 142 female). Proportionate simple random sampling was used to ensure representation of both male and female household heads were included in the sample. A sample size 136 household heads consisting of 92 males and 44 females were selected. Interviews were conducted on each sampled household and responses entered in the interview schedule. Data collected through the survey indicated changes in duration of drought in the area over a period of 10-20 years.

DATA ANALYSIS

Data on changes in the duration of droughts as experienced by the sampled households was cross tabulated and association between feeding practices and experienced drought related events tested with Chi-square test statistics

3 RESULTS AND DISCUSSION

DROUGHT OCCURRENCES EXPERIENCED

These findings of this study indicate that pastoralists were consciously aware of the period droughts lasted in the area. For instance, a majority (97.8%) reported having noticed changes in the duration of droughts within the last 10 to 20 years,

and for a large majority (72.8 %), droughts lasts for a period of six months to one year (Table 1). Therefore, pastoral communities in the area are affected by chronic water shortages. This observation is similar to that reported by ([26]) who indicated that duration is an essential characteristic of drought where it can develop quickly and become established from where it can persist for months or years. This situation is aggravated by rising average global surface temperatures ([10])). These changes according to ([27]) are likely to result in extreme weather events like prolonged droughts.

Associated with the duration of drought was the severity for which about half of the sample (48.5%) attributed to scarcity of water for livestock and availability of pasture (42.6%). This community considered water availability for livestock a more important indicator of severity of droughts than availability of pastures, which may be explained by heavy reliance of water pans for livestock in the area during the wet season and the combined effects of high evaporation rates and siltation that dry up the pans very fast at the onset of drought. ([1])) reported that ASAL areas are prone to prolonged drought which results in the drying up of seasonal water sources.

Table 1. Occurrence, Duration and Indicators of Last Severe Drought in Mailwa Sub-location.

	Frequency	Percent
When last severe droughts occurred		
2008 – 2009	47	34.6
2008- 2010	21	15.4
2009- 2010	4	2.9
2009- 2011	64	47.1
Trend in drought duration		
0 - 6 months	32	23.5
7 - 12 months	99	72.8
13 - 18 months	4	2.9
19- 24 months	1	.7
Indicator of severity of droughts		
Number of dry months	3	2.2
Number of livestock deaths	9	6.6
Availability of pasture	58	42.6
Scarcity of water for livestock	66	48.5
Total	136	100.0

Ability of the pastoralists to recall when the last major drought in the area occurred, where they moved their livestock to in coping response and the distance covered in search of pasture and water was considered important for this study. The results reflect that about half of the sample households (47.1%) remember the last major drought to have occurred during the period 2009 to 2011. Livestock is grazed within the sub-location during the wet season but when drought sets in the area, pastoralists move their livestock in search of pasture and water to neighbouring group ranches, national parks, and other parts of the country and to the neighbouring Tanzania. About half of the sampled household (44.1%) indicated moving their livestock to neighbouring locations in Tanzania, but avoid national parks which are protected areas. This observation is in line with ([17]) view that despite changes in land tenure in Kajiado, traditional herd mobility patterns were used as a coping strategy to the severe la Nina induced drought.

INFLUENCE OF DROUGHT ON LIVESTOCK FEEDING PRACTICES

The distance covered in search of pasture and water during the period of severe drought for most of the pastoralists (92.6%) was in excess of 100 Km(Table 2) from the homesteads implying that livestock movement in search of pasture and water remains the most coping strategy for drought in the study area when livestock feeding is a challenge. Results showed duration of severe droughts, distance covered during droughts and availability of water for livestock use significantly ($p < 0.05$) influenced livestock feeding practices and is attributed to prolonged drought experienced in the area which is an observation consistent with those of ([4]). The author reported that the number, distribution and productivity of permanent

pastures and water points, which are critical for livestock survival during the dry season, are on decline. In the absence of supplementary feeding, pastoralists in this area solely relied on natural pasture to feed their livestock. Therefore how long the droughts persisted impacts on the availability of pastures and water which in turn influence movement of livestock to other areas.

Kajiado County is one the most affected counties by the high rates of mortality with an overall livestock mortality rate of 25-40 per cent. The livestock economy is the most affected, since livestock body condition deteriorates due to the decline in pasture and the long distance trekking to water sources up to an average distance of 100 km during the dry spells ([6]). ([15]) confirms that the costs of the 1998/2000 drought were estimated at US$2.8 billion where in some regions, up to one third of all livestock perished due to drought. ([22]) adds that, when the probability of drought increases to once every three years, herd sizes decreases as a result of increased mortality and poorer reproductive performance. This decrease in livestock numbers affect food security and compromise the sole dependence of pastoralists on animals and their products, as well as the additional benefits they confer. Droughts in East Africa's dry lands are becoming more frequent Water is an important component of livestock feed. Availability of water for livestock is affected by the duration of drought. This is in line with ([20]) who reported that water and pastures are critical for pastoral livelihoods which are characterized by frequent movements in search of water and feed during the long periods of scarcity. ([7]) also observed that with no reliable supplies of permanent water, pastoralists adapt to an increasingly arid and unpredictable environment by moving livestock according to the shifting availability of water and pasture.

When asked to indicate sources of water for their livestock during both the drought and rainy season, all identified water pans and boreholes for livestock during the rains and dry seasons but all water pans dry up during periods of drought and use of boreholes becomes important to provide water for livestock use. However, there are only two boreholes in the area, unable to stand the pressure and now face the risks of depletion of pastures and water. ([28]) observed that ASAL areas are adversely affected by drought and the worsening effects of climate change leading to drying up of water pans. Similar view was expressed by ([8]) who reported that pastoral systems operate in dry lands, where access to water is a limiting factor when determining herd sizes for many individuals and communities in times of drought. During periods of drought, there is insufficient supply of water to meet demand resulting in the drying of water-holes, the disruption of natural water flows and siltation of pans.

In this study, sampled households indicated pasture species disappearance during periods of prolonged droughts of which a large majority (89.5%) identified *erikaru* (*digitaria macroblephara*) to have had the greatest reduction in proportion (Table 2). The disappearance of erikaru (digitaria macroblephara) show that it is a preferred pasture for livestock, but there is a trend towards altering pasture composition leading to reduction of the most palatable ones, a situation that may cause even to move frequently and longer movement of livestock. For instance, recent studies have suggested that there is likely to be an increase in browse species as a result of increased browse in the range lands ([16]). This change in range land species composition will have a significant influence on the type of animal species that can be kept by communities that rely on the range land. A similar view is held by ([18) who reported that the Maasai community had noted changes in plant species composition where some key species had declined. This is also similar to ([5]) observation that the Maasai community attributed reduction in species composition and diversity to drought variability as consecutive droughts and seasonal rains did not allow pasture to reach flowering and hence a reduction in biomass. (14) reported that in Kajiado, there was an emergence of unpalatable species that included *Ipomoea kituiensis*, *I. hildebrandtii*, *Astripomoea hyocyamoides*, *Solanum incanum*, *S. arundo*, *Gnidia latifolia* and *Acacia stuhlmannii.* This conforms to what was reported by ([25]) that due to climate change, pasture quality and quantity will be affected. Decrease in grasslands due to increases in tropical woody vegetation could reduce options for accessing dry season feeding resources. The author reported that the number, distribution and productivity of permanent pastures and water points, which are critical for livestock survival during the dry season, are on decline. In the absence of supplementary feeding, pastoralists in this area solely relied on natural pasture to feed their livestock. Therefore how long the droughts persisted impacts on the availability of pastures and water which in turn influence movement of livestock to other areas.

Table 2. Grazing Areas, Distance Covered and Pastures that Disappear During Severe Drought in Mailwa Sub-location.

	Frequency	Percent
Grazing areas moved to during severe droughts		
In other group ranches within Kajiado County	30	22.1
In national parks	14	10.3
In areas outside Kajiado County	32	23.5
Tanzania	60	44.1
Distance covered for grazing and water searching		
41 – 60 Km	1	.7
61 – 80 Km	1	.7
81 - 100 Km	8	5.9
More than 100 Km	126	92.6
Pasture species disappearing during severe drought		
Erikaru digitaria macroblephara	122	89.5
Enkopuru - chloris roxbhurgiana	14	10.3
Total	136	100.0

During periods of drought, there is insufficient supply of water to meet demand resulting in the drying of water-holes, the disruption of natural water flows and siltation of pans. This is similar to what was reported by ([23]) indicating that availability of water resources in both quantity and quality in Kenya has been decreasing over time as a result of persistent droughts and land-use patterns and the situation is expected to worsen due to rainfall variability and increased evaporation due to higher temperatures. The impacts are largely felt in the marginal rainfall areas of the country. This is view is reinforced by ([24]) who reported that the high number of emergency water trucking interventions carried out during the 2008-9 droughts in ASALs was an indicator that there was inadequate water in arid districts to meet the needs of vulnerable households and their livestock. There are still parts of the rangelands of Kenya that lack the necessary water resources for their basic needs, whether in terms of quantity or quality or both. Demographic growth is likely to increase pressures for the development of water resources and further exploitation of existing ones. ([7]) observed that with no reliable supplies of permanent water, pastoralists adapt to an increasingly arid and unpredictable environment by moving livestock according to the shifting availability of water and pasture.

This study tried to determine the influence of duration of droughts on livestock feeding practices among the pastoralists in Mailwa sub-location, Kajiado County.

4 CONCLUSIONS

Maasai community is continuing with traditional herd mobility in coping with drought effects with limited uptake of supplementary feeding practices with commercial feeds and hay. This demonstrates non uptake of planned adaptation strategies, which poses threats to livestock assets of this pastoral community and should attract attention of the development agencies in planned intervention including introduction and promotion of harvesting and storage of natural hay for drought feeding, use of drought tolerant livestock breeds, targeted livestock off-take to reduce economic losses and construction of watering facilities in the area. Regular desilting of existing water pans is a necessary accompanying intervention to increase the volume of water harvested during the rains for watering livestock during prolonged periods of drought.

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

The work was a component of a wider Masters study for JMG. KSM and BOB were University supervisors of the candidate. JMG, KSM and BOB made substantial contributions to the work from conception through data collection, analysis, drafting and revising the manuscript. All authors read and approved the final manuscript.

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JMG is a Masters student and an agriculture extension officer in Nakuru County, Kenya. KSM is a community development specialist at the Department of Applied Community Studies, Egerton University, Njoro, Kenya. BOB is a livestock production systems specialist at the Department of Animal Science, Egerton University, Njoro, Kenya.

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Effect of EDTA-Urea Peroxide combination at different time periods on smear layer and root dentin surface: A SEM study

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ABSTRACT: *Aim* - To evaluate the effect of EDTA-Urea peroxide combination on smear layer and root dentin surface at different time intervals.
Methodology - 24 specimens were prepared from 12 freshly extracted non carious intact human maxillary central incisors. These 24 specimens were randomly divided into 2 groups. Group-A: Control group having 4 specimens. Group-B (15% EDTA-10% Urea peroxide combination) 20 specimens – samples were divided (3 minutes, 6 minutes, 9 minutes and 12 minutes) into four subgroups of 5 specimens each. The specimens were examined under SEM. The presence of smear layer and erosion of dentinal surface was evaluated using a four step scoring criteria. Mean scores were calculated & statistically analyzed for significance ($p<0.01$) using Student's unpaired 't' test.
Result - 12 minutes of application of EDTA-Urea peroxide combination (Group B) caused severe erosion with incomplete removal of the smear layer.
Conclusion - Within the limitation of the present study, EDTA-Urea peroxide combination (Group B) when used for 12 minutes, cannot remove the smear layer completely, but caused severe erosion of dentinal surface.

KEYWORDS: EDTA, Urea peroxide, Cleaning & Shaping, Smear layer, SEM.

1 INTRODUCTION

When root canals are instrumented during endodontic therapy, a layer of material composed of dentin, remnants of pulp tissue and odontoblastic processes and sometimes bacteria are also formed on the canal walls. This layer is called as the **"smear layer".**[1-3] The presence of smear layer on root canal walls was first reported by McComb and Smith (1975).[4] The removal of smear layer is necessary to achieve disinfection of the root canal system, by deeper penetration of the root canal

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medicaments and irrigants. It also allows greater penetration of the root canal sealers into the dentinal tubule openings aiding in an intimate adaptation of the obturating materials with the prepared canal walls.[1-3, 5-9]

Over the years various chemical agents like Sodium hypochlorite (0.5% to 5.25%), Urea peroxide, Hydrogen peroxide, Organic acids like Citric acid (6%, 10%, 50%), Chelating agents like EDTA at 15-17% have been used to remove the smear layer. However none of the above is totally effective or has received universal acceptance for eradicating smear layer. EDTA and NaOCl combination is the most tried and tested combination during the chemico-mechanical preparation of root canals to disinfect the canal, to lubricate the canal and to remove the smear layer. [7] Another documented reagent for removing the smear layer is EDTA-Urea peroxide combination which is a potent bactericidal agent and increases the permeability of dentin significantly. [10, 11]

This study attempts to assess the effect of EDTA-Urea peroxide combination at various time periods, on the smear layer and root dentin surface.

2 AIM & OBJECTIVES

The aim of the study was to evaluate the effect of EDTA-Urea peroxide combination on smear layer and root dentin surface at different time intervals

The objectives of the study were:

i) To evaluate the efficiency of EDTA-Urea peroxide combination in removing smear layer from the root canal walls at 3 minutes, 6 minutes, 9 minutes and 12 minutes of application.
ii) To evaluate the effect of EDTA-Urea peroxide combination on root dentin surface at 3 minutes, 6 minutes, 9 minutes and 12 minutes of application.

3 MATERIAL & METHOD

3.1 MATERIALS

i) Twelve freshly extracted non-carious intact human maxillary central incisors.
ii) Normal saline (0.9 % w/v, Nirma Ltd., India).
iii) 15 % EDTA-10 % Urea peroxide gel (RC-Prep, Premier Dental Products Co, King of Prussia, PA).
iv) Scanning Electron Microscope (JSM 6360 – JEOL Ltd. Tokyo JAPAN).

3.2 METHOD

Twelve freshly extracted non carious intact human maxillary central incisors with single canals were chosen. Endodontic access cavity was prepared using # 012 round diamond point and # 017 non-end cutting tapered fissure. Root canals were instrumented with H and K files upto # 70, using step-back technique. Intermittent copious irrigation using normal saline solution was done. The teeth were cut at cemento-enamel junction, to separate the roots from the crowns using diamond disc on micromotor contrangle handpiece. Each root was then cut longitudinally into two halves, thus resulting in 24 hemisections. These 24 specimens were randomly divided into 2 groups as follows:-

Group-A: Control group having 4 specimens which were not treated with any test solutions.

Group-B: 20 specimens – the exposed dentin of the root canals were treated with 15% EDTA-10% Urea peroxide combination. Samples were divided into four subgroups of 5 specimens each. The combination gel was kept on each specimen for 3 minutes, 6 minutes, 9 minutes and 12 minutes respectively.

Once stipulated time was over for each of the subgroup, the specimens were washed with 10 ml of normal saline and air-dried. The specimens were now ready for viewing under a SEM.

The photomicrographs were evaluated by five observers in a blind manner, as per the following scoring criteria:

For smear layer-

- **0** – No smear layer seen with all the dentinal tubules opened (100% distinguishable tubular outline).
- **1** – Little smear layer seen with more than 50 % distinguishable tubular outline.

- **2** – Moderate smear layer seen with less than 50 % distinguishable tubular outline or with more than 50 % indistinguishable tubular outline.
- **3** – Heavy smear layer seen with indistinguishable tubular outline.

For erosion of root dentin surface

- **0** – No erosion of dentinal surface.
- **1** – Little erosion of dentinal surface not involving more than 50 % of the surface.
- **2** – Moderate erosion of dentinal surface involving more than 50 %, but not the entire surface.
- **3** – Severe erosion of dentinal surface involving almost entire surface.

The data was analyzed statistically using **Student's unpaired 't' test.**

4 RESULTS

The results of this study can be summarized as follows:

i) Group A: Normal saline was unable to remove the smear layer (mean score-3). Heavy smear layer was noted in all the specimens (Figure 1).

ii) Group B:

- EDTA-Urea peroxide combination was unable to remove smear layer when used for 3 minutes (Figure 2.A) and 6 minutes (Figure 2.B). All the samples showed presence of heavy smear layer (mean scores-3).
- EDTA-Urea peroxide combination when used for 9 minutes (Figure 2.C), partially removed smear layer but major part of dentinal surface was covered with smear layer (mean score-2) with mild erosion (mean score-1).
- EDTA-Urea peroxide combination when used for 12 minutes (Figure 2.D), smear layer was partially removed with only some part of dentinal surface still covered by smear layer (mean score-1). It also caused severe erosion of dentinal surface, making the surface irregular (mean score-3).

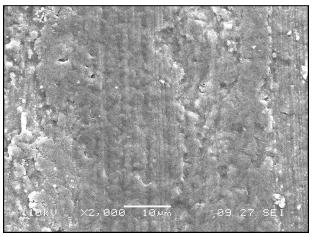


Figure 1: Exposed dentin of the root canals when treated with normal saline

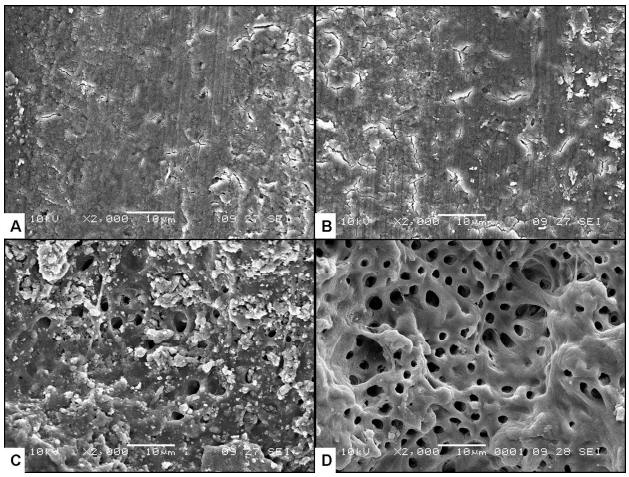


Figure 2: Exposed dentin of the root canals when treated with EDTA-Urea peroxide combination for 3 minutes (A), 6 minutes (B), 9 minutes (C), 12 minutes (D).

Table-1. Comparison of the observations of EDTA-Urea peroxide combination (Group B) on removal of smear layer at various time intervals

Time (mean scores)	't' value	'p' value	Result
3 mins (3 ± 0.0) Vs 6 mins (3 ± 0.0)	0	p>0.05	Not significant
3 mins (3 ± 0.0) Vs 9 mins (2 ± 0.4)	5.73	p<0.01	Highly significant
3 mins (3 ± 0.0) Vs 12 mins (1 ± 0.3)	15.22	p<0.01	Highly significant
6 mins (3 ± 0.0) Vs 9 mins (2 ± 0.4)	5.73	p<0.01	Highly significant
6 mins (3 ± 0.0) Vs 12 mins (1 ± 0.3)	14.92	p<0.01	Highly significant
9 mins (2 ± 0.4) Vs 12 mins (1 ± 0.3)	4.54	p<0.01	Highly significant

Table-2: Comparison of the observations of EDTA-Urea peroxide combination (Group B) on erosion of root surface dentin at various time intervals

Time (mean score)	't' value	'p' value	Result
3 mins (0 ± 0.15) Vs 6 mins (0 ± 0.15)	0	p>0.05	Not significant
3 mins (0 ± 0.15) Vs 9 mins (1 ± 0.8)	2.74	p<0.01	Highly significant
3 mins (0 ± 0.15) Vs 12 mins (3 ± 0.16)	35.71	p<0.01	Highly significant
6 mins (0 ± 0.15) Vs 9 mins (1 ± 0.8)	2.74	p<0.01	Highly significant
6 mins (0 ± 0.15) Vs 12 mins (3 ± 0.16)	35.71	p<0.01	Highly significant
9 mins (1 ± 0.8) Vs 12 mins (3 ± 0.16)	2.77	p<0.01	Highly significant

5 DISCUSSION

Smear layer is a very thin microscopic layer, soluble in acid, hence it is not apparent on routinely processed specimens examined under the light microscope. Therefore samples were viewed under SEM.

SEM was used for the evaluation of samples in this study for the following reasons –

i) With SEM, much higher magnification can be achieved.
ii) It allows simple direct examinations of the specimens.
iii) Details of each specimen can be seen clearly and are well defined.
iv) It has ability to examine large number of samples.

A combination of EDTA and Urea peroxide acts as an effective chelating and irrigating agent for root canals and allowed deeper penetration of the medicament into the dentin (Stewart and colleagues 1969). [11]

Not much research has been carried out on EDTA-Urea peroxide combination. When EDTA-Urea peroxide combination was used for 3 minutes (Figure 2.A) and 6 minutes (Figure 2.B), it showed that homogenous smear layer was present on the canal wall which obliterated the surface of dentinal tubules completely. However when this combination was used for 9 minutes, most of the canal wall was covered by non homogenous smear layer and very few tubular openings with indistinguishable outlines were visible (Figure 2.C).

The combination of EDTA and Urea peroxide when used for 12 minutes, opened most of the tubules (Figure 2.D). But the 12 minutes application of EDTA and Urea peroxide caused the severe deterioration of dentinal surface. This might be the reason for maximum leakage into filled canals as reported by Cooke et al (1976).[12] Deterioration of dentinal surface might be because of residue of RC-Prep which remained on the canals inspite of thorough irrigation and cleansing. This has also been reported by Zubriggen et al (1975).[12] Viscosity of the material may have a role to play.

Thus in this present study it was found that even after 12 minutes of application of EDTA-Urea peroxide combination, smear layer was not removed completely. This finding is in agreement with Rane (1980), who stated that RC-Prep left a smear layer after canal instrumentation rather than removing it.[1]

6 CONCLUSION

From the present study, it is concluded that:

i. Normal saline is unable to remove smear layer.
ii. Smear layer cannot be removed completely, even with 12 minutes using EDTA-Urea peroxide combination (Figure 2.D).
iii. Severe erosive changes on dentinal structure are seen with 12 minutes application of EDTA-Urea peroxide combination (Figure 2.D).

Thus, within the limitation of the present study, EDTA-Urea peroxide combination cannot remove smear layer completely even after 12 minutes of application and it caused severe erosive changes on dentinal surface.

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Forecasting of Sporadic Demand Patterns with Spare Parts

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ABSTRACT: Items with irregular and sporadic demand profiles are frequently tackled by companies, given the necessity of proposing wider and wider mix, along with characteristics of specific market fields (i.e., when spare parts are manufactured and sold). Furthermore, a new company entering into the market is featured by irregular customers' orders. Hence, consistent efforts are spent with the aim of correctly forecasting and managing irregular and sporadic products demand. In this paper, the problem of correctly forecasting customers' orders is analyzed by new method. Specifically, new proposal forecasting method (i.e., CUM modCr Method) for items are empirically analyzed and tested in the case of data coming from the industrial field and characterized by intermittence. Hence, in the conclusions section, new method produces better results than the existing method.

KEYWORDS: Croston's Method; forward coverage; irregular demand; spare part; service parts inventory.

1 INTRODUCTION

In the recent competitive environment, where manufacturing and service companies operate in unstable sectors, managing irregular and sporadic demand patterns represents an increasingly frequent and complex issue. Startup productions, multiechelon supply chains or spare parts production, and selling are some examples of market fields characterized by intermittent demand profiles.

Accurate forecasting of demand is one of the most important aspects in inventory management. However, the characteristic of spare parts makes this procedure especially difficult. Up to now, Croston's method is the most widely used approach for irregular demand forecasting.

This paper studies and compares different forecasting techniques. Levén and Segerstedt (2004) suggested a modification of the Croston method where a demand rate is directly calculated when a demand has happened. The idea with the modification in Levén and Segerstedt (2004) is that time between demand and demand size is not independent. But this modification has shown poor results. Therefore Wallström and Segerstedt (2010) suggest another modification, "a forward coverage" instead of a "backward coverage".

In this paper suggest another method, cumulative mean of demands. These different techniques are compared with Mean Squared Error (MSE).Using a numerical experiment, show that the new forecasting method is better than the "forward Coverage" (Wallström and Segerstedt (2010) method.

2 LITERATURE REVIEW

A most adopted technique for short-term forecasting is the single exponential smoothing (SES) from Brown (1959, 1962). The limited computational effort and low requirement of memory storage appropriate for yesterdays restricted computer

capacity was an advantage compared to moving averages. The ability for SES to forecast an item when the forecasting time periods often have zero demand, slow moving items or intermittent demands, has been questioned. Croston (1972) presented a method that separates the forecasts in two parts; in time between withdrawals or demand and demand size. The forecasts are updated only when there is a demand. The usefulness of Croston's method is verified by e.g. by Willemain et al (1994). Levén and Segerstedt (2004) suggested a modification of the Croston method where a demand rate is directly calculated when a demand has happened. Syntetos and Boylan (2005) recommended an adjustment of the Croston method due to a systematic error notified by Syntetos and Boylan (2001).

Syntetos and Boylan (2005) recommended an adjustment of the Croston method due to a systematic error notified by Syntetos and Boylan (2001). Levén and Segerstedt (2004) suggested a modification of the Croston method where a demand rate is directly calculated when a demand has happened. The idea with the modification in Levén and Segerstedt (2004) is that time between demand and demand size is not independent. But this modification has shown poor results. Therefore Wallström and Segerstedt (2010) suggest another modification, "a forward coverage" instead of a "backward coverage".

For a literature review about previous studies with similarities to this investigation we refer to Wallström and Segerstedt (2010).

NOTATION

X t	Demand in period t
Xˆ t	Demand forecast in period t
α	Smoothing parameter, value 0-1
β	Smoothing parameter, value 0-1
tn	Time period for the latest demand
tn−1	Time period for the previous demand
tn − tn−1	Inter–demand interval between the latest and previous demand
dˆt	Forecast of the demand rate in period t
N	Number of demand occasions, N ≤ T
X n	Demand in demand occasion n
pˆ t	Estimated probability of demand for period t

3 FORECASTING METHODS

3.1 CROSTON'S METHOD

The Croston method is a forecasting approach that was developed to provide a more accurate estimate for products with intermittent demand.

The Croston method consists of two main steps. First, Croston method calculates the mean demand per period by separately applying exponential smoothing. Second, the mean interval between demands is calculated. This is then used in a form of the model to predict the future demand.

Let Y(t) be the estimate of the mean size of a nonzero demand, let P(t) be the estimate of the mean interval between nonzero demands, and let Q be the time interval since the last nonzero demand.

If X (t) = 0 then
Y(t) = Y(t-1) P(t) = P(t-1)
Q = Q + 1
Else
Y (t) = αX(t) + (1-α)Y(t-1)
P(t)= αQ + (1-α)P(t-1)
Q = 1

The estimate of mean demand per period

$$M(t) = Y(t)/P(t) \quad (1)$$

3.2 MODIFIED CROSTON (MODCR)

Levén and Segerstedt (2004) [3] presented another modification of Croston's idea. Every time there is a demand a new experienced demand rate is calculated. The update occurs when there is a demand, but maximum is once per time unit (e. g. day or working day). If there are several demands during a time unit, the demands are added together. The demand rate is the quotient between the demand and the inter-demand interval:

If X t= 0, then dˆt +1 = dˆt , (2)

If X t ≠ 0 , then $\hat{d}t+1 = \hat{d}t + \alpha \frac{Xn}{tn-tn-1} - \hat{d}t$ (3)

The idea of ModCr is that in many practical occasions the size of the withdrawal or demand is not independent of the time between withdrawals. However this idea has shown unsatisfactory results, overestimation of demand (cf. Boylan and Syntetos (2007), Teunter and Sani (2009) [7], Wallström and Segerstedt (2010)) [8].

3.3 MODIFIED MODIFIED CROSTON (MOD MODCR)

Wallström and Segerstedt (2010) [8] in their tests discovered a difference, between the mean of the different ModCr's demand rates and the mean demand rate for the whole time horizon. This indicated that ModCr is wrongly designed; if the time between demands and demanded quantity not are independent then eq. (5) may model reality better than eq. (3):

If X t= 0 , then dˆt +1 = dˆt , (4)

If X t ≠ 0 , then $\hat{d}t+1 = \hat{d}t + \alpha \frac{Xn-1}{tn-tn-1} - \hat{d}t$ (5)

If time between demands and demanded quantity are independent then a construction like equation (3) or (5) is of less important; but if they are dependent the construction is crucial. Eq. (3) makes an assumption of a "backward coverage", the new demand, or withdrawal, covers a demand that has already been experienced, but eq. (5) Assumes that the current withdrawal, or demand, will cover demand until the next withdrawal, a "forward coverage".

3.4 CUM MODIFIED MODIFIED CROSTON (MA MOD MODCR)

The proposal method has been calculated by calculating the mean of time between demand and demand size.By applying Moving Average of past two months demands to mod ModCr ,to show that the new Procedure better than the mod ModCr.

Using ratio of the mean square forecast error (MSE) from the mod mod ModCr method and the mod ModCr's method as a measure of the improvement, we can evaluate the efficiency of the modified one.

The modification of modModCr Method works as follows:

If X t= 0 , then dˆt +1 = dˆt , (6)

If X t ≠ 0 , then $\hat{d}t+1 = \hat{d}t + \alpha \frac{\sum_{I=1}^{n} Xi}{N\ i} - \hat{d}t$ (7)

The value of α that minimizes the MSE can be obtained through Solver in Excel commercial software.

4 COLLECTION AND PRELIMINARY ANALYSIS OF DATA

4.1 MEAN SQUARE ERROR (MSE)

In this section present and discuss the different measures use in the forthcoming analyses. Common measures for forecasting errors and its variability are MSE and also Mean Absolute Deviation (MAD). Silver et al (1998) recommend the use of MSE, because MSE is related to standard variation of forecast errors. However MSE is more sensitive to outliers and errors smaller than one due to the squared Function.

4.2 NUMERICAL EXAMPLE

Table 1 gives an example about the intermittent demand data.

Table 1. Intermittent demand data

Month	Demand	Month	Demand
1	0	13	0
2	0	14	0
3	19	15	3
4	0	16	0
5	0	17	0
6	0	18	19
7	4	19	0
8	18	20	0
9	17	21	0
10	0	22	5
11	0	23	4
12	0	24	5

Table 2 and 3 give the results of the "forward Covrage"(mod ModCr)method and the modified one that are computed based on the above data.

Table 2. The result of mod ModCr's method

Month	Demand	$\hat{d}t+1 = \hat{d}t + \alpha \frac{Xn-1}{tn-tn-1} - \hat{d}t$	MSE
		α=0.3	
1	0	0.00	0.00
2	0	0.00	0.00
3	19	0.00	361.00
4	0	0.00	0.00
5	0	0.00	0.00
6	0	0.00	0.00
7	4	0.00	16.00
8	18	1.20	282.24
9	17	6.24	115.78
10	0	6.24	38.94
11	0	6.24	38.94
12	0	6.24	38.94
13	0	6.24	38.94
14	0	6.24	38.94
15	3	4.37	1.87
16	0	4.37	19.10
17	0	4.37	19.10
18	19	3.06	254.12
19	0	3.06	9.36
20	0	3.06	9.36
21	0	3.06	9.36
22	5	2.14	8.17
23	4	3.00	1.00
24	5	3.30	2.89
MSE			**54.33**

Table 3. The result of modified model

Month	Demand	$d\hat{}t+1 = d\hat{}t + \alpha \frac{\sum_{I=1}^{n} Xi}{N\,i} - d\hat{}t$	MSE
		α=0.3	
1	0	0.00	0.00
2	0	0.00	0.00
3	19	2.85	260.82
4	0	2.85	8.12
5	0	2.85	8.12
6	0	2.85	8.12
7	4	3.15	0.73
8	18	3.96	197.16
9	17	4.95	145.30
10	0	4.95	24.50
11	0	4.95	24.50
12	0	4.95	24.50
13	0	4.95	24.50
14	0	4.95	24.50
15	3	4.77	3.14
16	0	4.77	22.75
17	0	4.77	22.75
18	19	4.75	203.04
19	0	4.75	22.56
20	0	4.75	22.56
21	0	4.75	22.56
22	5	4.54	0.21
23	4	4.39	0.15
24	5	4.30	0.49
MSE			**44.63**

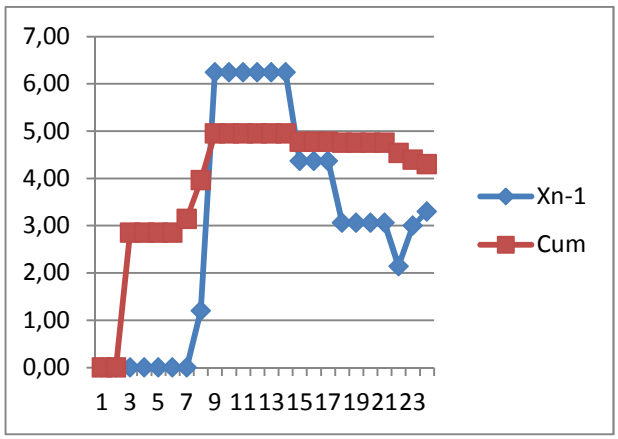


Fig. 1. The comparison between the mod ModCr method and the modified one(forecast)

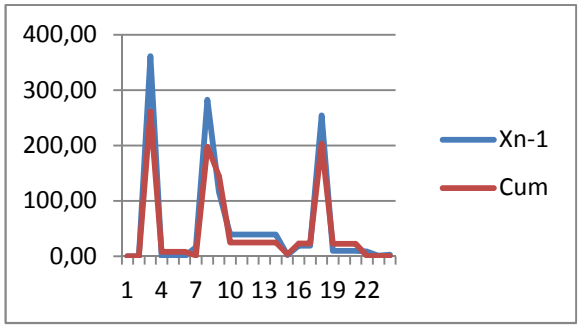


Fig. 2. The comparison between the mod ModCr method and the modified one(MSE)

Table 2 and 3 show that MSE of the modified Croston's method is smaller than that of the original one with optimal value of α (0.3), namely 44.63 compared with 54.33. From the numerical results, point out that the modified method brings out the better outcome as opposed to the original Croston's method regarding to MSE Criterion.

5 CONCLUSION

In this paper, propose a new forecasting approach to deal with the intermittent demand problem. Traditional statistical forecasting methods such as "Forward Coverage" (mod ModCr) that work well with normal and smooth demands do not give the accurate results with intermittent data. Numerical experiments show that the proposed method give the better mean square error when we compare with the traditional one. For further studies, the more appropriate assumption of lead time demand's distribution is expected to be stated so that the better results can be found.

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Maraichage à Niamey: approche socio-anthropologique

[Truck farming in Niamey: socio-anthropological approach]

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ABSTRACT: This article aims main aim to show the nutritional and food side truck farming of the town of Niamey through the dependents of the producers. It also shows that the production of vegetables is a completely male activity. This work was completed after a series of investigations in the town of Niamey (of 2008 to 2010), carried out near a sample of 324 producers. Each one of these investigations primarily interested three localities of Niamey (Cornice of Gamkalley, Gounti yéna and Saga) in which are cultivated vegetables which thereafter are marketed or autoconsommés. The quantitative information which is collected at the time of these investigations was supplemented thereafter by those, obtained in certain public services natives of Niger (ministry for agriculture, ministry for town planning and the land register as well as the ministry for the population). The various national college libraries also made an important contribution in the realization of this article. The principal assumption of this article is the following one: the owners are various origins. As for the specific assumptions, they are formulated like such: the first supposes that the production of vegetables is an activity which dates for a long time. The second makes the observation according to which most urban producers are young people. Lastly, a last specific assumption affirms that these producers are as well natives of Niger as foreign.

KEYWORDS: truck farming, city, Niamey, Niger, sites, age, civils servant, tradesmen, producers, ethnic origin, and professional experience.

RESUME: Cet article a pour objectif principal de montrer le côté nutritionnel et alimentaire du maraichage de la ville de Niamey à travers les personnes à charge des producteurs. Il montre également que la production de légumes est une activité totalement masculine.

Ce travail a été réalisé après une série d'enquêtes dans la ville de Niamey (de 2008 à 2010), effectuées auprès d'un échantillon de 324 producteurs. Chacune de ces enquêtes a intéressé essentiellement trois localités de Niamey (Corniche de Gamkalley, Gounti yéna et Saga) dans lesquelles sont cultivés des légumes qui sont par la suite commercialisés ou autoconsommés. Les données quantitatives qui sont recueillies lors de ces enquêtes ont été par la suite complétées par celles, obtenues dans certains services publics nigériens (ministère de l'agriculture, ministère de l'urbanisme et du cadastre ainsi que le ministère de la population). Les différentes bibliothèques universitaires nationales ont également apporté une contribution importante dans la réalisation de cet article.

L'hypothèse principale de cet article est la suivante : les exploitants sont d'origines diverses. Quant aux hypothèses spécifiques, elles sont formulées comme telles : la première suppose que la production des légumes est une activité qui date de longtemps. La seconde fait la constatation selon laquelle la plupart des producteurs urbains sont jeunes. Enfin, une dernière hypothèse spécifique affirme que ces producteurs sont aussi bien des nigériens qu'étrangers.

MOTS-CLEFS: maraichage, ville, Niamey, Niger, sites, âge, fonctionnaires, commerçants, producteurs, origine ethnique, expérience professionnelle.

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1 INTRODUCTION

Selon, Camille TOULMIN et Bara GUEYE[1], *l'Afrique de l'Ouest présente une grande diversité d'exploitations en terme de critères tels que la taille, le niveau d'équipement, l'ouverture vers le marché, les revenus, la diversification des activités, la dépendance par rapport aux recettes de migrants et la vulnérabilité face au risque.*

A Lomé, certains producteurs survivent avec leur revenu, tandis que d'autres vivent et peuvent entretenir une famille plus ou moins nombreuse. Une partie du revenu est destinée à des frais fixes que le ménage doit assumer, le loyer et l'alimentation notamment qui sont peu ou pas compressibles, même si une partie de la production est autoconsommée. Rares sont les maraîchers qui sont propriétaires de leur logement ; quelques-uns d'entre eux ont la possibilité d'habiter chez leurs parents, certains logent dans leurs jardins et d'autres doivent louer une habitation[2]. Ce qui est contraire au cas des maraîchers de Niamey. Bien que la plupart aient des familles nombreuses, il y'en a également des célibataires qui ne nourrissent personne selon les résultats de nos enquête de 2010, 1/3 des producteurs de Niamey sont des célibataires âgés de moins de quarante ans.

A Dakar, les exploitations familiales (90 % des exploitations) ont souvent moins d'un hectare (Fall et al, 2000) et sont peu équipées (irrigation manuelle), la production étant essentiellement vendue sur les marchés locaux. En revanche, les exploitations « commerciales» disposent de plus de 20 ha et sont très équipées (motopompe, goutte à goutte): leur production est très spécialisée et destinée essentiellement à l'exportation (haricot vert notamment) (Ba Diao, 2004 ; Temple et Moustier, 2004). A Niamey, il existe des producteurs qui exploitent leurs propres jardins et ceux qui sont des locataires. Sur les trois localités qui ont fait objet d'enquête en 2010, on se rend compte qu'à Gounti yéna ce sont surtout des locataires qui exploitent les jardins. C'est aussi l'endroit où on trouve plus de maraîchers d'origines étrangères (généralement burkinabé) que nigériennes. Car, Gonti yéna est le premier endroit où les ouvriers burkinabés produisaient de légumes pour ravitailler le petit marché. Selon des sources orales, c'est à cet endroit que le gardien du premier gouverneur (période de colonisation) avait un terrain qu'il exploite pour le compte de celui-ci.

Ainsi nous verrons dans un premier temps l'expérience professionnelle des maraichers dans le domaine. Dans la mesure du possible, nous aborderons l'âge, les personnes à charge ainsi que l'origine ethnique des producteurs de Niamey. Enfin, nous terminerons ce travail par les différentes catégories socioprofessionnelles auxquelles appartiennent les maraichers.

2 EXPÉRIENCE PROFESSIONNELLE

Ainsi, ces résultats montrent que la moyenne de l'expérience dans le maraîchage est élevée. Les mêmes résultats révèlent que la part de producteurs qui ont une expérience professionnelle importante dans le maraîchage est également assez élevée. Ce qui montre également que cette activité a commencé à se développer depuis des décennies et surtout au moment où la présence des expatriés occidentaux était importante. Les producteurs qui ont plus 10 ans d'expérience représentent à eux seuls plus de 46,%. Les résultats de l'enquête de 2010 confirment la constatation selon laquelle le maraîchage est devenu aujourd'hui une activité qui prend de plus en plus place dans les habitudes des résidents de Niamey. Car, la moitié des producteurs ont plus de 10 ans d'expérience dans l'activité maraîchère. Dans les jardins de Saga on trouve sur les 10 producteurs, un qui a plus de 30 ans d'expérience professionnelle. Ce nombre est négligeable pour confirmer que le maraichage s'est développé depuis il y'a trente ans.

[1] *Camille TOULMIN et Bara GUEYE, Transformations de l'agriculture ouest africaine et rôle des exploitations familiales, International instute for environment in development, London, 2003, p.13.*

[2] *Christine SCHILTER,* L'agriculture urbaine à Lomé*, éditions Karthala, Paris, 1997.*

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Tableau1: producteurs par site

Classes	site	nationalité nigérienne		nationalité burkinabé	autre nationalité	T. complet	T.partiel
		Zarma	Touareg	Mossi			
<30 ans	Gounti yéna	3			1	1	3
]30;50]	Gounti yéna	2		3		4	1
+50 ans	Gounti yéna			1		1	
<30 ans	saga	2				2	
]30;50]	saga	5		1		4	2
+50 ans	saga	2				2	
<30 ans	corniche	1				1	
]30;50]	corniche	6				2	4
+50 ans	corniche	1		2		2	1

Source: enquête 2010

3 AGE

Les résultats de nos enquêtes montrent qu'il y ait assez peu d'exploitants de moins de vingt ans. Ils montrent également que les producteurs qui ont plus de 30 ans sont les plus nombreux. Ils représentent jusqu'à 73,3% des producteurs. C'est aussi à cette catégorie d'âges où on s'intéresse beaucoup plus à s'intégrer dans la société qui s'effectue généralement par le biais du mariage et la capacité de nourrir et habiller une famille. Les héritiers qui n'ont pas d'autre moyen de création de revenu passent par le maraîchage pour obtenir un revenu régulier. Cependant, on trouve également des ouvriers locataires qui ont un âge compris entre 20 et 36 ans, mais ne représentent que 26,7% des producteurs. Ce type de producteurs, n'ayant pas de terrains, préfère pratiquer le maraîchage pour leur propre compte plutôt qu'être employé pour gagner un salaire mensuel qui n'excède pas 30 000 FCFA. Les résultats montrent aussi, qu'une part importante de producteurs qui ont plus de 36 ans se trouvent dans toutes les catégories socioprofessionnelles (commerçants, fonctionnaires, retraités, etc.). Les maraîchers âgés de plus de 60 ans sont principalement des fonctionnaires, retraités et commerçants. Car, l'âge de la retraite est fixé au Niger à 62 ans et c'est l'occasion pour certains fonctionnaires de s'adonner à d'autres activités génératrices de revenu. Les résultats de nos enquêtes nous conduisent à dire qu'ils peuvent représentent une grande proportion. Ils montrent également que les étrangers s'impliquent dans la production de légumes. Mais, ils ont de difficultés à trouver des terrains en milieu périurbain (saga) d'une part pour le fait que les habitants ont la culture d'exploitation de la terre, d'autre part, parce que la pauvreté est présente dans ce milieu.

4 PERSONNES À CHARGE

Les producteurs peuvent être également étudiés sous l'angle familial, c'est-à-dire selon les personnes qu'ils ont à charge (tableau2). Il s'agit de montrer alors, le nombre des personnes à charge par producteur. Ici, on assimile le mot producteur à celui qui bénéficie de la récolte des légumes. Les producteurs incluent alors, à la fois des propriétaires et des locataires. Les ouvriers qui sont rémunérés ne font pas partir de cette catégorie. Les résultats récapitulés de nos enquêtes montrent que ceux, ayant moins de cinq personnes à charge sont les plus nombreux. Ils représentent 47,92% de la totalité d'exploitants. Ce sont généralement les jeunes qui ont moins de personnes en charge. Lors de nos enquêtes de terrain nous n'avons pu rencontrer qu'une personne qui n'a aucune personne à charge. Cet agriculteur est d'origines burkinabé et est la seule personne âgée de moins de 20 ans. Pour le reste de nos échantillons, tous les producteurs nourrissent d'autres personnes. La part d'exploitants ayant entre 5 et 9 est aussi importante. Ces exploitants qui ont à charge des familles nombreuses représentent 33,33% des producteurs urbains. Ce pourcentage qui équivaut à 1/3 des personnes qui profitent de la production des légumes est quelque chose qui reflète la réalité sociale de la Communauté Urbaine de Niamey. Ce sont généralement les producteurs âgés de plus de 30 ans qui constituent la majorité de ceux qui ont plus de 5 personnes à charge. Quant à ceux, ayant de 10 à 14 personnes représentent jusqu'à 16,67% d'exploitants urbains. C'est la catégorie des producteurs âgés de 40 à 60 ans. C'est à cette tranche d'âge que beaucoup de maraîchers pratiquent la polygamie.

Contrairement au maraîchage dans la ville de Tahoua[3] où les personnes à charge de certains producteurs varient de 0 à 27, dans la ville de Niamey, le nombre n'excède pas 14.

Tableau2: Producteurs

N° producteur	Nationnalité	éthnie	sexe	Age	niveau d'inst	statut matrimonial	Charge(pers)	Nom site
1	beninoise	nago	M	35	sécondaire	marié	1	Gountiyena
2	burkinabé	mossi	M	70	aucun	marié	14	Gountiyena
3	burkinabé	mossi	M	25	sécondaire	célibataire	Néant	Gountiyena
4	nigerienne	zarma	M	28	primaire	célibataire	Néant	Gountiyena
5	nigerienne	zarma	M	30	primaire	marié	3	Gountiyena
6	nigerienne	zarma	M	39	aucun	marié	6	Gountiyena
7	burkinabé	mossi	M	41	aucun	marié	11	Gountiyena
8	burkinabé	mossi	M	49	aucun	marié	6	Gountiyena
9	nigerienne	zarma	M	26	aucun	célibataire	0	Gountiyena
10	burkinabé	mossi	M	39	aucun	célibataire	2	Gountiyena
11	nigerienne	zarma	M	25	aucun	célibataire	0	Saga
12	nigerienne	zarma	M	48	sécondaire	marié	20	Saga
13	nigerienne	zarma	M	36	primaire	marié	5	Saga
14	nigerienne	zarma	M	37	sécondaire	célibataire	14	Saga
15	nigerienne	zarma	M	29	aucun	célibataire	0	Saga
16	nigerienne	zarma	M	43	aucun	marié	8	Saga
17	nigerienne	zarma	M	36	primaire	marié	5	Saga
18	nigerienne	zarma	M	50	primaire	marié	17	Saga
19	nigerienne	zarma	M	65	aucun	marié	10	Saga
20	nigerienne	zarma	M	56	sécondaire	marié	8	Saga
21	burkinabé	mossi	M	47	aucun	marié	16	Corniche
22	nigerienne	zarma	M	24	sécondaire	célibataire	2	Corniche
23	burkinabé	mossi	M	45	école cora	marié	10	Corniche
24	burkinabé	mossi	M	68	aucun	marié	10	Corniche
25	burkinabé	mossi	M	57	école cora	marié	8	Corniche
26	nigerienne	touareg	M	42	école cora	marié	8	Corniche
27	nigerienne	zarma	M	42	primaire	marié	13	Corniche
28	nigerienne	zarma	M	38	sécondaire	marié	12	Corniche
29	burkinabé	mossi	M	36	aucun	marié	3	Corniche
30	nigerienne	zarma	M	54	sécondaire	marié	18	Corniche

Source; enquête 2010

5 ORIGINE ETHNIQUE

Certains enquêtés affirment que dans les années 1980, les cultures maraîchères étaient pratiquées à Niamey et ses périphéries principalement par les gardiens de jardins de fruits. Les résultats de nos enquêtes de 2008 et 2009 montrent que la main d'œuvre, notamment dans ce domaine, était constituée essentiellement d'étrangers et surtout ceux d'origine burkinabé. Aujourd'hui, on constate que la tendance est renversée avec l'implication des citoyens nigériens (haoussa et zarma) dans le domaine. C'est ce qui ressort de nos enquêtes de 2010 où on constate que la plupart des ouvriers sont des personnes de nationalité nigérienne. En effet, ce sont surtout sur le site de Saga et de la Corniche (généralement

[3] *Sylviane VAN GYSEGHE, « La ceinture maraîchère de Tahoua (Niger) », revue Espaces Tropicaux, n°10, Talence, CEGET-CNRS, 1993, p.160.*

propriétaires fonciers) qu'on trouve des ouvriers qui exploitent des jardins. Cela est certainement dû à la persistance de la pauvreté dans la ville et des opportunités financiarise de l'activité.

Les producteurs ne sont plus des burkinabés, mais sont également des nigériens urbains. Ils sont fonctionnaires, commerçants, retraités, ou simples héritiers dont les parents sont eux-mêmes natifs de la capitale.

6 PROFESSION

6.1 FONCTIONNAIRES

Les résultats de notre enquête de 2008 sur les 324 producteurs urbains montrent que, les fonctionnaires représentent 9,5% de propriétaires terriens. Notre enquête de 2010 sur 30 producteurs a montré aussi que les locataires sont nombreux à Gounti yéna (9/10) que dans les deux autres sites (Saga et Corniche de Gamkalley).

Par contre, dans les jardins de Gounti yéna, les fonctionnaires sont peu nombreux par rapport à la Corniche de Gamkalley. Les résultats de cette enquête montrent d'ailleurs que 47% de terrains appartenant aux fonctionnaires se situent sur la Corniche. Quant à Gounti yéna, ils ne représentent que 38% des producteurs et 15% à Saga. Car, les propriétaires sont des paysans qui exploitent aussi les jardins. La préférence des fonctionnaires par la Corniche est liée à la proximité du fleuve. Dans les années 1980, ils plantaient dans leurs jardins des arbres qui produisent des fruits et qui leur servaient de lieu de repos en fin de semaine. Généralement, les fonctionnaires emploient des ouvriers pour l'exploitation de leurs terrains. Aujourd'hui, où ces jardins sont transformés en maraîchage, certains fonctionnaires ne s'intéressent pas au rendement des cultures. D'autres, sont des citadins assez fortunés et avisés pour produire des fortes quantités de vivre[4]. C'est le cas d'Omar Garba dit Omar SATOM qui dispose d'un jardin presque dans tous les sites de la Communauté Urbaine de Niamey.

Seuls les fonctionnaires d'origine burkinabé en retraite prennent le maraîchage, comme une activité rémunératrice et s'intéressent à son rendement. Cela est du à leur culture d'exploitation de la terre. Ils surveillent régulièrement l'évolution des plants de semi à la récolte. Concernant la commercialisation, ce sont eux-mêmes qui vendent les cultures produites. Ces fonctionnaires sont arrivés à Niamey dans les années 1960 pour travailler dans la fonction publique nigérienne. C'était une période où, le Niger disposait de peu de cadres supérieurs.

6.2 COMMERÇANTS

Tous les commerçants qui s'impliquent dans le maraîchage et surtout dans sa production, sont des résidents même de la ville de Niamey. Les résultats de nos enquêtes révèlent qu'ils représentent 10,5% des propriétaires fonciers. Parmi eux, 63% sont du « grand marché » et du « petit marché ». Ils emploient dans leurs jardins des ouvriers, faiblement rémunérés. Dans ce secteur d'activité le salaire moyen se situe entre 15 000 et 20000 FCFA par mois. A la fin de saison, ce sont les commerçants qui vendent eux-mêmes les récoltes aux revendeurs. Parallèlement à leurs activités commerciales quotidiennes, ils font du maraîchage une activité rémunératrice. 51% des terrains appartenant aux commerçants se trouvent sur les sites de Saga, 28% à Gounti yéna et 21% sur la Corniche. Le prix du mètre carré d'un terrain de Saga est plus bas que celui de Gounti yéna ou la Corniche de Gamkalley. Car la valeur foncière varie selon la situation du terrain par rapport au centre ville.

Bien que la production de légumes soit dominée par une part importante des commerçants et grands fonctionnaires, celle des terrains maraîchers qui ont été acquis par semi direct ne représente que 3,3 %. Ce qui montre la spéculation autour de la terre dans la ville de Niamey.

6.3 HÉRITIERS

Dans la ville de Niamey, 78% de propriétaires ont hérité les terrains de leurs parents et, ce nombre est plus important à Saga où 50% de producteurs a hérité son jardin (enquête 2010). Les propriétaires fonciers héritiers de nos jours sont les descendants des premiers habitants des quartiers situés à proximité des sites maraîchers. C'est souvent à l'ainé que les

[4] *Jean Louis CHALEARD, Temps des villes, temps de vivres : L'essor du vivrier marchand en Côte-d'Ivoire, Karthala, 2000, Collection Homme et Société, p. 328.*

membres de la famille confient la production et la commercialisation des légumes. Dans certains cas, et surtout après la mort du père les ayant droit morcellent leurs jardins pour les partager entre les membres de leur famille pour les exploiter et dans ce cas, ce sont les garçons qui exploitent les parts de filles. Les familles polygames sont les plus fréquentes à partager les terrains. Le partage se fait soit en fonction du nombre d'enfants, soit en fonction du nombre de femmes que le propriétaire avait dans son foyer conjugal avant de mourir. D'autres héritiers, surtout ceux d'une seule mère exploitent le terrain collectivement. Dans ce cas précis, le partage ne s'effectue qu'après avoir vendu tous les produits de la saison. On partage l'argent entre tous les membres de la famille. On donne une part égale aux hommes et un demi de celle de l'homme est légué à chacune des filles de la famille:

L'héritage d'un terrain est la chose la plus souhaitable pour un nigérien, surtout pour ceux qui vivent dans la Communauté Urbaine de Niamey du fait de la flambée des prix de parcelles. La valeur marchande de la terre devient de plus en plus importante et seuls les plus riches ou les héritiers possèdent aujourd'hui un espace plus ou moins grand pour habiter.

Les terrains des héritiers sont les plus exposés au risque de prise en vente, surtout si la famille vit dans un conflit. A cela s'ajoute au fait que les jardins maraîchers se situent de plus en plus au centre ville. Les héritiers terriens sont généralement de l'ethnie Zarma-songhay. Car, ce groupe ethnique est le premier à habiter dans la ville de Niamey. C'est pourquoi les producteurs qui appartiennent à cette ethnie sont les plus nombreux (53,3% des exploitants).

6.4 CHEFS TRADITIONNELS

Depuis les années 1970, a été mis en place dans la Communauté Urbaine de Niamey, un système de chefferie traditionnelle dans le but est de faciliter les collectes d'impôts auprès des résidents urbains. Ce système qui correspondait à celui de chef de village dans les campagnes, a très vite été confronté à des difficultés, nées à la suite de la décentralisation qui confiait la gestion des quartiers aux élus locaux. Dès lors, le pouvoir des chefs diminue au profit des élus.

Petite ville avant la décolonisation, Niamey était entouré par des cantons, tels que Saga et Goudel. Ces quartiers ont fait progressivement partir de la capitale par une urbanisation massive intervenue dans les années 1980 et qui a accentué l'extension de la ville. Ils sont actuellement dirigés par une autre chefferie traditionnelle qui est au dessus de la première: cette seconde chefferie est ce que l'on appelle le système de chef de canton.

Les chefs traditionnels représentent 2% de propriétaires fonciers. On constate qu'il y'a dans le maraîchage urbain, une part peu importante des terrains qui revient à ces différents chefs. Les jardins de ces différentes personnalités sont exploités par des habitants de leurs quartiers ou de leurs cantons.

6.5 OUVRIERS

Un ouvrier maraîcher est un producteur qui a un pouvoir limité de prise de décision dans la commercialisation des légumes. La main d'œuvre nigérienne est composée des personnes non scolarisées ou qui n'ont pas reçu de formations poussées, originaires des milieux économiquement défavorisées. Dans la plupart des cas, les ouvriers sont des saisonniers qui viennent travailler afin de subvenir aux besoins les plus vitaux. Ce sont aussi des immigrés burkinabés ou béninois qui s'adonnent à temps partiel à la production des légumes. Les ouvriers qui ont une famille à charge, préfèrent rester dans les jardins pour éviter de louer une maison dans la ville. Ils sont aidés par leurs enfants qui ont l'âge d'aller à l'école mais qui refusent d'y aller. D'une manière générale les ouvriers ont la responsabilité dans la production des légumes, mais n'ont pas toujours le droit de vendre.

Selon Eicher Cral et al. (1970) *les petites exploitations agricoles constituent le système agricole dominant en Afrique subsaharienne. Elle se caractérise principalement par le recours à une main-d'œuvre familiale, par des petits capitaux et par une abondance de terre par rapport aux pays asiatiques. La main-d'œuvre familiale constitue le principal moyen de production et représente 80 à 90% de la main-d'œuvre totale.* A Niamey, la main d'œuvre familiale est plus importante que les personnes embauchées pour exploiter les terrains. Car, les producteurs préfèrent employer leurs enfants le soir après l'école afin que ces derniers s'habituent pour s'adonner à leur tour au maraîchage. En moyenne les ouvriers sont rémunérés autour de 14000 F CFA par mois.

Ce passage révèle les constatations que, dans la plupart des pays de l'Afrique subsaharienne, le maraîchage est pratiqué par des personnes à faibles revenus. Mais, dans la ville de Niamey, les propriétaires fonciers sont généralement des citoyens nigériens, la main-d'œuvre, elle, est composée en grande majorité des étrangers et particulièrement des burkinabés, dont, certains sont même des résidents de Niamey depuis des décennies. Ce sont les groupes d'immigrés, arrivés dans les années 80, une période où la demande d'uranium sur le marché international était plus forte et où le Niger connaissait une bonne

situation économique. Le pays attirait les immigrés en provenance des pays limitrophes, comme le Mali, le Burkina Faso, le Bénin, le Togo et même du Sénégal.

6.5.1 EMPLOYÉS

Les employés sont donc pour la plupart des burkinabés ou béninois qui quittent les campagnes pour chercher un emploi dans la capitale nigérienne. Les résultats de nos enquêtes révèlent que ce sont surtout les jeunes ou bien les plus âgés qui font du maraîchage leur activité principale. La période de novembre à juin est le moment où on trouve de plus d'immigrés dans les exploitations. Car ces derniers se rendent, périodiquement dans leur pays d'origine. Du fait qu'ils soient une ethnie commune entre Niger et Burkina Faso, ils ont moins de problèmes d'intégration au sein de la société nigérienne. On les trouve principalement dans les jardins de la Corniche de Gamkalley et Saga. Dans les premiers, les ouvriers sont payés pour surveiller les jardins de fruits et en profitent pour exploiter les espaces vides.

Il existe dans les jardins urbains une autre catégorie d'ouvriers. Cette catégorie est composée essentiellement de nigériens urbains, immigrés nationaux[2]. Certains de ces ouvriers ont quitté leurs villages pour s'installer dans la communauté urbaine de Niamey.



Photo: un ouvrier agricole

6.5.2 LOCATAIRES

Aujourd'hui, les ouvriers locataires, sont d'origines diverses. Ils sont aussi bien d'origine nigérienne, que burkinabé et dans de rares cas, des personnes d'origines béninoises. Dans certains, cas aussi, ce sont des jeunes nés à Niamey qui se spécialisent dans le maraîchage. Les locataires sont des personnes qui préfèrent travailler à leur compte au lieu d'être employés. Certains d'entre eux, surtout ceux de la corniche, pratiquent le maraîchage comme une sorte de seconde activité. Parmi eux, on trouve des photographes, des gardiens de villa dans les quartiers résidentiels de Niamey, des petits commerçants, des agriculteurs qui travaillent parallèlement dans les champs de céréale. Au cours de nos différentes enquêtes menées sur ces trois sites, nous n'avons trouvé aucun jardin qui est loué par un seul locataire. Généralement, les locataires exploitent collectivement les terrains. Les jardins loués représentent 45,2% des terrains exploités. Sur la Corniche de Gamkalley juste à côté du rond point Kennedy, il existe un vaste terrain qui est loué par 11 agriculteurs. Pour des raisons liées à la rentabilité du maraîchage dans la ville de Niamey, certains locataires quittent leurs régions natales (intérieur du pays) pour s'installent définitivement dans la communauté urbaine. Ce sont des hausa et zarma ayant déjà pratiqué le maraîchage dans leurs localités, qui s'intéressent aujourd'hui et de plus en plus au maraîchage dans la ville D'autres, sont des manœuvres retraités de la fonction publique. Pour des raisons financières, ou du fait qu'ils viennent des régions éloignées du

Niger, certains producteurs nigériens n'arrivent pas à obtenir leurs propres terrains. Ils sont beaucoup plus pauvres que le reste de la population et leur sécurité alimentaire est plus précaire que celle des pauvres des milieux urbains.

7 CONCLUSION

A travers tout ce que nous venons de voir dans ce travail, nous pouvons conclure en disant que le maraichage est pratiqué dans la ville de Niamey par des nigériens et burkinabés. Il est dominé par des personnes appartenant à toutes les couches sociales de Niamey (ouvriers, fonctionnaires, commerçants, retraités, chefs traditionnels). Les hommes mariés sont les plus nombreux dans la production de légumes et ont à charge plus de 3 personnes Les ouvriers sont le plus souvent des personnes d'origine immigrée (nigérienne, burkinabé ou béninoise) qui ont la culture du maraichage. La production de légumes attire les classes d'âges (16 à 70 ans) et, est devenu une activité qui rentre dans les habitudes des habitants de Niamey.

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A SOCIOLOGICAL ANALYSIS OF EFFECTIVENESS OF DIFFERENT TEACHING STRATEGIES AMONG GRADUATE STUDENTS: A CASE OF B.Z.UNIVERSITY MULTAN

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ABSTRACT: The present research examines the different teaching strategies especially among the graduated students. This research focuses on the different teaching strategies and how can these types affected on the students. The study examines the effectiveness of the different strategies among graduated students. The main objective of this research is to explore the different teaching strategies, who much they are different from each other and what's the linkage between the different teaching strategies. Because researcher objective to examined the effectiveness on the graduated students. That's why the universe for this research consisted of all the graduated students of Multan in Pakistan. Then the target population of the present research was the students of Bahauddin Zakariya University, Multan. For this research, 800 respondents were selected through the convenient sampling technique from the different department of the Bahauddin Zakariya University, Multan. Relationship among variables and statistical analysis was done through SPSS Software. Chi square test was used to find out the association between the teaching technique and its effectiveness. The main finding of this research is that different teaching strategies raise the level of interest of learners. Teacher should make their teaching style more interesting and challenging for the students. For this purpose teacher can take help from the different teaching strategies. Different students come from the different culture and linguistic background. That's why no single strategy is effective for the entire learner and adopt such a technique that is effective for all the students.

KEYWORDS: Sociological, Effectiveness, Teaching Strategies, Graduated Students, learning techniques.

1 INTRODUCTION

There are many forms of teaching strategies and there are some difference and distinction among them cooperative learning, learning communities, reciprocal learning, peer teaching, peer learning, team learning, collaborative learning, collective learning, study circles, study groups, and group work. There are three general types of group work: informal learning groups, formal learning groups, and study teams (Johnson & Smith 1991).There are different ways which can be adopted to teach the students. These ways include direct instruction, providing reading materials, problem solving method, cooperative learning, explore information, role plays, students' research, case study and students' writing. In direct instruction we put emphasis on each level, in which we judge the student's level on the basis of pre-medieval and post tests (Roseshine 1987). In this way, teacher performs a various and significant role, it is useful to provide reading material to the students to have some common understanding of the concept which would be discussed in the class. Providing reading material to the students encourages the students to participate in the class discussion (Buckelew 1991). Another strategy uses cooperative learning; we can also say that it is among the most researched teaching strategies of the current era. Through this students can get progress and achievement not only in academic but also in social areas. The academic and social outcomes include enhanced level of achievement, improved self esteem, positive attitude towards schools and improvement in time management skills. It is also proved through the numerous studies that cooperative learning is beneficial for high, average and low level students. It encourages the weak students to persist their work and helps the average and high level students to identify the ways in which they can enhance their knowledge and understanding more effectively (Felder & Brent 1994). Another important teaching strategy is using a role playing technique. It is just like a role

play but don't have a script to follow. Teaching strategy also uses the case study in teaching techniques. Case study is a story with a hidden message which develops the deeper understanding of the concepts and issues among the students. Students just watch and listen to the play and draw out the main ideas of that play through their direct observations (Volpe 2002). But effective teaching techniques also depend on the teacher. Teacher should adopt best and suitable techniques according to the students' abilities and capabilities (Hartley & Davies 1976). Teachers are given a class of students which consist of the range of abilities. When students come, some of them are on the grade level, some are above the grade level and some are below the grade level. So it all depends on the teacher to select such a strategy which is suitable for all the students (Whitman & Schwenk 1983). Discussion is also an important teaching technique. It helps students to share their abstract ideas with their teachers. Discussion plays a vital role in the development of problem solving skills as compare to other strategies. But it is again up to the teachers that how they can make discussion helpful and meaningful. Teacher also has responsibility to direct and instruct the manners among students about how they can take part in the discussion (Hoyles 1985). Discussion also provides a way to understand the lesson more effectively rather then the traditional method, in which teacher cram the lesson. Discussion have both aspects, it can be advantageous and at the same time detrimental to learning. So it is teacher's responsibility and ability to ensure that discussion promotes learning (Sharan & Sharan 1976). Cooperative learning technique also plays a significant role in the academic achievements. It involves typical logic and argumentation. To develop the most favourable teaching technique is not only important for the students. But it is also important for the teachers, planners and administrators (Peters & Moore 1982). In cooperative learning, it is the duty of each team member to help their teammates in such a ways that they equally in participate in team work. Assignment which is done under the group is successfully understood and completed. The important feature of cooperative learning is that it helps students to develop skills in oral communication (Stallings & stipek 1986). Group task also provides rich opportunities to assess the students' plan, flexibility, creativity and communication skills. Group work mentioned as positive outcomes not only in the whole class discussion but also in the cooperative learning. Group work enhances the ability among the students to rely less on the teachers and depend more on their ability to think and try to dig out the information from their resources (Zeichner 1987). Problem solving technique is a very real part of the learning. This technique presumes that students can take the responsibility of learning, can take action to resolve the conflicts and discuss the alternatives. This technique helps the students to acquire new knowledge at higher level of thinking. Problem solving process is an ongoing activity in which we take what we know to discover what we don't know (Schmidt & Henny1992). Problem solving technique develops an ability among the students to enhance their knowledge for other situations. It teaches the students to see only the teacher as a resource who can help them for learning rather than a source of information (Wilkins 1993).

2 SIGNIFICANCE OF THE STUDY

Teaching strategy consists on various technique and this techniques have great effect on the students learning. As every man is different from each other same as every students have different mental approach. So researchers identify different teaching learning techniques. Teachers use different method to educate their students. But it is also clear that no single teaching strategy is effective for all. Teacher's ability plays a vital role when they communicate with the learners. Teacher must have a grip and complete hold on the teaching lesson. Some teachers have ability and grip over his subject but due to the lack of information about the different teaching strategies put a great effect on his teaching method. That's why researcher explore the different teaching strategies that help not only the students but also effective for the teachers. Researcher objective not only identify the various technique but also highlight the ways in which teacher improve their teaching method more effectively. This research helps the teachers to understand the different advantage and disadvantage of various techniques and apply the best suitable technique according to the mental ability of the students

3 OBJECTIVES

- To identify the different kinds of teaching learning techniques
- To examine the difference between the various types of teaching learning techniques
- To explore the effectiveness of each teaching learning techniques
- To clarify the linkage between the different teaching learning techniques

4 RESEARCH METHODOLOGY

For the present research quantitative research has been used. Logic of this quantitative research design was that we require generalization and generalization require large sample. That's why researcher used quantitative research.

Quantitative research also ensures the validity and reliability of the data. The target population of the present research was the students of Bahauddin Zakariya University, Multan. There were approximately more than 25,000 students in 52 departments. There were more than 500 teachers. Different teaching techniques use in different department according to the level and discipline. So researcher use simple random sampling and select the 8 department. Each department consists of 2 types of students, male and female. Than researcher select 100 students from the each department through the convenient sampling. Sample size of the present study was 800 respondents. The researcher used self administered questionnaire as a tool for data collection. Before the collection of the final data, researcher conducted a pre test. In the light of pre test researcher remodify the questionnaire, according to the result of pre test, and finalize the questionnaire. After finalize the questionnaire, data collected and put this data in to **SPSS** with different codes. The data is analyzed through using a program **SPSS.** Chi square test used to check the hypothesis.

5 RESULT AND FINDINGS

Table no .1 Percentage distributions of respondents regarding their views about teaching technique

Categories	To Great Extent	To Some Extent	Not At All
Class discussion can create confidence in students	39	45	16
Discussion is necessary for students learning	40	38	22
Group work is more effective than individual work	46	35	19
Group works create self-esteem among students.	62	29	9
Group work helps student problem solving skills.	55	33	12
Group work activates students in getting education	43	37	20
Group work improves student's oral skills.	48	29	23
Cooperative learning helps to achieve group goals.	80	13	7
Cooperative learning helps to motivate students.	51	33	16
Cooperative learning encourages learning process	78	17	5
Problem solving develops patience qualities.	84	12	4
Problem solving promotes interaction &teamwork.	67	22	11
Research develops an understanding of subject.	52	31	17
Research use available data in local community.	49	32	19
Writing can be a successful vehicle for learning.	72	19	9
Journal writing encourages students creativity	63	22	15
Direct instructions are effective ways of teaching.	51	33	16

DISCUSSION

Table no 1 show the different variables with respect to the different teaching technique. According to the first row information, class discussion creates confidence among students. Due to class discussion they are able to participate in the class educational activity. It is necessary part for the students in learning. Group work is more effective than the individual work. Group member learns a lot of thing from the group activity. It also creates self esteem among students. Group work also enhances the ability of problem solving skills, according to the majority of the respondents. Through the group work students become more activates in getting education. In the ways of getting education, students improve their oral communication skills. Majority of the respondents view that cooperative learning helps the students to achieve their group goals. Cooperative learning motivates students to achieve their educational goals to great extent. It also encourages the learning process with great extent. Problem solving technique develops the qualities of patience among students with great extent. This technique promote interaction among students and also promotes the team work, through this they can achieve their educated desired goals. Research is an important part of today's learning. Majority of our today's goals are achieved through the research. So the data also show that research develop the understanding of the specific subjects. Research develops a deeper level of understanding of subject among students. Research teaches the students to use the local community information and make a healthy use of the available information. Majority of the respondents view that writing is also a important tool of learning. Majority of the respondents agree that journal writing enhance their creative writing with great extent. Majority of the respondents agree with some extent that direct instruction also an effective of teaching.

5.1 TEST OF THE HYPOTHESIS

5.1.1 NULL HYPOTHESIS (H_0)

There is no association between the cooperative learning and effective teaching strategy used by the teachers during lecture.

5.1.2 ALTERNATIVE HYPOTHESIS (H_1)

There is an association between the cooperative learning and effective teaching strategy used by the teachers during lecture**.**

Table no. 2 Chi-square test

Teacher cooperate in your studies	cooperative learning help to motivate students			
	to great extent	to some extent	not at all	Total
To great extent	290	190	40	520
To some extent	86	21	48	155
Not at all	34	64	27	125
Total	410	275	115	800

Chi= 26.221 Degree of freedom = 4 Level of significance= 0.002

DISCUSSION

Researcher used chi square test to find the association between the cooperative learning and effecting teaching strategy. Researcher objective to identify the different teaching strategies and their effectiveness. Thus statement of the null hypothesis is that there is no association between the cooperative learning and effective teaching strategy used by the teachers during lecture and the statement of the alternative hypothesis is that there is an association between the cooperative learning and effective teaching strategy used by the teachers during lecture. The result of the chi square shows that the level of significance value is 0.002. The significance values accept the alternative hypothesis and reject the null hypothesis. Its mean cooperative learning and effective teaching strategy has an association.

6 SUMMARY

The effective teacher is one who maximizes the achievement of students. Different teaching techniques help students in different ways to achieve their academic goals. Mental ability and capability to learn the things are not equal in all the students. Some students want to learn new things in every day; these types of students are usually at the topper of the class. Some learner not likes to learn the new things; they are just wasting their time and deceive their parents/guardians. But some students are not able to learn the new things. Teaching technique is effective in each type of students but more effective in those students who are not able to learn the new things. When students are motivated than they learn more as compare to when they are not motivated. Defining the different teaching strategies, it is clear that no single technique is effective for all the learners. The logic of this argument is that teaching and learning both are consisted on complex processes and different things influenced on this processes. So if we make both technique (teaching and learning) more interesting and challenging for the learners than it become more effective. Teachers and learners both learn more due to the implementation of these techniques. Because when people accept someone challenge than they learn more. Social interaction is another source of learning. These social interactions widely base on the social environment. So teacher should take consideration of the physical, psychological and social aspect of learning context. Introduction of every lesson also have significant role in the process of learning. Introduction gives the overview of the lesson that tells what is covered after reading this lesson. A briefly discuss objectives and keys ideas should be given to the students before teaching the learners. Introduction should not be consist on the stories, joke or incidents but it clearly focus on the objectives. In short, introduction consists of three elements and these elements base on attention, motivation and an overview of the lesson. In

teaching strategy, teacher should use to simple word whenever possible. When the instructor talks directly to the students, teachers directly observe the reactions of the students and adjustment can be made based on their responses. So different teaching techniques have different ways of implementation but focus of all techniques is the learners that who can it clear the concept of learner about the subject and develop their own conclusion.

7 SUGGESTIONS

- Learning activities should be appropriate according to the level of the learners
- Learning activities should be enhancing the social development.
- Using such a technique that promotes the curiosity among students.
- In university, different students come from the different cultural and linguistic background. So teacher should into account the background of the learners.
- Teachers should put emphasize on the development of understanding of concepts rather than the development of routine skills.
- Students learn more in activities and it is helpful in understanding the new concepts.
- Teachers should promote learning through the group activity and build interpersonal skills of the students.
- Use Cooperative learning, because it organizes classroom activities in to academic and social learning experience.
- Teachers should provide course material before class. So that they prepare them, then come to class and participate actively during the class.

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Effect Training instantaneous by facilitation in the development of variables biomechanics to closer, payment, and long jump for young people

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ABSTRACT: Long jump consist of served connected stages of run of the approaching, preparing to upgrade with three final steps, upgrade, take off, and downgrade. Ostensibly of these phases whole constitute a artistic performance the correct if their interdependence that serves objective of this skill. Either the research problem results showed that at the local level far from at the international level in the long jump competition, and that This requires the staff prepare Training Programmers to train the own physical abilities and according to results achieved for the narrow the gap between the global and achievements of the Iraqi. This study aimed to identify some variables of momentary strain and speed of final upgrade step through kinetic analysis, facilitating exercises such as rubber cords in direction of the movement and mobile traffic device for application movements of momentary strain, detection the impacts of the training on mentioned variables. The research is to impose There are statistically significant differences between tribal and a posteriori the tests of the values of the intraday speed of payment approach and achievement of the two groups of search. While search proceedings were used the video and imaging variables the extracted from it, The variables included biomechanics speed last step (through analysis), Starting speed (through analysis), The momentum change during Rise (through analysis), the force hanging over panel when Rise using foot scanner. Has been applied workouts Balahbal rubber device traffic moving on the experimental group for a period not less than 8 weeks Reality two units every week and determine intensity accordance with the time of maximum ran done and maximum Of fo rce rope user was the training in the main section of the unit's training exercises complementary Be the gradient of pregnancy-training at 1: 3 in order to have influential and effective training depending on the scientific underpinnings. The Statistical means: statistic the bag been used (SPSS). Most Conclusions:
1- The correct special exercises using rubber cods and mobile traffic was more considerable in the long jump.
2- Exercises of rubber cords frequently lead to stimulation of nervous system and improvement of nervous signals sending to muscles, these exercises contribute to reduce the time of ground connection, and subsequent reduction of momental strain time.

KEYWORDS: Training, variables biomechanics, long jump, young people.

1 INTRODUCTION

Long jump consist of served connected stages of run of the approaching, preparing to upgrade with three final steps, upgrade, take off, and downgrade.

Morphologically, these steps if correlated, result the correct technical performance. Litter lures demonstrated that speed of jumper at run approaching constitute 70 to ≥≤ 90 % of this performance. Some players characterize with highest speed in run of approaching but weaken in correct connection the first step and upgrade, since, upgrade angle decreased when speed increasing and subsequently lead to weakness of performance.

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However, results of local long jump faraway from a world levels, this required training programs, more facilities to breakage the classical tools in strain force to coordinate between the last step at run of approach and momentary strain, because several of biomechanical connected variables such as: Kept of self discipline, strain time, and its efficacy.

This study aimed to identify some variables of momentary strain and speed of final upgrade step through kinetic analysis, facilitating exercises such as rubber cords in direction of the movement and mobile traffic device for application movements of momentary strain, detection the impacts of the training on mentioned variables.

The success of long jump depend on a suitable run of approach resulting a higher speed, true connection between speed of final steps speed, run of approach and upgrading, good flight with a body's balance in addition to a good preparation for downgrade, which require strongest leg muscles through speed of its associated contraction and diastole until upgrading.

Scientists documented that a best long jump require:

- Definition of the first moment of foot attach upgrade plate absorption stage, and a moment of ground push.
- Final speed for each run of approaching, absorption moment, and ground left.

1.1 THE PROBLEM OF RESEARCH

The results showed that at the local level far from the international level in the long jump competition, And that this requires staff prepare Training Programmers to train own physical abilities and according to results achieved to shorten the gap between the global achievements and Iraqi. This prompted researchers to the studying & researching to contribute to the development of achievement Iraq for this competition, through the adoption of the means facilitation to break the normal pattern to push force and must be achieved harmony between the last step of the to approach and moment of payment because there are many variables biomechanical associated with the payment of the force that is of the most important variables affecting in achieving the achievement good Balothb term (such as the preservation inertia of and the time of payment and efficiency .. To the number of the other variables that need to be careful analysis and properly diagnose in order bypass this node has Jumpes and achieve the goal of the performance, and had never of work careful analysis for the this stage in order recognize the errors and the preparation workouts that help to master the correct binding between the Approaches and the payment intraday effective, using the means of facilitates the application of this important stage and make a case of adaptation them.

1.2 THE GOALS OF RESEARCH

- Recognize some variables of of payment ingratiation and the speed of Rise recent step by kinetic analysis.
- Preparation of drills using the means of To facilitate help (The ropes rubber direction the movement and use a moving and walk downward the slopes) to apply the continuous movements intraday of payment them.
- To identify the effect of these private variables on the the exercises and the intraday speed of Approaches and achievement.

1.3 THE IMPOSITION OF SEARCH

There are significant differences between the tribal and a posteriori the tests of the values of the intraday and the speed of payment Approaches and achievement for the two sets of search.

1.4 THE AREAS OF RESEARCH

- **The human sphere:** National team players for the youth race for the long jump year 2014.
- **The domain of temporal:** The period 27/01 TO 29/03/2014.
- **The domain of spatial:** College of Physical Education, University of Baghdad - Jadiriya.

2 THE RESEARCH METHODOLOGY

2.1 SYLLABUS

The researchers used experimental method.

2.2 SAMPLING

An experimental sample of 12 players selected voluntary from Iraqi youth clubs (20 years less) during 2014 according to rules of International union of athletics, divided randomize into two equal groups: experimental and control.

2.3 DEVICES AND TOOLS

(2) video camera (200 photo/sec.), medicinal balance, mobile walk apparatus, foot scan, calculator, programs of kinetic analysis such as Dart fish, Kino via, and Maxtraq, rubber cords 2,3,5,8m timers.

2.4 VIDEO PHOTO FOR VARIABLE ANALYSIS

A sample was photo through the last 10m, and upgrade moment using a second camera to measurement the following biomechanical variable: speed of the last step, starting speed, change momentum during upgrade, power spotlight on the plate when upgrading by foot scanner.

2.5 PRIOR AND POSTERIOR TESTS

- Video cameras installed to photo three trial for each player, and the best performance was recorded.
- Exercises used rubber cords and mobile traffic:

Maximum intensity power of rubber cords was measured and considered as indicator for training, max speed of each player on the mobile traffic was recorded and thereafter , determination the training style to breakage speed barrier on the device, in addition to quick jumping drills.

2.6 Data analysis included Mean, standard deviation, differences between prior and posterior tests, calculated T for test a significance at ≤ 0.05.

3 RESULTS AND DISCUSSION

Table 1 means and stander divisions between pretest and post test for physical variables for both groups

Variables	unit	group	Pre test		Post test		F	ST. of F	**T**	Significance Level	results
			mean	Stander division	mean	Stander division					
achievement	meter	experimental	**6.23**	**0.25**	**6.57**	**0.15**	**0.34**	**0.109**	**3.12**	**0.023**	**significant**
		control	**6.18**	**0.35**	**6.22**	**0.30**	**0.04**	**0.025**	**1.58**	**0.061**	**Not significant**

Table 2 differences and value (T) for pre and post test for biomechanics variables for both groups

Variables	unit	group	pretest		posttest		F	ST. of F	T	Significant level	results
			mean	ST.	mean	ST.					
Speed of last step	m/sec.	Experimental	7.758	0.24	8.01	0.18	0.252	0.088	2.85	0.001	Significant
		control	7.68	0.265	7.77	0.243	0.05	0.023	2.11	0.654	Not Significant
Speed of start	m/sec.	Experimental	4.80	0.22	5.935	0.093	1.135	0.235	.834	0.002	Significant
		control	4.70	0.197	4.80	0.18	0.10	0.072	.381	0.098	Not Significant
Momentum chang	Kg*m/sec.	Experimental	180.05	14.07	152.53	9.20	27.52	4.95	.565	0.016	Significant
		control	178.53	19.83	171.25	20.60	4.26	2.266	.881	150.0	Not Significant
strength	Newton	Experimental	1704.1	155.61	20.30	89.16	325.84	88.30	3.69	0.003	Significant
		control	1707.3	124.6	1736.6	126.33	29.33	14.57	2.013	0.121	Not Significant

Table 3 means and stander divisions and value of T between pretest and post test for both groups in biomechanics average for difference stage

test	unit	Experimental		control		T	Significant level	results
		mean	ST.	mean	ST.			
Speed of last step	m/sec.	8.01	0.18	7.77	0.243	19.5	0.000	Significant
Speed of start	m/sec.	5.935	0.093	4.80	0.18	13.73	0.000	Significant
Momentum change	Kg*m/sec.	152.53	9.20	171.25	.6012	9.75	0.000	Significant
strength	Newton	20.30	89.16	1736.66	6.3301	5.17	0.001	Significant
achievement	meter	6.57	0.15	6.22	0.30	3.21	0.023	Significant

Data in Table (1) showed a significant experimental variables prior and posterior tests resulted by impact exercises of rubber cords and mobile traffic.

These exercises constitute one of the assistant techniques that spotlight a type of external resistance on the different muscles to help the body's uncommonly and develop the speed, since a small resistance momentary or upgrading speed in long jump, increasing mobilize and stimulation of muscle fibers through compatibity of nervous – muscles and between muscles (pross, 1983). Thus, the players enables a high run speed and high ability to generate alternate central and non-central power in muscles at upgrading moment that lead achievement of momentary strain and a high speed in starting with proportionate values between horizontal and vertical speed at stain moment, as well as use of explosive power to achievement a high final speed that produce a vertical lifting and a best harmonic capacity(otuson, 1976).

3.1 BIOMECHANICAL TESTS

Results in Table(2) showed comparable following variables speed of the last step. Starting speed, momentum change, and the spotlight power upgrading moment.

Apparently, effectiveness of rubber cord exercise and mobile traffic improved and lead to breakage of locomotors pattern with certification of no decreasing in a momentum at upgrading, and a high spotlighting power for continuation this momentum.

Technically, the long jump consider a simplest athletics jump, because, run of the approaching * achieve for one direction, turn the steering of run speed to maximum in the jumping and best downgrading don't form a great difficulties for body's kinetics compared to skipping or other three jumps(boom triple, higher jump, and pole vault) that induce barriers in the connection coordination between different body's movement. Therefore the suggesting exercises was contributed in the development of speed last step, starting, angle of oscillating leg, and flighting scientists observed that development in these speeds came harmonious with supported stimuli that induced the best contraction and muscles diastole according to the aim of approaching run i.e arrival the player to upgrading point in a maximum speed using rubber cords. Thus, approaching must be accomplished gradually to performance a successful take off, since the great acceleration may be cause slowdown at the end of approaching and takeoff(Dintiman et al.2003).the qualitative development happened in the spotlighting power at upgrading due to mobile traffic and rubber cords as resistors in the fast run contributed in muscles tensile, since these instruments generate a straight with raw in different.

Speeds, as well as the action of jump exercise using cords against and with ground gravity which helped in the development of muscles strain, and subsequently achieved significant differences for individuals of this group.

3.2 POSTERIOR TEST OF SPEED

Calculated T of the experimental test of speed of last step, starting, momentum change, and spotlighting power presented in Table(3) were significant ≤ 0.05. Therefore, the analysis of players speed in both experimental and control groups in pre and post starting gave a clear concept about performance at this moment, this may be reflect a clear importance of sustain the speed in a balance and continual during both of two stages when applied the mentioned special exercises compared to control.

Kinetic analysis of the examined performance revealed that the foot drive was directly in contact with the plate at upgrading moment with a simple diastole in joints of the same foot. This forced the leg muscles to a negative contraction i.e non-central contraction with gravity, and subsequently non-central contraction against gravity .

The latte when preceding with appositive diastole, the muscle stores elastic energy that's called muscles load or muscles stimulation (Mouch bahani etal.2004).

Because the final step is usually shorter than the penultimate steps, thus jumper should be think about setting the final steps i.e along steps followed by short one during application of approach and upgrading using rubber cords, since the positioning of the last foot in front body with long distance result in stop or slow down the speed that subsequently perform a bad jump(Ibde).

Results confirmed on the gained speed during the last two steps and enhance continuity of oscillating the arm for continuation liner momentum during pivot and strain according to the power exerted by the same leg to continue a momentum chang as a little as possible (Tabach-anik, 1992). Tylez and james (2000) supported our results and confirm that trainers should encouraged the players to think firstly and then running. Otherwise, the upgrading of leg don't stimulate and muscles intensiled completely (Bedi, 1997). Setting of foot upgrading in flat and in front of body result in maximum lifting force, since positioning of toe on ground firstly lead to stoppage effect and slow down his speed, however, setting of fingers firstly on ground result in a weak balance or may be fall down and thereafter declination of upgrading or curved.

4 CONCLUSION

1- The correct special exercises using rubber cods and mobile traffic was more considerable in the long jump.
2- Exercises of rubber cords frequently lead to stimulation of nervous system and improvement of nervous signals sending to muscles, these exercises contribute to reduce the time of ground connection, and subsequent reduction of momental strain time.
3- Speed application using rubber cords and excess jump exercises on the mobile traffic device contributed in the change of movement model in the final steps of approach and upgrade.
4- Improvement mechanical factors in the stages of approach and upgrading of jump performance.
5- Rubber cords training developed the maximum speed and explosive power.
6- Exercises of rubber cords and mobile traffic certified the compatibility of muscles kinetic according to development of biomechanical variables.

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Web Design and Implementation for Online Registration at University of Diyala

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ABSTRACT: Internet is an important facilitator for students and students use this medium almost every time. As an Online Registration, internet attracts students to apply online at university for easier, save their time, Available in (anytime / anywhere). Online registration is beneficial for both students and university. Students can adapt newer technologies so they can adapt internet as registration tool in university of Diyala. By just clicking a mouse, student can register in any college at university of diyala online. This paper is to design online registration forum for university of diyala and also to study the benefit and reason describing the attraction of the students towards online registration.

KEYWORDS: Online Registration; Web design; Internet; E-Commerce; Online stores; Online Application Forum.

1 INTRODUCTION

By the turn of the century, information, including access to the Internet, will be the basis for personal, economic, and political advancement [1].

The Internet has quickly become an indispensable tool in Eastern society. Many people use the Internet daily for work or private purposes. Searching for job online have also become popular activities [6], [2].

The Internet links are computer networks all over the world so that users can share resources and communicate with each other. Some computers have direct access to all the facilities on the Internet such as the universities, libraries, and government websites. And privately-owned computers, have indirect links through a commercial service provider, who offers some or all of the Internet facilities. In order to be connected to Internet, you must go through service suppliers. Many options are offered with monthly rates. Depending on the option chosen, access time may vary [1].

The "Web", short for "World Wide Web" (which gives us the acronym www), is the name for one of the ways that the Internet lets people browse documents in the networks connected by hypertext links [3].

The principle of the Web is based on using hyperlinks to navigate between documents (web pages) with a program called a browser such as (Firefox, Internet Explorer, chrome). A web page is a simple text file written in one of the programming such as (Html, Visual C#, PHP,…etc) that encodes the layout of the document, graphical elements, and links to other documents, all with the help of tags [3].

WebPages are transported and accessed with the Hypertext Transfer Protocol (HTTP), which may optionally employ encryption (HTTP Secure, HTTPS) to provide security and privacy for the user of the webpage content. The user's application, often a web browser, renders the page content according to its HTML markup instructions onto a display terminal. There are two types of websites:[4]

- **Static website**

A static website is one that has web pages stored on the server in the format that is sent to a client web browser. It is primarily coded in Hypertext Markup Language (HTML).

- **Dynamic website**

A dynamic website is one that changes or customizes itself frequently and automatically, based on certain criteria.

Essentially, the idea of Online Registration is to lead students to a convenient way of applying online by using Asp.Net technique with C# language and visual studio 2008 and publishing website on server 2008. Students will be able to save their time and money, plus submit their information with just in few minutes. In additional, can be done anytime, anywhere according to their preferences. On the whole this research intends to study four main criteria that can contributes to customer satisfaction in Iraq which are design online forum for Iraqi Universities, quality database with rich in private information to each student, quality of information, high security website, and saving time.

Table 1: Reasons why students going to Online Registration

Reasons	Persent (Number of Students 1200)
Easier	83%
Save time / Convenience	90%
Save money	70%
Available in (anytime / anywhere)	90%
Other	8%

2 LITERATURE REVIEW

There has been plentiful research in this area recently, which has yielded in online application with database better to use the Asp.Net technique with C# language.

(Lisa M., 2011) [9] who design the success Program Online Teaching (POT) Certificate Class indicates that an open online class may be an appropriate format for advancing the professional development of online college instructors and others engaged in online teaching.

(U.Nanaji et al. 2013) [10] makes a survey about such types of protection mechanism and makes awareness to the people.

(Chih-Chieh Yang, et al. 2008) [11] present their novel methodologies for enhancing the streaming capabilities of Java RMI to provide a flexible and convenient framework for streaming applications.

(Sendy, Tim, Martin, and Jan, 2007) have sought to provide more insights into the relationships among the frequencies of online searching, online buying, and non-daily shopping trips, while taking account of other factors known to affect shopping behavior in a structural equation modeling analysis.

(Kala et al., 2013) [8] who identifies the factors that may influence Malaysian customer's online shopping satisfaction.

3 THE BASIC OF ASP.NET

ASP.NET is a server-side Web application framework designed for Web development to create dynamic Web pages. It was developed by Microsoft to allow programmers to build dynamic web sites, web applications and web services. It takes an object-oriented programming approach to Web page execution. Every element in an ASP.NET page is treated as an object and run on the server. It was developed in direct response to the problems that developers had with classic Active Server Pages (ASP). ASP.NET is built on the Common Language Runtime (CLR), allowing programmers to write ASP.NET code using any supported .NET language [5],[7].

4 RESEARCH DESIGN AND METHODOLOGY

The main work of this research was to design an online registration forum for university of diyala students to provide their information and documents for accepting letter at the university. Fig. 1 presents an overview of our proposed architecture, called Registration Online.

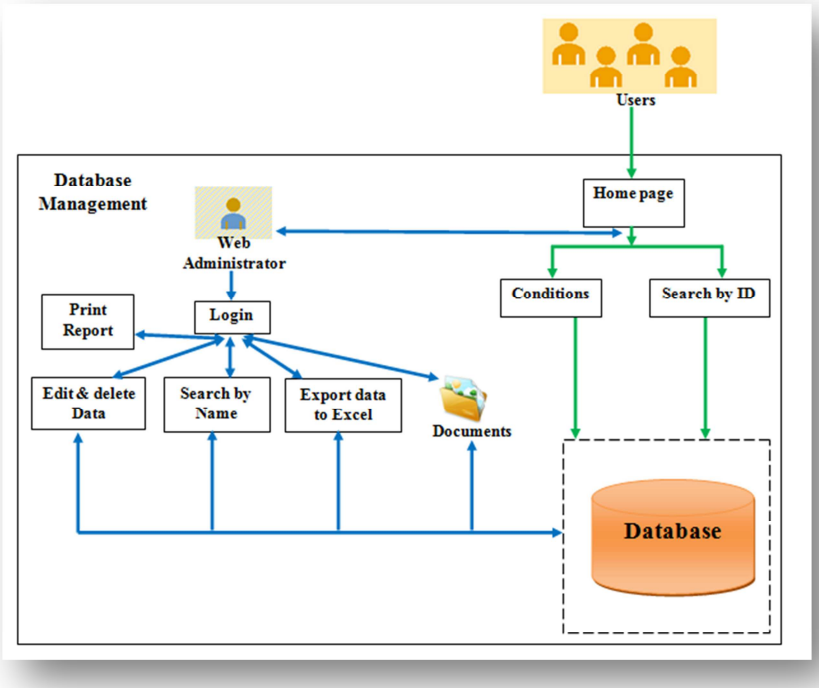


Fig. 1. Overview of Online Registration Architecture.

Several important pages are needed in the design.

User's interface: the area of the Web store that is accessed by users (students) to the Online Registration. User interfaces exist in any server, and provide a means of:

- Input, allowing the users to manipulate a system
- Output, allowing the system to indicate the effects of the users' manipulation.

(Home page, College registration page, Finishing registration page, etc) and other pages (e.g. contact us page, conditions page, etc.) are dynamically generated by the software based on the information saved in the store database.

Home Page is the first page illustrate when student open the website at (www.apply.uodiyala.edu.iq). Home Page contains fourteen colleges of university of diyala. in addition, in front of each college there is a number, this number means "numbers of students apply in this college". Also its contain Dropdown list button that make students free to choose the college from the list. Fig.2 shown the Home Page.

College Registration Page is the forum shows the necessary fields for the college you chose it from the first page. Fig.3 revealed registering at engineering college.

Finishing Registration Page is the last page presented after student submitted their information data through the Online Registration. It contained full name of student who filled the application forum with the unique number of application and also student can print final information by clicking on print page. Appendix A shows student forum. Fig.4 illustrated Finishing Registration Page.
Furthermore, the look of the Online Registration can normally be changed by the store owner so that it merges with the rest of the Web site.

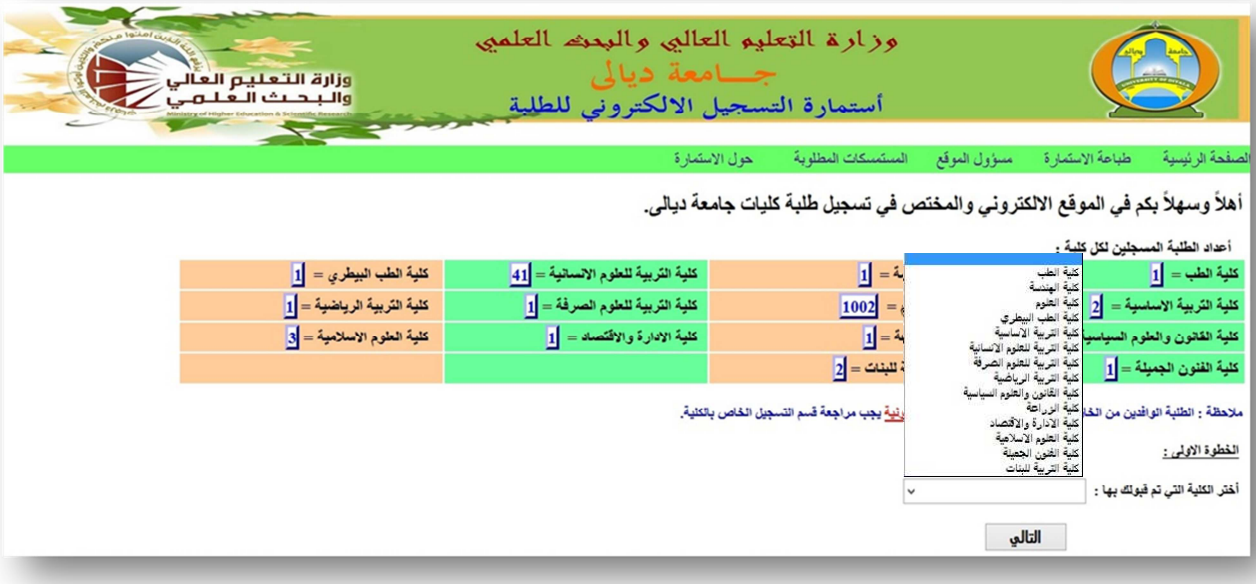


Fig.2 : Screenshot from Home Page of Online Registration web browser, Mozilla Firefox.



Fig.3 : An exmple of registering at engineering college.



Fig.4 : Finishing Registration Page.

Administrator interface: the area of the Web store that is accessed by the admin to manage the Registration Online. In general a store manager is able to **(insert, edit, show details, Search by name and export data to excel sheet, etc)**. Fig.5 shown the Administrator control panel.



Fig.5 : Administrator Control Panel.

Security

Security is a very important consideration with any website, **a Login page** is included in the design to obtain access to a website control. Also **Logout page** can close the control system is intended.

The administration area can be:

- Web-based (accessed through a Web browser).
- Desktop-based (a desktop application that runs on the user's computer and then transfers changes to the storefront component).

5 CONCLUSION

The Internet is grow to be an increasing part of our personal and professional lives. The study reported in this paper has introduced some of technology behind the internet and Web and has illustrated how students registering online at University of Diyala with easy, safety, and economic way. Research results show that students are more familiar and have more positive attitude for applying online. The online registration will benefit University of Diyala in many way. First, it provides an high quality database. It prevents crowds in front of centre of registration office at university. And the data is inserted automatic by students through the online registration that will help employees at centre of registration office to achieve their work quickly. The whole system is available at (www.apply.uodiyala.edu.iq).

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APPENDIX A

بســـــــــــــــم الله الرحمن الرحيم



أستمارة التسجيل الالكتروني
جامعة ديالى - كلية الهندسة

طباعة الاستمارة

رقم الاستمارة : 2

الاسم الرباعي واللقب : ليث كاظم فرحان البياتي

الكلية : كلية الهندسة

الجنس : ذكر الحالة الاجتماعية : أعزب الديانة : مسلم القومية : عربي

محل الولادة : ديالى تاريخ الولادة : 22/07/2014 المحافظة : ديالى

مسقط راس الاب : ديالى مسقط راس الجد : ديالى

ولي امر الطالب : كاظم فرحان خضير عنوانه : ديالى - الخالص

عنوان السكن الدائم:

المحافظة : ديالى القضاء : الخالص

الناحية : هبهب الحي : الخويلص

رقم هوية الاحوال : 8899 تاريخ اصدارها : 08/07/2014

محل اصدارها : هبهب

رقم شهادة الجنسية : 9876 تاريخ اصدارها : 09/07/2014

محل اصدارها : بعقوبة رقم الموبايل : 07700762638



أستمارة التسجيل الالكتروني
جامعة ديالى - كلية الهندسة

معلومات الدراسة الاعدادية للفرع العلمي :

الفرع الدراسي : علمي اسم المدرسة : الازهر الرقم الامتحاني : 211209876543

مجموع الدرجات : 555 سنة التخرج : 2014 / 2013 الدور : الاول

درجات المواد الدراسية:

المادة الدراسية	الاسلامية	اللغة العربية	اللغة الانكليزية	الرياضيات	الاحياء	الكيمياء	الفيزياء	المجموع
الدرجة رقماً	80	89	90	91	100	95	99	555

أختيار الاقسام:

أقسام الكلية		حقول رغبة الطالب	
التسلسل	القسم	الاختيار	القسم
1	قسم الحاسبات والبرامجيات	الاختيار الاول	قسم هندسة الحاسبات والبرامجيات
2	قسم الهندسة المدنية	الاختيار الثاني	قسم الهندسة الالكترونية
3	قسم هندسة الاتصالات	الاختيار الثالث	قسم هندسة الاتصالات
4	قسم الهندسة الالكترونية	الاختيار الرابع	قسم الهندسة المدنية
5	قسم هندسة الكيمياوي	الاختيار الخامس	قسم هندسة القدرة والمكائن الكهربائية
6	قسم الهندسة الميكانيكية	الاختيار السادس	قسم الهندسة الميكانيكية
7	قسم هندسة القدرة والمكائن الكهربائية	الاختيار السابع	قسم هندسة الكيمياوية

* تم التسجيل على الانترنيت في 10:58 PM 7/10/2014 , أصادق على جميع البيانات المدخلة من قبلي, وبخلاف ذالك اتحمل كافة المسؤولية القانونية المترتبة علية.

أستمارة التعهدات

*** يجب أن تملئ باليد مع التوقيع عليها.**

أنني الطالب ( ) المقبول في كلية الهندسة / جامعة ديالى للعام الدراسي :
أتعهد بأنني غير راسب في الصف (السادس الاعدادي) ولم يتم ترشيحي او قبولي في اي كلية او معهد سابقاً وبخلافه اتحمل كافة الاجراءات القانونية.

توقيع :
أسم الطالب :
التاريخ :

تعهد شخصي

أنا الموقع ادناه ( ) ، الساكن في منطقة ( )،
محلة ( ) ، زقاق ( ) ، رقم الدار ( ) ، وبصفتي احد اقرباء الطالب ومن الدرجة ( ) أكون ملزماً بالتضامن معه بتسديد كافة النفقات الدراسية المترتبة على الطالب بموجب قرار مجلس قيادة الثورة المرقم (106) في (4 / 2 / 1985) وفي حالة الاخلال في احد بنود التعهد فأني متعهد بدفع كافة المبالغ المترتبة وفق ذالك من اموالي المنقولة ودون حاجة الى انذار رسمي او مراجعة المحاكم .

أسم المتعهد : ..... مهنته : .....

عنوانه الكامل : .....

رقم الهوية : ..... تاريخ اصدارها : .....

جهة أصدارها : .....

توقيع المتعهد : ..... بتاريخ : .....

المستمسكات المطلوب احضارها اصلية:
1- طباعة الاستمارة الالكترونية مع التعهدات 2- وثيقة مدرسية معنونة الى كلية الهندسة / جامعة ديالى ومصدقة من مديرية التربية .
المستمسكات المطلوبة على قرص (CD)
1- وثيقة مدرسية معنونة الى كلية الهندسة / جامعة ديالى ومصدقة من مديرية التربية .
2- الفحص الطبي. 3- هوية الكفيل + تاييد استمرار بالخدمة. 4- بطاقة مدرسية او مايعادلها.
5- هوية الاحوال المدنية للطالب وللوالدين. 6- شهادة جنسية الطالب وللوالدين. 7- تاييد سكن (بصورة) او بطاقة السكن.
8- بطاقة تموينية. 9- تعهد خطي للطالب. 10- شهادة وفاة في حالة وفاة احد الوالدين.
11- الامر الاداري الخاص بالاجازات الدراسية بالنسبة للمعلمين المجازين مدرسياً.

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EFFECT OF GEOMETRIC DESIGN ON HIGHWAY SAFETY (ADO – IKERE ROAD, SOUTHWESTERN, NIGERIA AS A CASE STUDY)

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ABSTRACT: The economic growth of a country is somehow dependent on the road network of such country and for the highways to be very effective, its geometrical features must be in line with required standards. A study for the effects of geometrical features on highway was conducted on Ado-Ikere road, Nigeria. The paper therefore looks into the critical points where accidents occur frequently along the road. Some geometrical features on these points were examined and it was observed that the medians measured 1.00m to 2.00m instead of the standard of 5.0m while the shoulders measured between 1.50m to 2.7m instead of 2.75m. The specified drainage design width of 3.00m ranges between 0.60m and 0.63m when measured and the right of way of 60.00m standard value ranges between 25.50m to 45.00m while the sight distance of 150.00m for the design speed of 100km/h ranges between 38m – 120m at Chainage 0 + 000 to Chainage 3 + 150 along the route. It was also discovered that there was no provision for other features like pedestrian walkways, lay-by, road markings and traffic light at intersections. The improper construction on the field could be the cause of accident along the route and may need to be re-constructed in conformity with the standard specifications.

KEYWORDS: Effect, Geometric Design, Highway, Safety, Ado – Ekiti, Ikere.

1 BACKGROUND

Good road network is a factor on which the economy of a nation depends and the planning of the effectiveness and optimum utilization of the roads must be a continuous process. The geometric parameters such as intersections, interchanges, curves etc. are mostly incorporated into highway designs for convenience and safety of the users.

This paper therefore aimed at highlighting the problems of poor planning and layout (with regards to geometrical features) of Ado – Ikere road, which is one of the major roads affecting the economic, social and political development of Ekiti-State, Nigeria and has recorded some casualties due to accidents in the recent past as shown in tables 1 & 2.

The horizontal alignment of a road must be carefully chosen to have a good correlation with the vertical alignment and the elements such as radius of curvature, design speed, lane width, and details of super elevation and adequate sight distance must be adequately considered [8].

The design speed of a road may not necessarily be its maximum safe speed but a major factor in choosing super elevation rates and radii of curves, sight distances and length of crest and sag of vertical curves. Road with lighter travel speed requires sweeping curves, steeper curve banking's, longer sight distances and more gentle hill crest and valley [9].

Provision of adequate drainage is of paramount importance in road design since it reduces / eliminates the energy generated by flowing water which adversely affects the engineering properties of the materials with which the road is constructed [6].

Shoulders must be adequate in both sides of the roadway but for congestion relieve, lane width reduction to about 3.4m should first be considered while reduction of the left shoulder must be considered with that of the right [5].

Corresponding Author: O. O. Ayeni

Super-elevation, which is described in terms of super-elevation rate, is the rise in the roadway super-elevation for inside to outside edge of the road and the maximum permissible super-elevation is recommended by I.R.C [3].

The lane width is limited by the physical dimensions of automobile and trucks to be a range of 2.7 and 3.6m and it increases with an increase in the design speed of the highway [9].

The general range of median width is from 1.2m usually in urban areas to 2.4m or more in rural areas [4].

2 MATERIAL AND METHODS

Geometrical features of the highway like median width, lane width, shoulder, drainage width and right of way was measured directly in site using the steel tape. Leveling of the route was carried out using a digital leveling instrument while the speed at which vehicles plies the critical portions was determined by boarding different vehicles plying the route and the speed of each vehicle observed and determined and the super-elevation calculated using the I.R.C recommended equation.

$$E = \frac{V^2}{225\ R}$$

E = Super – elevation
V = Speed Limit
R = Radius of curvature

Table 1: Accident recorded along Ado-Ikere road for the year 2010

S/N	DATE	NO. OF PEOPLE INVOLVE	NO. OF PEOPLE INJURED	NO. OF PEOPLE KILLED	TOTAL CASUALTY
1	13-032-010	02(2m)	02(2m)	-	02(2m)
2	02-04-2010	01(1m)	-	01(1m)	01(1m)
3	07-042010	01(1m)	01(1m)	-	01(1m)
4	10-04-2010	06(5m,1f)	04(4m)	-	04(4m)
5	28-06-2010	02(2m)	01(1m)	-	01(1m)
6	27-09-2010	02(2m)	01(1m)	-	01(1m)
7	26-10-2010	06(6m)	06(6m)	-	06(6m)
8	01-11-2010	01(1m)	01(1m)	-	01(1m)
9	23-11-2010	03(3m)	02(1m,1f)	-	02(1m,1f)

***N.B.** M – Male, F – Female*
Source: FRSC ADO-EKITI

Table 1. Table 2: Accident recorded along Ado-Ikere road for the 2011 (Source: FRSC, ADO-EKITI)

S/N	DATE	NO. OF PEOPLE INVOLVE	NO. OF PEOPLE INJURED	NO. OF PEOPLE KILLED	TOTAL CASUALTY
1	01-02-2011	09(6m,3f)	03(2m,1f)	-	03(2m,1f)
2	03-02-2011	04(4m)	03(3m)	-	03(3m)
3	23-02-2011	03(2m,1f)	03(2m,1f)	-	03(2m,1f)
4	14-04-2011	03(3m)	01(1m)	-	01(1m)
5	12-06-2011	02(2m)	01(1m)	-	01(1m)
6	28-06-2011	14(10m,4f)	01(1m)	-	01(1m)
7	01-08-2011	02(1m,1f)	-	02(1m,1f)	02(1m,1f)
8	24-12-2011	02(2m)	02(2m)	-	02(2m)

***N.B.** M – Male, F – Female*

Table 3: IRC Standard and field measurement values of Geometric Design parameter

S/N	Element of highway geometry	IRC standard specification (m)	IRC STANDARD VALUE AND FIELD MEASUREMENT VALUE OF GEOMETRIC DESIGN PARAMETERS									
			FIELD VALUE									
			CHAINAGE									
			0+000	0+025	0+850	1+400	1+900	2+250	3+000	7+025	8+100	11+250
1	Lane width	7.30	8.62	7.32	7.35	7.37	7.33	7.30	7.31	7.32	7.32	7.31
2	Shoulders	2.75	1.63	1.52	1.41	1.40	1.35	1.33	1.55	2.70	2.72	2.70
3	Camber	1:48 – 1:60	Nil	Nil	Nil	Nil	Nil	Nil	Nil	1 in 48	1 in 48	1 in 48
4	Speed limit	100km/h	30km/h	40km/h	50km/h	60km/h	80km/h	80km/h	60km/h	100km/h	100km/h	100km/h
5	Right of way	60	28.50	25.50	35.00	37.00	35.00	35.00	38.00	60.00	45.00	45.00
6	Sight distance	150	38.00	50	77.00	87.00	120.00	75.00	150.00	150.00	150.00	150
7	Super elevation	0.10	Nil	0.04	Nil	0.10	0.03	0.10	Nil	Nil	Nil	0.10
8	Walk way	2.00	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
9	Median width	5.00	Nil	Nil	Nil	Nil	Nil	Nil	Nil	3.50	1.00	1.50
10	Drainage width	varies	0.61	0.62	0.62	0.62	0.61	0.60	0.62	0.62	0.61	0.62

3 DISCUSSIONS

From table 3, the lane width was seen to be adequate as it ranges from 7.30m to 7.38m while the shoulders were grossly inadequate, measuring 1.30m to 2.70m instead of 2.75m. Between chainage 0 + 000 to 3+ 350, the right of way was between 28.00m to 38.00m which is less than the standard of 60m. Since the road design speed was 100km/hr., the equivalent sight distance (I.R.C Recommendation) was 150m but 50m was measured at chainage 0 + 025, 77m in 0 + 850 and 38m in 3 + 350 which was far less than the specified value. No camber as provided between Ch. 0 + 000 to 3 + 350 while a camber of 1 in 48 was provided thereafter. Also, from Ch.0 + 000 to 3 + 350, no median was provided but thereafter a median of between 1.00m to 2.00m was provided which fell short of the 5.0m specified.

Speed Limit of 100km/hr. was adhered to by motorists but facilities such as road markings, walkways, lay-bys etc. were not provided on the roadway.

4 CONCLUSION

Though the entire route was designed as dual carriage way, single carriage way was seen between Chainage 0 + 000 to 3 + 350. Most of the geometrical features except the lane width do not conform satisfactorily to their respective specified values and the inadequacies may be the cause of increase number of accidents and congestion on the road.

However, the road may need to be re-designed and re-constructed in line with the specified geometric factors.

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Modélisation de la contagion financière de la Grèce et d'autres pays de la zone Euro

[Modeling of financial contagion between Greece and other countries of the Euro zone]

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ABSTRACT: The international financial crisis of 2007 is a good illustration of the realization and the spread of systemic risk. The banking crisis has peaked in September 2008 with the collapse of Lehman Brothers and later support for the financial system. In the spring of 2010, it turned into a sovereign debt crisis. Since the summer, 2011, general instability has continued to reach new heights. This article deals with a phenomenon that lies at the heart of the current situation in the euro area: the phenomenon of contagion. The contagion is one of the mechanisms by which financial instability spreads to the point that a crisis reached systemic proportions. In this article, we use the CDS as an instrument to test the contagion in the financial markets of 9 countries of the Euro area: Portugal, Ireland, Italy, Germany, Greece, Spain, Austria, France and Belgium using the DCC-GARCH model.

KEYWORDS: CDS, Sovereign CDS, financial contagion, the Euro zone, DCC GARCH model.

RESUME: La crise financière internationale de 2007 constitue une bonne illustration de la concrétisation et de la propagation du risque systémique. La crise bancaire a culminé en septembre 2008, avec la faillite de Lehman Brothers et le soutien apporté par la suite au système financier. Au printemps 2010, elle s'est transformée en crise de la dette souveraine. Depuis l'été 2011, l'instabilité générale n'a cessé d'atteindre de nouveaux sommets. Cet article traite d'un phénomène qui se trouve au cœur de la situation actuelle dans la zone euro : le phénomène de contagion. La contagion est l'un des mécanismes par lesquels l'instabilité financière se propage au point qu'une crise atteint des proportions systémiques. Dans cet article, on utilisera les CDS comme instrument pour tester la contagion des marchés financiers de 9 pays de la zone Euro : le Portugal, l'Irlande, l'Italie, l'allemand, la Grèce, l'Espagne, l'Autriche, la France et la Belgique en utilisant le modèle DCC-GARCH.

MOTS-CLEFS: CDS, CDS souverains, contagion financière, l'Euro zone, modèle DCC GARCH.

1 INTRODUCTION

La crise économique et financière qui a débuté en août 2007 est un cas évident de la matérialisation et la propagation du risque systémique. La crise bancaire a atteint son apogée en septembre 2008 avec l'effondrement de Lehman Brothers et

l'appui au système financier. Au printemps 2010, il est devenu une crise de la dette souveraine. Une instabilité généralisée atteint de nouveaux sommets à plusieurs reprises depuis l'été 2011.

Dans cet article, on voudrait aborder un phénomène qui est au cœur même de ce que nous vivons dans la zone euro, le phénomène de la contagion.

La contagion est un des mécanismes par lesquels l'instabilité financière devient tellement répandue qu'une crise atteint des dimensions systémiques. Les deux autres mécanismes qui constituent des facteurs de risque systémique sont les déséquilibres financiers majeurs et la volatilité inexpliquée [1] .

Dans cet article, on utilisera les CDS comme instrument pour tester la contagion des marchés financiers de 9 pays de la zone Euro : le Portugal, l'Irlande, l'Italie, l'allemand, la Grèce, l'Espagne, l'Autriche, la France et la Belgique en utilisant le modèle DCC-GARCH.

2 LA MÉTHODOLOGIE DU MODÈLE DCC-GARCH

Le modèle de la DCC a un principal avantage sur les autres modèles de corrélation, puisque le nombre de paramètres à estimer est indépendant du nombre de séries. Ainsi, on peut estimer de grandes matrices de corrélation. (Engel, 2002) Plus, le modèle est décrit comme parcimonieux car c'est un modèle en deux étapes où la première étape consiste à estimer Les modèles GARCH univariés de chaque actif, et ensuite, à utiliser les résidus transformé de la première étape pour estimer un estimateur de corrélation conditionnelle dans un second temps [2]. Enfin, selon Engel (2000), son modèle possède les caractéristiques d'être aussi flexible qu'un modèle GARCH univarié mais pas aussi complexes que le modèle GARCH multivarié [3].

Rendements l'écart conditionnelle fois la perturbation normalisée :

$$H_{i,t} = E_{t-1}(r^2{}_{i,t}), \qquad r_{i,t} = \sqrt{h_{i,t}\varepsilon_{i,t}}, \qquad i = 1,2$$

L'expression ci-dessus précise la relation entre les corrélations conditionnelles et les variances conditionnelles. En outre, epsilon est un terme de perturbation normalisé avec une moyenne égale à zéro et une variance égale à un.

Au lieu de la formule de corrélation normale

$$\rho_{12,t} = \frac{E_{t-1}(r_{1,t} r_{2,t})}{\sqrt{E_{t-1}(r^2{}_{1,t}) E_{t-1}(r^2{}_{2,t})}}$$

Il est donc possible d'écrire

$$\rho_{12,t} = \frac{E_{t-1}(\varepsilon_{1,t}\varepsilon_{2,t})}{\sqrt{E_{t-1}(\varepsilon^2{}_{1,t}) E_{t-1}(\varepsilon^2{}_{2,t})}} = E_{t-1}(\varepsilon_{1,t}, \varepsilon_{2,t})$$

Par conséquent, la formule ci-dessus affirme que la corrélation conditionnelle est égale à la covariance conditionnelle des perturbations normalisées.

En outre, le modèle supposent que les rendements sont conditionnellement multivariés normale avec une espérance de rendement égale à zéro et une matrice de covariance H_t.

$$r_t \left| \Omega_{t-1} \sim N(0, \mathrm{H}_t) \right.$$

Et

$$\mathrm{H}_t = D_t R_t D_t$$

Où $D_t = diag\left\{\sqrt{h_{i,t}}\right\}$ est une matrice diagonale des écarts types temporellement variables issues des modèles GARCH univariés avec $\sqrt{h_{it}}$ sur la $i^{ème}$ diagonale, et $R_t = \left\{\rho_{ij,t}\right\}$ représente la matrice des coefficients de corrélation conditionnelle.

$$D_t R_t D_t = \begin{bmatrix} \sqrt{h_{1,t}} & 0 \\ 0 & \sqrt{h_{2,t}} \end{bmatrix} \begin{bmatrix} \rho_{12} & 0 \\ 0 & \rho_{21} \end{bmatrix} \begin{bmatrix} \sqrt{h_{1,t}} & 0 \\ 0 & \sqrt{h_{2,t}} \end{bmatrix}$$

$$= \begin{bmatrix} \sqrt{h_{1,t}} & 0 \\ 0 & \sqrt{h_{2,t}} \end{bmatrix} \begin{bmatrix} \sqrt{h_{1,t}} & \rho_{12}\sqrt{h_{2,t}} \\ \rho_{21}\sqrt{h_{1,t}} & \sqrt{h_{2,t}} \end{bmatrix}$$

$$= \begin{bmatrix} {h_{1,t}}^2 & \sqrt{h_{1,t}}\rho_{12}\sqrt{h_{2,t}} \\ \sqrt{h_{2,t}}\rho_{21}\sqrt{h_{1,t}} & {h_{2,t}}^2 \end{bmatrix}$$

$$= \begin{bmatrix} {\sigma_{1,t}}^2 & \dfrac{\sigma_{12,t}}{\sigma_{1,t}\sigma_{2,t}}\sigma_{1,t}\sigma_{2,t} \\ \dfrac{\sigma_{21,t}}{\sigma_{2,t}\sigma_{1,t}}\sigma_{1,t}\sigma_{2,t} & {\sigma_{2,t}}^2 \end{bmatrix}$$

$$= \begin{bmatrix} {\sigma_{1,t}}^2 & \sigma_{12,t} \\ \sigma_{21,t} & {\sigma_{2,t}}^2 \end{bmatrix}$$

Le modèle DCC diffère de la façon qu'il permet à *R* d'être temporellement variable, c'est-à-dire conditionnelle. Ceci rend le modèle plus applicable, puisque l'hypothèse d'une corrélation conditionnelle constante est sans doute trop restrictive sur des longues périodes [4].

Dans cette étude le modèle DCC suit une spécification GARCH(1,1)

$$q_{ij,t} = \overline{\rho}_{ij} + \alpha(\varepsilon_{i,t-1}\varepsilon_{j,t-1} - \overline{\rho}_{ij}) + \beta(q_{ij,t-1} - \overline{\rho}_{ij})$$

et la forme multivariée

$$\sigma_t^2 = \sigma^2 + \alpha(r_{w,t-1}^2 - \sigma^2) + \beta(\sigma_{t-1}^2 - \sigma^2)$$

$\overline{\rho}_{ij}$ est l'espérance inconditionnelle du produit croisé tandis que pour les variances $\overline{\rho}_{ii}$ =1 et l'estimateur conditionnel qui a la propriété satisfaisante d'être positive défini :

$$\rho_{ij,t} = q_{ij,t} \Big/ \sqrt{q_{ii,t}\, q_{jj,t}}$$

L'espérance inconditionnelle du numérateur de la formule ci-dessus est $\overline{\rho}_{ij}$ et chaque terme du dénominateur a une valeur d'espérance égale à 1.

En outre, le modèle DCC spécifié aura les propriétés d'un processus de retour à la moyenne tant que :

$$\alpha + \beta < 1$$

Pour garantir que le modèle est positif défini que les paramètres sont contraints à être positif :

$$\alpha \geq 0 \quad ; \quad \beta \geq 0$$

Enfin, l'estimateur de la Log vraisemblance peut être exprimé comme suit et il est maximisé sur les paramètres de modèles

$$r_t \left| \Omega_{t-1} \sim N(0, \mathrm{H}_t) \right.$$

$$L = -\frac{1}{2}\sum_t (n\log(2\pi) + \log\left|H_t\right| + r_t' H_t^{-1} r_t)$$

$$= -\frac{1}{2}\sum_t (n\log(2\pi) + \log\left|D_t H_t D_t\right| + r_t' D_t^{-1} R_T^{-1} D_t^{-1} r_t)$$

$$= -\frac{1}{2}\sum_t (n\log(2\pi) + 2\log\left|D_t\right| + \log\left|R_t\right| + \varepsilon_t' R_t^{-1} \varepsilon_t)$$

$$= -\frac{1}{2}\sum_t (n\log(2\pi) + 2\log\left|D_t\right| + r_t' D_t^{-1} R_t^{-1} D_t^{-1} r_t - \varepsilon_t' \varepsilon_t + \log\left|R_t\right| + \varepsilon_t' R_t^{-1} \varepsilon_t)$$

Le code de programmation utilisé dans Eviews 6 se trouve à l'annexe (Annexe I).

2.1 ESTIMATEUR DE LA VOLATILITÉ : LE MODÈLE GARCH

Le modèle symétrique de GARCH(1,1) qui a été initialement introduit par Bollerslev (1986) qui est appliqué dans la première étape dans le modèle DCC peut être écrit comme suit :

$$\sigma^2 = \omega + \alpha r_{w,t-1}^2 + \beta \sigma_{t-1}^2$$

Les paramètres du vecteur GARCH sont estimés par la maximisation de la fonction de Log vraisemblance.

$$Log\ L(\theta; r_{w,t}, \ldots, r_{w,1})\alpha\ - \sum_{t=1}^{T} \left[\log \sigma_t^2(\theta)\ - \sigma_t^{-2}(\theta) r_{w,t}^2 \right]$$

Tout d'abord, un processus GARCH(1,1) implique que la volatilité réelle est une moyenne mobile pondérée exponentielle des rendements passés au carré. Deuxièmement, la covariance du processus GARCH(1,1) stationnaire a des dynamiques qui produit éventuellement une réversion de la volatilité à une valeur constante à long terme, ce qui permet des prévisions réalistes et intéressantes.

Après dérivation, on peut réécrire le modèle GARCH(1,1) comme suit :

$$\sigma_t^2 = (1 - \alpha - \beta)\sigma^2 + \alpha r_{w,t-1}^2 + \beta_{t-1}^2$$

$\sigma^2 = \omega / (1 - \sigma - \beta)$ indique la variation à long terme, ou inconditionnelle. Cette représentation montre que les prévisions GARCH sont construites comme une moyenne de trois éléments.

De manière équivalente, on peut écrire également le modèle comme suit :

$$\sigma_t^2 = \sigma^2 + \alpha(r_{w,t-1}^2 - \sigma^2) + \beta(\sigma_{t-1}^2 - \sigma^2)$$

Ce qui montre explicitement comment le modèle GARCH(1,1) prévoit, en faisant des ajustements à la variance réelle, l'influence de du rendement au carré de long terme, ou variance inconditionnelle, enfin, on peut aussi écrire :

$$\sigma_t^2 = \sigma^2 + (\alpha + \beta)(\sigma_{t-1}^2 - \sigma^2) + \alpha\sigma_{t-1}^2(z_{t-1}^2 - 1)$$

Où le dernier terme sur la côté droite en moyenne est égal à zéro. Par conséquent, cela montre comment le modèle GARCH(1,1) Prévoit en faisant des ajustements autour de la variance de long terme avec la variance persistance régie par $(\alpha + \beta)$ et la volatilité de la volatilité liée au niveau de volatilité ainsi que la taille d' α [5] .

2.2 ANALYSE ECONOMETRIQUE

2.2.1 STATIONNARITE

Si une série satisfait les trois conditions ci-dessous elle dite un processus stationnaire faible. Un processus stationnaire doit avoir une moyenne constante, une variance constante et une structure d'autocovariance constante. Si la variance constante et la moyenne constante est facile à interpréter, la structure d'autocovariance constante peut être un peu plus lourd. Elle détermine comment y correspond aux valeurs précédentes, et pour un processus stationnaire la covariance entre y_t et y_{t-1} devrait être le même comme pour y_{t-10} et y_{t-11} (Brooks, 2008).

$$E(y_t) = m$$
$$E(y_t - m)(y_{t2} - m) = \sigma^2 < \infty$$
$$E(y_t - m)(y_{t2} - m) = y_{t2-t1} \ \forall t_1, t_2$$

Il est important de tester la stationnarité des séries de données. Dans le cas contraire, des séries non stationnaires peuvent trouver des résultats fallacieux entre les différentes variables, ce qui signifie que les relations trouvées sont sans valeur. En outre, une analyse asymptotique sera effectuée dans le présente étude et les hypothèses de normalité ne sont pas valides lorsque les séries employée sont non stationnaires. Enfin, les chocs dans les séries non stationnaires ne s'atténuent pas de suite [6].

2.2.2 TEST DE DICKEY-FULLER AUGMENTÉ (ADF)

Les tests de Dikey-Fuller Augmentés (ADF, 1981) consiste à comparer la valeur estimé de t de Student associé au paramètre ϕ aux valeurs tabulés de cette statistique. Les valeurs tabulées pour ces tests diffèrent cependant des valeurs tabulées du test de Student. Les valeurs critiques de cette statistique, notée ADF dans ce qui suit, sont données par MacKinnon (1996). L'hypothèse nulle de non stationnarité de la série temporelle est rejetée au seuil de 5% lorsque la valeur observée du test de Student est inférieur à la valeur critique tabulée par Mackinnon (1996) ou $t_{ols} < ADF_{.05}$.

Les Modèles de test ADF, ne prends pour hypothèse les processus ε_t pour bruit blanc (au contraire pour les Tests Dikey fuller simple), autrement dit dans ces tests, il n' y a aucune raison que pour que, à priori l'erreur soit non corrélée.

Les tests ADF sont fondés, sous l'hypothèse alternative $|\phi_1| < 1$, ses trois ur l'estimation par les MCO des trois modèles :

$$Modèle[4]: \Delta y_t = \rho y_{t-1} - \sum_{j=2}^{p} \phi \Delta y_{t-j+1} + \varepsilon_t$$

$$Modèle[5]: \Delta y_t = \rho y_{t-1} - \sum_{j=2}^{p} \phi \Delta y_{t-j+1} + c + \varepsilon_t$$

$$Modèle[6]: \Delta y_t = \rho y_{t-1} - \sum_{j=2}^{p} \phi \Delta y_{t-j+1} + c + bt + \varepsilon_t$$

Le test se déroule de manière similaire aux tests ADF simples, seules les tables statiqtiques diffèrent. La valeur de ρ peut-être déterminée selon les critères d'Akaike et de Swartz, ou encore en partant d'une valeur suffisamment importante de ρ , on estime un modèle $\rho - 1$, puis $\rho - 2$ retards, jusqu'à ce que le coefficient du $\rho^{ième}$ retard soit significatif [5].

$$H_0 = Non - stationnaire$$

Ce qui est testé, si la série contient une racine unitaire, elle est rejetée. Par conséquent, H_0 est rejetée, si la statistique du test est plus négative que la valeur critique.

Dans le cas de notre étude, les séries des spreads de CDS ont une racine unitaire, nous les avons stationarisé en utilisant le logarithme des différences premières :

$$r_{w,t} = \log(y_t) - \log(y_{t-1})$$

Avec

y_t est le spread des CDS du pays i, $i = 1,.....9$ à la période t

Et $r_{w,t}$ représente Les logarithmes des rendements.

2.2.3 LA MÉTHODE MAXIMUM DE VRAISEMBLANCE

La méthode de maximum de vraisemblance choisit les valeurs des paramètres qui sont plus susceptibles d'avoir produit les données observées. Une fonction de vraisemblance (FV) est une fonction multiplicative des données réelles, cependant, en raison de sa complexité afin de maximiser la fonction avec le respect des paramètres, le logarithme est pris en considération. Ainsi, il va se transformer la fonction de vraisemblance (LF) en une fonction additive de l'échantillon des données, qui est connu sous le nom de la fonction de Log-vraisemblance (FLF). Maximiser la fonction de Log-vraisemblance (FLF) est fait de chercher l'espace de paramètre jusqu'à ce que les « bonnes » valeurs sont trouvées, ce qui est équivalente à minimiser conjointement :

$$\sum_{t=1}^{T} \log\sigma_t^2$$

Et

$$\sum_{t=1}^{T} \frac{(y_t - m - \phi y_{t-1})^2}{\sigma_t^2}$$

Où σ_t^2 est la variance conditionnelle temporellement variable instationnaire des erreurs normalisées. Dans cette étude la technique itérative est appliquée afin de maximiser la fonction de Log-vraisemblance (FLF). Cela implique que les valeurs des paramètres initiaux sont choisies, et que à partir de ces paramètres les valeurs sont mises à jour après chaque itération jusqu'à ce que l'optimum soit atteint. L'inconvénient de cette méthode est que plusieurs des maximums locaux peuvent exister, dans lequel des valeurs initiales différentes peuvent ainsi conduire à des résultats différents.

3 DONNEES ET RESULTATS DES ESTIMATIONS

3.1 LES DONNÉES DU MODÈLE

Les données utilisées sont les CDS souverains journaliers de 9 pays : le Portugal, l'Irlande, l'Italie, l'allemand, la Grèce, l'Espagne, l'Autriche, la France et la Belgique.

Elles sont extraites de la base de données de REUTERS. La période d'observation s'étale du 8 janvier 2008 jusqu'à 21 Aout 2010 (un échantillon en continu c'est-à-dire sans compter les weekends).

Les choix de la période et du nombre de branches sont dictés par la disponibilité des données.

3.2 LES STATISTIQUES DESCRIPTIVES

Table 1. Exemple d'un tableau

Pays	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Observations
PORTUGAL	243.8842	1216.228	18.33300	262.9989	1.494855	4.612321	965
ITALY	134.4939	504.1960	18.16700	78.31555	1.144662	5.438879	965
IRELAND	263.0485	1191.501	10.99500	256.9855	0.973366	3.018063	965
GREECE	531.4698	4048.961	20.83300	589.1349	1.706493	6.523806	965
SPAIN	146.3803	429.5300	16.66700	101.0306	0.668389	2.383973	965
GERMANY	35.48127	90.61000	5.566000	18.62864	0.547485	3.331039	965
FRANCE	53.51237	192.5150	6.250000	36.00543	0.829238	3.861586	965
AUSTRIA	74.09902	268.9800	4.500000	46.25340	0.982478	5.618786	965
BELGIUM	89.00446	298.5340	7.750000	62.78057	0.816633	2.983502	965

Les statistiques descriptives montre des disparités au niveaux des comportement des spreads des CDS souverains, les hausses les plus importantes des spreads sont accusées par les pays connus durant la crise de la zone euro sous le nom de PIIGS , la Grèce avec 4048.96, le Portugal avec 1216.228, l'Irlande avec 1191.501 et l'Espagne avec 429.53. Donc deux pays du cœur de la zone ont vu leur dette publique surévalué qui sont l'Italie et l'Espagne et 3 pays de la périphérie de la zone euro sont également touchés qui sont la Grèce, l'Irlande et le Portugal. En terme de volatilité, Les écart types (standard deviations) montrent que les valeurs les plus volatiles sur les marchés financiers des CDS souverains sont : la Grèce avec un écart type de 589.13 suivi du Portugal avec un écart type de 262.99, suivi de l'Irlande avec un écart type de 256.98 et puis de l'Espagne avec un écart type de 101.03. Les valeurs les moins volatiles sont l'Allemagne avec 18.62 et la France avec 36.005.

Ces variables sont caractérisées par des coefficients d'aplatissement (kurtosis) différents selon les pays. En effet Le Portugal, l'Italie, la Grèce, l'Allemagne, l'Irlande, la France et l'Autriche ont une distribution leptokurtique (coefficient d'aplatissement > 3), plus tranchante qu'une distribution normale, avec des valeurs concentrées autour de la moyenne et les queues épaisses. Cela signifie une forte probabilité pour les valeurs extrêmes. Alors que pour l'Espagne et la Belgique ont une distribution platicurtique (coefficient d'aplatissement > 3) , plus plate que d'une distribution normale avec un pic plus large. La probabilité pour que les valeurs extrêmes est inférieure à une distribution normale, et les valeurs représentent la plus large diffusion autour de la moyenne.

Les variables ont tous des coefficients d'asymétrie>0, c'est-à-dire une répartition asymétrique à droite, la plupart des valeurs sont concentrées gauche de la moyenne, avec des valeurs extrêmes à droite.

4 LES RÉSULTATS DES ESTIMATIONS

Étant donné que les estimations des deux paramètres DCC sont significatives au niveau de 5%, tous les supportent le modèle de corrélation conditionnelle dynamique. En d'autres termes, l'hypothèse à propos de la présence des structures de corrélation stable entre les séries est rejetée. Le tableau suivant montre les valeurs des paramètres estimé les α et β respectivement, générées par le modèle DCC.

Table 2. Résultats des estimations DCC-GARCH

Pays	Coefficients	Std.Error	Z-Statistics	Prob.
Grèce /Autriche				
α	0.025127 ***	0.002737	9.180192	0.0000
β	0.970394***	0.003279	295.9458	0.0000
Grèce /Belgique				
α	0.179104***	0.008139	22.00499	0.0000
β	0.658412***	0.012431	52.96594	0.0000
Grèce /Irlande				
α	0.078574***	4.64E-06	16937.40	0.0000
β	0.920871***	9.60E-06	95954.41	0.0000
Grèce /Allemagne				
α	0.037835***	0.002956	12.80149	0.0000
β	0.964457***	0.002890	333.7625	0.0000
Grèce /Italie				
α	0.131658***	0.011680	11.27230	0.0000
β	0.842207***	0.015064	55.90764	0.0000
Grèce /Portugal				
α	0.048547***	0.003222	15.06779	0.0000
β	0.936586***	0.003897	240.3494	0.0000
Grèce /France				
α	0.081359***	0.011683	6.964082	0.0000
β	0.882037***	0.017239	51.16592	0.0000
Grèce /Espagne				
α	0.230451***	0.015349	15.01379	0.0000
β	0.617598***	0.016401	37.65687	0.0000

*** Sinification au seuil de 5%

La persistance des chocs à court terme sur les corrélations dynamiques est plus grande entre Grèce /Espagne, suivi par Grèce /Belgique, suivi par Grèce/, en raison de leur valeurs des α élevés. L'effet à court terme dans le pair de corrélation entre Grèce /Espagne et le pair de corrélation Grèce/Belgique est augmenté puisque les deux pairs de corrélation ont vu également la valeur de leur paramètre β le plus bas, par conséquent l'estimation de la corrélation temporellement variante estimée devient donc encore plus sensible aux chocs à court terme. Ainsi, cela indique qu'il n'existe pas une structure de corrélation stable entre les couple Grèce /Espagne et aussi entre les couple Grèce/Belgique, ils sont donc relativement pays moins étroitement liés. Toutes les autres paires de corrélation ont des valeurs relativement élevées de β, ce qui indique que le modèle met plus de poids aux informations de long terme. Par conséquent, il y a une relation de corrélation de long terme entre les autres différents pays. Enfin, toutes les spécifications du modèle ont la propriété des processus de retour à la moyenne puisque les valeurs de paramètres sont conjointement inférieures à l'unité.

Pour s'assurer que les résultats de l'étude sont fiables, la propriété statistique de stationnarités des résidus standardisés issus des estimations du modèle GARCH(1,1), sont une condition nécessaire pour le modèle DCC (Engle, 2002). Ainsi, un test de stationnaire des résidus standardisés GARCH a été fait. Le test ADF montre que tous les résidus standardisés de chaque

série GARCH stationnaire. Les résultats des estimations des valeurs des paramètres du modèle GARCH(1,1) sont mentionnés dans le tableau 3. Nous présentons ci-après les résultats des estimations graphiques des Corrélations conditionnelle dynamiques entre la Grèce et les autres souverains (figure 1).

Table 3. Résultats des estimations GARCH(1,1)

Pays	ω	α	β
Grèce	6.99E-05***	0.103188***	0.890707***
	(3.017277)	(2.761551)	(26.94326)
Espagne	0.000140***	0.193727***	0.763762***
	(3.607115)	(4.833613)	(19.55682)
Portugal	8.31E-05	0.184310	0.814755
	(1.239627)	(2.739893)	(10.66215)
Italie	0.000104***	0.240690***	0.758166***
	(2.224598)	(3.501398)	(11.47930)
Irlande	0.007450***	0.191790***	0.797048***
	(1.540064)	(1.698533)	(1.336898)
Allemagne	0.017450***	0.201790***	0.697148***
	(1.540064)	(1.698533)	(1.336898)
France	0.001234***	0.305589***	0.677822***
	(3.769855)	(3.637164)	(1.954126)
Belgique	0.000831***	0.144520***	0.866181***
	(1.188878)	(1.475965)	(5.458797)
Autriche	5.30E-06***	0.035557***	0.964594***
	(0.512654)	(1.841056)	(47.78821)

*** *Sinification au seuil de 5%*

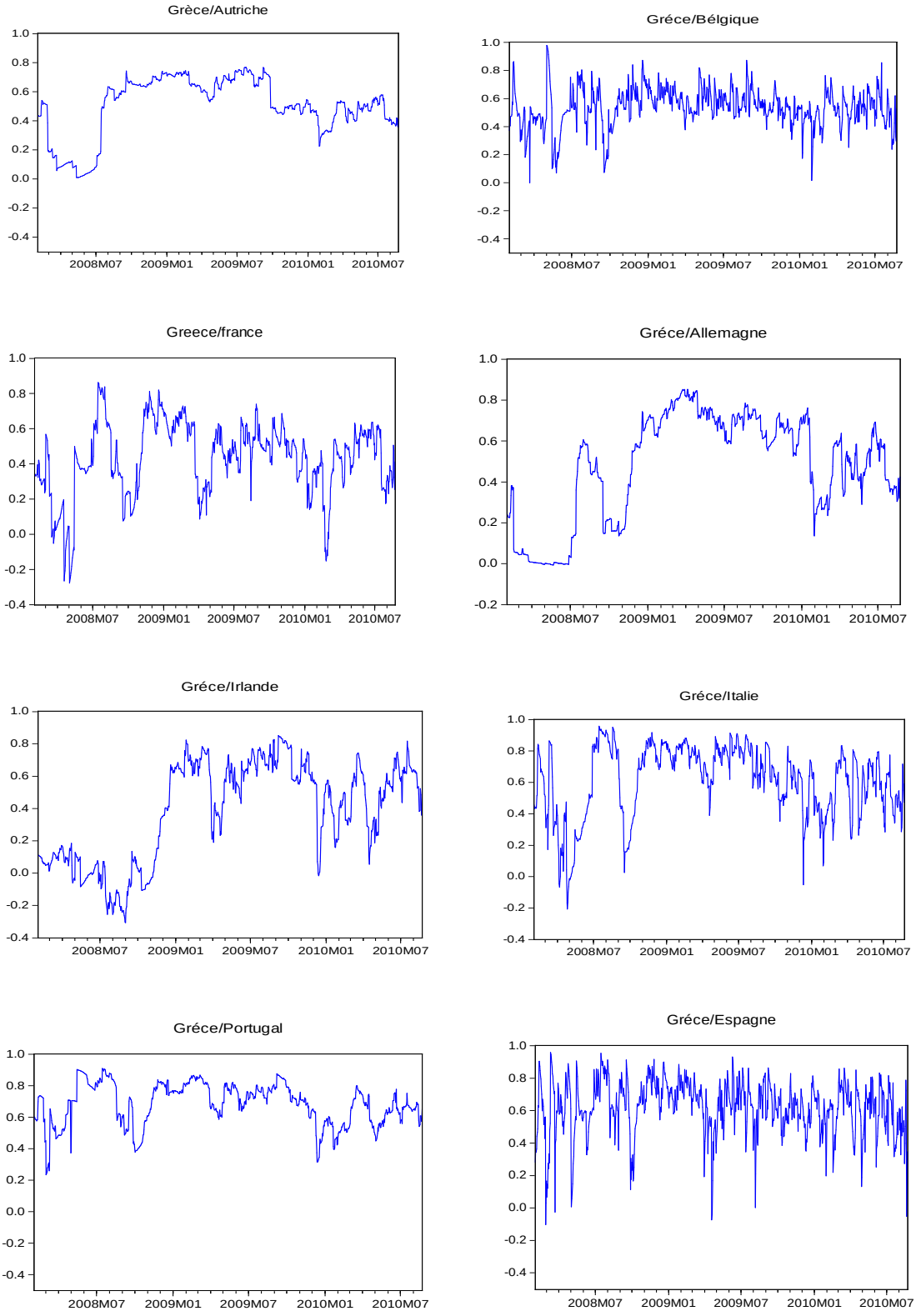


Fig. 1. Corrélations entre la Grèce et les autres pays de la zone Euro DCC-GARCH

Les graphes nous montrent que la corrélation varient selon les pays de la zone euro, c'est pourquoi nous calculons des moyens des coefficients de corrélation pour nous une information sur le niveau de corrélation entre ces pays.

Table 4. coefficient de corrélation moyenne entre Grèce et les autres pays de la zone Euro

Pays/coefficient de corrélation moyenne de la période	Belgique	Portugal	Italie	Irlande	Espagne	Allemagne	France	Autriche
Grèce	0.53	**0.68**	**0.61**	0.38	**0.62**	0.47	0.43	0.50

5 CONCLUSION

D'après les résultats nous constatons que la contagion financière est assez évidente pour le Portugal, l'Italie et l'Espagne et moyenne pour la Belgique et l'Autriche et moins évidente pour l'Allemagne, la France est l'Irlande, nous concluons que les CDS reste un bon instrument pour la mesure du risque de crédit cependant la zone euro n'est pas bien intégrée financièrement, c'est évident d'après la théorie de Robert Mendel que la zone euro ne constitue pas une zone monétaire optimale et par conséquent n'est pas aussi bien économiquement intégré comme c'est le cas pour des pays comme les Etats Unis ou la Suisse.

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ANNEXE I: CODE EVIEWES DU PROGRAMME DCC-GARCH

```
'set sample range
sample S1 2/2/2008 8/22/2010
scalar pi=3.14159
'defining the return series in terms of y1 and y2
series y1=greece
series y2=portugal
'fitting univariate GARCH(1,1) models to each of the two returns series
equation eq_y1.arch(1,1,m=1000,h) y1 c
equation eq_y2.arch(1,1,m=1000,h) y2 c
'extract the standardized residual series from the GARCH fit
eq_y1.makeresids(s) z1
eq_y2.makeresids(s) z2
'extract garch series from univariate fi
eq_y1.makegarch() garch1
eq_y2.makegarch() garch2
'Caculate sample variance of series z1, z2 and covariance of z1and z2 and correlation between z1 and z2
scalar var_z1=@var(z1)
scalar var_z2=@var(z2)
scalar cov_z1z2=@cov(z1,z2)
scalar corr12=@cor(z1,z2)
'defining the starting values for the var(z1) var(z2) and covariance (z1,z2)
series var_z1t=var_z1
series var_z2t=var_z2
series cov_z1tz2t=cov_z1z2
'declare the coefficient starting values
coef(2) T
T(1)=0.2
T(2)=0.7
' .....................................................
' LOG LIKELIHOOD for correlation part
' set up the likelihood
' 1) open a new blank likelihood object and name it 'dcc'
' 2) specify the log likelihood model by append
' .....................................................
logl dcc
dcc.append @logl logl

'specify var_z1t, var_z2t, cov_z1tz2t
dcc.append var_z1t=@nan(1-T(1)-T(2)+T(1)*(z1(-1)^2)+T(2)*var_z1t(-1),1)
dcc.append var_z2t=@nan(1-T(1)-T(2)+T(1)*(z2(-1)^2)+T(2)*var_z2t(-1),1)
dcc.append cov_z1tz2t=@nan((1-T(1)-T(2))*corr12+T(1)*z1(-1)*z2(-1)+T(2)*cov_z1tz2t(-1),1)
dcc.append pen=(var_z1t<0)+(var_z2t<0)
'specify rho12
dcc.append rho12=cov_z1tz2t/@sqrt(@abs(var_z1t*var_z2t))

'defining the determinant of correlation matrix and determinant of Dt
dcc.append detrRt=(1-(rho12^2))
dcc.append detrDt=@sqrt(garch1*garch2)
dcc.append pen=pen+(detrRt<0)
dcc.append detrRt=@abs(detrRt)
```

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La protection environnementale à l'échelle Internationale

[Environmental Protection in International Scale]

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ABSTRACT: The theme of environmental protection at the international level dresses very special interest, and it in light of substantial damage to the planet, and the ecological and financial losses that result. Therefore, this article raises the inescapable problem attached to answer the following questions: What is the legal framework for environmental protection at the international level? Is there a real protection of the environment at the international level through the implementation of this legislation at the time of injury affecting the international environment? And finally, can we make a critical assessment of the failure of international environmental law?
To better understand this topic two components seem essential to mention, namely, a study of protective legal regime of international environmental law, and the implementation of environmental legislation in the context of injury related to the international environment through the study of a criminal trial on the damage to the environment.

KEYWORDS: Protection, environment, damage, international law, environmental legislation.

RÉSUMÉ: La thématique de la protection environnementale à l'échelle internationale revêt un intérêt très particulier, et ce au regard des dommages conséquents subis par la planète, et les pertes écologiques et financières qui en découlent. De ce fait, cet article soulève, la problématique incontournable attachée à la réponse aux questions suivantes : Quel est le cadre juridique de la protection de l'environnement à l'échelle internationale ? Est-ce qu'il y a une véritable protection de l'environnement à l'échelle internationale à travers la mise en œuvre de cette législation à l'occasion d'un dommage touchant à l'environnement international ? Et enfin, peut-on faire une appréciation critique sur les défaillances du Droit international de l'environnement ?
Pour mieux cerner ce sujet, deux volets nous paraissent essentiels à évoquer, à savoir, une étude du régime juridique protecteur de l'environnement en Droit international, et la mise en œuvre de la législation environnementale dans le cadre d'un dommage touchant à l'environnement international, à travers l'étude d'un procès judiciaire relative à l'atteinte à l'environnement.

MOTS-CLEFS: Protection, environnement, dommage, droit international, législation environnementale.

1 INTRODUCTION

Partout dans le monde, le contentieux de l'environnement demeure pour sa part l'une des questions les plus sensibles à résoudre. Le volume des infractions commises contre l'environnement inquiète les pouvoirs publics internationaux, raison pour laquelle les Etats se sont engagés durant ces dernières décennies à la mise en place d'une nouvelle stratégie de lutte contre ce fléau, la preuve est le nombre consistant des sommets et conférences qui tendent à implanter de nouvelles manières d'adaptation de l'Homme avec son écosystème.

Les atteintes à la nature et à l'environnement ne sont pas un phénomène nouveau, distinct au sens strictement juridique ; elles ont été commises depuis des siècles. Dès les années 1300, des sanctions ont été appliquées à la pollution de l'environnement. En 1306, un propriétaire londonien a été exécuté pour la pollution qu'il avait provoquée, en utilisant du charbon pour chauffer sa maison. Cependant, en particulier au cours du processus d'industrialisation au vingtième siècle, le taux d'irrégularités, de violations et de délits perpétrés contre l'environnement a augmenté rapidement. Bien que le recours à des peines pour la protection de l'environnement ait une longue tradition, le délit contre l'environnement est un des termes les plus nouveaux en droit pénal européen [1].

Les délits environnementaux en tant qu'atteintes portées à la nature sont en relations étroites avec des délits économiques, parce qu'un grand nombre de ces délits contre l'environnement sont commis par des entreprises ayant pour objectif le profit. Certaines tendances suggèrent que de plus en plus les entreprises sont à la fois cibles et auteurs de ces délits. En outre, les délits contre l'environnement, comme la pollution, et les problèmes qui en résultent, tels les risques pour la santé publique, seront de plus en plus l'objet des agendas internationaux concernant la criminalité et son contrôle [2].

De ce fait, la Conférence des Nations Unies sur l'environnement et le développement (CNUED), ayant eu lieu à Rio de Janeiro en juin 1992, a confirmé la place centrale que les questions touchant l'environnement, comme le réchauffement du climat et la diminution de la diversité biologique, occupent dans la politique mondiale. En fait, les vingt années qui se sont écoulées entre la Conférence de Stockholm sur l'environnement de 1972 et la CNUED de 1992 ont connu, outre une prise de conscience croissante des menaces que les activités humaines font peser sur l'environnement à l'échelle locale et mondiale, une forte augmentation du nombre d'instruments juridiques internationaux y relatifs.

Ainsi, avant de parler du système juridique de protection environnementale à l'échelle internationale et les étapes judiciaires qui le garnissent, il s'avère fort indispensable de cerner le champ d'interpellation du Droit de l'environnement qui associe différentes approches et concerne différentes sous-branches qui font le quotidien des juristes de l'environnement, à savoir :

- Celles liées aux éléments composant l'environnement : droit de l'air, droit de l'eau et de la mer, droit des sols, droit de la biodiversité et des biotopes ;
- Celles liées à des activités humaines : droit de la chasse, de la pêche, de l'énergie ;
- Celles liées à des activités nuisibles ou polluantes : droit du bruit, droit des installations classées (autrefois établissements), droit de l'assainissement, droit des risques majeurs industriels ou naturels ;
- Celles liées à un objet particulier : droit de la protection de la nature (incluant maintenant dans certains pays la protection de l'environnement nocturne contre la pollution lumineuse, droit des produits chimiques, droit des déchets, droit des sites, des monuments historiques, etc ;
- Celles liées à un secteur économique auquel on appose ses problématiques juridiques environnementales propres : agriculture et environnement, industrie et environnement, services et environnement. La déclinaison peut aller à l'infini par sous-secteur : pisciculture, nucléaire, tourisme, santé-environnement, etc.

D'après cette classification il est fondé de dire que l'infraction constitue dans la majorité des cas une pierre angulaire dans le déclenchement du contentieux environnemental qui commande les textes législatifs régissant le déroulement des procès.

De ce fait, la terminologie « protection juridique de l'environnement » signifie l'ensemble des lois et actions judiciaires qu'ont un rapport avec les activités touchant à l'environnement.

Pour le dispositif juridique applicable en matière de protection environnementale internationale, ce dernier fait appel à une panoplie de textes de lois nationales, et des conventions internationales et interrégionales, encadrant chaque type d'atteinte à l'environnement, et en fonction de la nature des causes génératrices des violations.

2 LE RÉGIME JURIDIQUE PROTECTEUR DE L'ENVIRONNEMENT EN DROIT INTERNATIONAL

Dans ce chapitre nous allons faire une analyse du régime juridique protecteur de l'environnement en Droit international (2.1.), et les acteurs internationaux qui veillent à la protection juridique de l'environnement ainsi de leur champ d'intervention (2.2.).

2.1 LA PROTECTION JURIDIQUE DU MILIEU MARIN ET DES RESSOURCES NATURELLES EN DROIT INTERNATIONAL

La protection de l'environnement à l'échelle internationale est régie par une législation juridique très abondante allant des simples accords bilatéraux ou régionaux à des conventions opposables à la majorité des pays, au point que certains juristes du Droit de l'environnement qualifient ce dernier comme un Droit conventionnel [3].

Cependant, vouloir cerner le sujet de la protection juridique de l'environnement à l'échelle internationale dans un simple exposé, s'avère une donne qui relève de la gageure, et ce au motif du champ très vague qu'englobe le Droit international de l'environnement. Donc nous nous contenterons d'un aperçu des principales conventions internationales portant sur l'environnement. Bien qu'un tel inventaire énumère de préférence les conventions de portée mondiale, il ne faut pas négliger l'important réseau d'accords régionaux et bilatéraux qui ne cesse de s'étendre.

Avant les années 50, la majorité des conventions sur l'environnement portaient sur la préservation des espèces sauvages[1], mais après cette date on assiste à la sensibilité des dirigeants internationaux vis-à-vis des dangers qui menacent l'environnement international dans sa globalité. Cette prise de conscience a commencé avec l'adoption des premières conventions internationales sur la pollution par les hydrocarbures, notamment avec la convention internationale pour la prévention de la pollution des eaux de la mer par les hydrocarbures (OILPOL), 1954, telle que modifiée en 1962 et en 1969. Le texte de cette convention a innové en créant un cadre réglementaire pour le transport maritime des hydrocarbures ; mais les premières conventions qui ont prévu une action d'urgence et une indemnisation pour les dommages dus à la pollution par les hydrocarbures ont été adoptées en réaction au premier accident mondial majeur causé par un pétrolier, le naufrage du navire libérien Torrey Canyon au large des côtes du sud-ouest de l'Angleterre en 1967.

2.1.1 LA PROTECTION JURIDIQUE DU MILIEU MARIN

La protection juridique du milieu marin est régie par une panoplie conventions et accords internationaux, l'arsenal le plus important parmi eux est la convention de Montego Bay de 1982 sur le droit de la mer. Cette convention trace un cadre général pour la réglementation des questions d'environnement marin, dont les rejets par les navires et la pollution d'origine tellurique, et établit certaines obligations générales concernant la protection du milieu marin [4].

L'Organisation maritime internationale (OMI) a été à l'origine de trois grands instruments qui traitent les questions de la protection juridique des milieux marins dans le détail à savoir :

- La convention sur la prévention de la pollution des mers résultant de l'immersion de déchets, Londres, 1972.
- La convention internationale pour la prévention de la pollution par les navires, 1973 telle que modifiée par le protocole de 1978 y relatif (MARPOL, 1973/78).
- La convention internationale sur la préparation, l'intervention et la coopération en cas de pollution par les hydrocarbures qui a créé en 1990 un cadre juridique mondial pour la collaboration et l'assistance en cas de déversements importants d'hydrocarbures.

D'autres conventions maritimes qui, à l'origine, ne concernent pas l'environnement sont toutefois dignes d'être mentionnées, notamment la convention sur le règlement international pour prévenir les abordages en mer, Londres, 1972. La convention internationale pour la sauvegarde de la vie humaine en mer, Londres, 1974 ; et la convention internationale sur les normes de formation des gens de mer, de délivrance des brevets et de veille, Londres, 1978.

Par ailleurs, la convention de Londres de 1972 a adopté une approche désormais courante en répertoriant les substances qui ne peuvent être déversées dans l'océan et celles qui ne peuvent l'être qu'avec une autorisation. La structure de la réglementation, qui oblige les Etats signataires à faire respecter ces obligations par tout navire chargeant dans leurs ports ou arborant leur pavillon dans n'importe quel endroit du monde, a progressivement durci son régime et les parties ont désormais effectivement cessé d'immerger en mer des déchets industriels [1].

La convention MARPOL 1973/78, qui remplace la convention OILPOL de 1954, a établit le principal régime applicable à la pollution provenant de navires de toutes sortes, y compris les pétroliers. MARPOL oblige les Etats dont les navires arborent le pavillon à imposer des contrôles sur les rejets volontaires de toutes les substances classées tels qu'ils résultent de l'exploitation. Le régime MARPOL a été modifié en 1978 de sorte qu'il s'étend progressivement aux différentes sources de pollution par les navires.

Concernant la protection juridique du milieu marin aux niveaux régionaux, le programme pour les mers régionales du PNUE (Programme des Nations Unies pour l'environnement) constitue un réseau étendu, bien qu'incomplet, de traités de protection des mers. Ce plan couvre : la Méditerranée (convention pour la protection de la mer Méditerranée contre la

[1] *Parmi les toutes premières conventions protégeant les oiseaux on peut citer la convention pour la protection des oiseaux utiles à l'agriculture, Paris 1902.*

pollution, Barcelone, 1976, et ses protocoles ; la région du Golfe (convention régionale de Koweït pour la coopération en vue de la protection du milieu marin contre la pollution, 1978, et ses protocoles, etc.

Ces traités sont complétés par des protocoles couvrant une large gamme de domaines, dont la réglementation de la pollution des océans par les opérations d'immersion, la pollution provenant de l'arrêt définitif des plates-formes de forage pétrolier en mer.

D'autres régimes régionaux ont été instaurés, en dehors du PNUE, notamment dans l'Atlantique Nord-Est, où un réseau très complet d'instruments régionaux couvre la réglementation des rejets en mer comme par exemple la convention pour la prévention de la pollution marine par les opérations d'immersion effectuées par les navires et les aéronefs, Oslo, 1972, et ses protocoles.

2.1.2 LA CONSERVATION DES RESSOURCES NATURELLES EN DROIT INTERNATIONAL

Concernant le volet de la conservation des ressources naturelles, sur le plan mondial, il convient de noter en particulier la convention de l'UNESCO pour la protection du patrimoine mondial, culturel et naturel en 1972. La convention sur le commerce international des espèces de faune et de flore sauvages menacées d'extinction, Washington, 1973, et la convention de Bonn sur la conservation des espèces migratrices appartenant à la faune sauvage, 1979. Au niveau régional, signalons la convention pour la protection de l'environnement entre le Danemark, la Finlande, la Norvège et la Suède, 1974, la convention pour la conservation de la nature dans le Pacifique Sud en 1976, la convention relative à la conservation de la vie sauvage et du milieu naturel de l'Europe à Berne en 1979. Et les traités relatifs à l'Antarctique -zone appartenant au patrimoine commun de l'humanité et ne relevant de la juridiction d'aucun Etat- notamment la convention sur la conservation de la faune et de la flore marines de l'Antarctique à Canberra, 1980[2].

Pour la ***compétence juridictionnelle*** internationale en matière de contentieux relatif à la protection des milieux marins de la pollution et la conservation des ressources naturelles, depuis 1993 la Cour internationale de justice a créé une chambre spéciale chargée de l'environnement.

Il y a également le Tribunal international du droit de la mer (installé à Hambourg Allemagne) qui est un organe judiciaire indépendant créé par la Convention des Nations unies sur le Droit de la Mer en 1982 à Montego Bay. Cet organe instruit et juge les différends auxquels pourraient donner lieu l'interprétation et l'application de ladite Convention.

2.2 LA RÉGLEMENTATION DES IMPACTS TRANSFRONTIÈRES SUR L'ENVIRONNEMENT

Aux termes du Principe 21 de la Déclaration de Stockholm « les Etats ont le devoir de faire en sorte que les activités exercées dans les limites de leur juridiction ou sous leur contrôle ne causent pas de dommage à l'environnement dans d'autres Etats ou dans des régions ne relevant d'aucune juridiction nationale ».

Les impacts transfrontières sur l'environnement a toujours constitué une pierre angulaire dans l'adoption des conventions internationales relatives à la pollution atmosphérique transfrontière à longue distance, la protection de la couche d'ozone, la notification et la coopération en cas d'accident nucléaire, les mouvements transfrontières de déchets dangereux et les changements climatiques mondiaux. De ce fait nous allons décortiquer la réglementation juridique internationale de chaque domaine parmi ceux-ci, et les réponses de la communauté internationale face aux atteintes à l'environnement transfrontière.

2.2.1 LA POLLUTION ATMOSPHÉRIQUE TRANSFRONTIÈRE À LONGUE DISTANCE

La pollution atmosphérique à longue distance en Europe est un sujet qui a été abordé pour la première fois à Genève, en 1979 (convention sur la pollution atmosphérique transfrontière à longue distance et ses protocoles). Il s'agit toutefois d'une convention-cadre dont l'objectif modeste était de limiter et réduire graduellement et de prévenir la pollution atmosphérique, y compris la pollution atmosphérique transfrontière à longue distance [3].

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[2] Pour plus de détails sur cette réglementation voir l'ouvrage de Jean-Maurice Arbour et Sophie Lavallée, Droit international de l'environnement, Éditions Yvon Blais, 2006.

2.2.2 LES CONSÉQUENCES TRANSFRONTIÈRES DES ACCIDENTS NUCLÉAIRES

La catastrophe de Tchernobyl en 1986 avait attiré l'attention de l'opinion publique sur les conséquences transfrontières des accidents nucléaires, mais des conventions antérieures avaient déjà abordé un certain nombre de questions relatives aux risques provenant des dispositifs nucléaires, dont la convention sur la responsabilité civile dans le domaine de l'énergie nucléaire, 1960, et la convention de Vienne relative à la responsabilité civile en matière de dommages nucléaires, 1963. Notons également le Traité interdisant les essais d'armes nucléaires dans l'atmosphère, dans l'espace extra-atmosphérique et sous l'eau, 1963. La convention de Vienne de 1980 sur la protection physique des matières nucléaires avait tenté d'établir des normes pour protéger les matières nucléaires d'un certain nombre de menaces, y compris le terrorisme.

2.2.3 LA PROTECTION DE LA COUCHE D'OZONE

La convention de Vienne pour la protection de la couche d'ozone signée en 1985, recommande aux Etats de coopérer, au moyen d'observations systématiques, de recherches et d'échanges de renseignements afin de mieux comprendre et apprécier les effets des activités humaines sur la couche d'ozone et les effets exercés sur la santé humaine et l'environnement par la modification de la couche d'ozone. Elle conseille aussi d'adopter des mesures législatives ou administratives appropriées et harmoniser les politiques appropriées visant à réglementer, limiter, réduire ou prévenir les activités humaines relevant de leur juridiction ou de leur contrôle s'il s'avère que ces activités ont ou sont susceptibles d'avoir des effets néfastes par suite de la modification, ou de la modification susceptible de se produire, de la couche d'ozone.

La convention de Vienne a été complétée par le protocole de Montréal relatif à des substances qui appauvrissent la couche d'ozone, 1987, lui-même adapté et modifié par la réunion de Londres de 1990 et par la réunion de Copenhague de novembre 1992.

2.2.4 LES MOUVEMENTS TRANSFRONTIÈRES DE DÉCHETS DANGEREUX

Suite aux incidents liés au caractère anarchique et périlleux du transport des déchets dangereux en provenance des pays développés vers les pays en développement, les mouvements transfrontières de déchets dangereux ont fait l'objet d'une réglementation internationale par la convention sur le contrôle des mouvements transfrontières de déchets dangereux et de leur élimination, Bâle, 1989. Cette convention repose sur le principe d'une information et d'un consentement préalables entre Etats avant tout acheminement de ces déchets. L'Organisation de l'unité africaine (OUA) est cependant allée plus loin avec la convention de Bamako (1991) sur l'interdiction d'importer des déchets dangereux et le contrôle de leurs mouvements transfrontières en Afrique, qui vise à interdire toute importation de déchets dangereux en Afrique.

2.2.5 LA CONVENTION-CADRE DES N.U RELATIVE AUX CHANGEMENTS CLIMATIQUES

La CCNUCC, signée à Rio de Janeiro en juin 1992 par quelques 155 Etats, établit un cadre dans lequel les obligations seront négociées de façon plus précise par la voie de protocoles détaillés. L'objectif fondamental de la convention est de stabiliser les concentrations de gaz à effet de serre dans l'atmosphère à un niveau qui empêche toute perturbation anthropique dangereuse du système climatique, et ce dans un délai suffisant pour que les écosystèmes puissent s'adapter naturellement aux changements climatiques, que la production alimentaire ne soit pas menacée et que le développement économique puisse se poursuivre d'une manière durable [1].

D'après le développement qu'on a vu ci-dessus, la protection de l'environnement à l'échelle internationale n'est pas confrontée à un vide législatif et réglementaire, car les conventions et les accords sont très nombreux et couvrent tous les domaines menaçant l'environnement et les écosystèmes. En revanche, la mis en œuvre de ces textes quand il y a un dommage écologique, reste très timide et ce au vu de la réticence des grandes puissances industrielles qui font fi au processus de la protection de l'environnement.

3 LA MISE EN ŒUVRE DE LA LÉGISLATION ENVIRONNEMENTALE DANS LE CADRE D'UN DOMMAGE TOUCHANT À L'ENVIRONNEMENT INTERNATIONAL

Nous analysons dans cette partie l'application de la législation internationale protectrice de l'environnement à l'occasion de la survenance d'un contentieux écologique. Nous allons donc se contenter d'une affaire écologique qui a fait couler beaucoup d'encre, ainsi qu'une appréciation critique sur la place de la protection de l'environnement à l'échelle internationale.

3.1 LE CONTENTIEUX INTERNATIONAL DE L'ENVIRONNEMENT : LE PROCÈS D'ERIKA

Le 12 décembre 1999, la tempête fait rage au large de Penmarc'h dans le Finistère. L'Erika[3] pétrolier battant pavillon maltais coule, à son bord, 31 000 tonnes de fuel dont 20 000 qui tapisseront quelques jours plus tard 400 kilomètres de côtes, handicapant pour des mois tous ceux qui y travaillent et tuant au moins 150000 oiseaux.

Sept ans après, le procès s'ouvre sur des exigences bien connues à savoir, dénoncer la culpabilité de Total, sanctionner les différents responsables, mettre en évidence l'absence de réglementation suffisamment dissuasive ou contraignante et l'inadéquation du système OMI/FIPOL[4].

La première défaillance du Droit international de l'environnement est détectée dans système de l'octroi des certifications de navigabilité, car dans le cadre du procès de l'Erika les expertises judiciaires ont démontré par la suite que l'état réel des structures du navire ne correspondait pas à la certification établie par le RINA[5].

Le procès d'Erika a débuté le 12 février 2007 afin de tenter d'identifier les responsabilités. Parmi des accusés figurent notamment le propriétaire italien de l'Erika, le commandant indien du navire, la société de classification italienne RINA, quatre responsables des secours à terre accusés d'avoir multiplié les dysfonctionnements et la société Total.

Pour les parties civiles elles sont les principales ONG de protection de l'environnement à savoir : Greenpeace, France Nature Environnement, Le WWF, Eau et rivières de Bretagne, le Comité anti-marée noire, l'Association pour la protection des animaux sauvages (ASPAS) et l'Association des amis du chemin de ronde 56. Le procès a duré quatre mois d'audience (pour sept ans d'enquête et quinze personnes poursuivies), il réunissait quarante-neuf témoins et experts et une cinquantaine d'avocats.

Le tribunal correctionnel de Paris a rendu son jugement le 16 janvier 2008. Le Groupe Total a été reconnu coupable de pollution maritime par les magistrats et condamné à verser 192 millions d'euros. L'armateur, le gestionnaire ainsi que l'organisme de certification du navire ont été déclarés, quant à eux, coupables de faute caractérisée. Le jugement détaille les fautes que le tribunal considère comme ayant été commises par les différents intervenants. Le 25 janvier 2008, Total a fait appel de cette condamnation, tout en décidant le début du versement des dommages-intérêts.

En 2009, la Cour d'appel de Paris avait établi la responsabilité pénale des prévenus. Ils avaient été pénalement condamnés aux amendes maximales pour délit de pollution maritime et à verser des indemnités de réparation pour préjudices «matériel, écologique et moral» au civil. Ils s'étaient alors tous pourvus en cassation.

Les prévenus ont invoqué l'incompétence des juridictions françaises à statuer sur l'affaire, car le sinistre a eu lieu dans la Zone Economique Exclusive (ZEE) et les conventions internationales primeraient. La Cour de cassation a rejeté ces demandes en argumentant que les dommages causés par la marée noire de l'Erika ont été subis par les côtes françaises, et par conséquent confirmer la teneur juridique du Droit international dans ce cas d'espèce[6].

Si certaines affaires relatives à la protection de l'environnement internationale sont tranchées par les juridictions de Droit commun, d'autres prennent la voie des modes alternatifs de règlement des différends, en l'occurrence l'arbitrage (Affaire de la Fonderie du Trail).

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[3] L'Erika est un pétrolier à simple coque de 185 mètres, d'une capacité de 37 000 tonnes. Construit au Japon en 1975, il avait donc 24 ans de mer en 99 et était déjà passé dans les mains de 8 propriétaires. En raison de son âge, il figurait donc sur la « liste noire » de la plupart des grands groupes pétroliers dont Total.

*[4] **OMI** : L'Organisation Maritime Internationale. **FIPOL :** Les Fonds internationaux d'indemnisation pour les dommages dus à la pollution par les hydrocarbures (FIPOL) sont trois organisations intergouvernementales (le Fonds de 1971, le Fonds de 1992 et le Fonds complémentaire) qui ont pour vocation l'indemnisation en cas de pollution par des hydrocarbures persistants à la suite de déversements provenant de pétroliers.*

[5] La RINA est une Société de classification qui a une double mission de classification pour l'armateur et de certification pour l'État du pavillon. Elle vérifie l'application des règles en matière de sécurité des navires et délivre un certificat de classe qui atteste notamment de l'intégrité de la structure du navire.

[6] Les décisions de la Cour ont été basées su les conclusions du rapport d'enquête sur le naufrage de l'Erika : Bureau d'enquêtes sur les événements de mer (BEAmer).

3.2 APPRÉCIATION CRITIQUE SUR LES DÉFAILLANCES DU DROIT INTERNATIONAL DE L'ENVIRONNEMENT

La protection de l'environnement à l'échelle internationale n'a pas une teneur absolue, car même en présence d'un arsenal juridique et réglementaire conséquent, la réparation des dommages écologiques reste néanmoins minuscule. Cette situation est due à la bonne mise en œuvre du Droit international de l'environnement qui est bourré de lacunes.

De ce fait, les lacunes du droit de l'environnement en général tiennent moins à l'insuffisance des textes qu'à leur inefficience. Celle-ci résulte tant de leur inapplication que de leur source d'une faiblesse relative par rapport à d'autres branches du droit. Au niveaux nationaux, la multiplication des textes, source de pouvoir discrétionnaire et parfois arbitraire, l'inadaptation des procédures juridictionnelles au droit de l'environnement, les règles de charge de la preuve qui rendent la situation des victimes profondément inégalitaire et injuste, l'ambiguïté du rôle des pouvoirs publics font de ce droit un droit qui reste mineur dans ses branches pénale et civile, peu efficient dans sa branche administrative [2].

Sur le plan international, l'absence de gouvernance mondiale et de sanction juridictionnelle aux Accords multilatéraux de l'environnement rend ce droit encore très virtuel [6]. En plus, il revêt la posture d'un Droit inadapté pour réparer les dommages à l'environnement faute de règles juridiques adaptées.

Cependant, le problème majeur qui empêche une réelle protection de l'environnement international réside dans la « nature du dommage » environnemental, qui ne revêt pas un caractère "personnel" et ce, suivant le principe traditionnel du droit civil. Cette s'accentue avec la course impitoyable vers la réalisation des profits économiques et la satisfaction des besoins des populations qui prime sur le concept de la protection de l'environnement.

4 CONCLUSION

Depuis une vingtaine d'années la communauté internationale a complètement changé d'attitude à l'égard de la protection et de la gestion de l'environnement. Cette évolution a consisté notamment en une forte augmentation du nombre et de la portée des instruments internationaux y relatifs, qui vont de pair avec l'affirmation de nouveaux principes et la création d'institutions. Les principes du pollueur-payeur et de précaution, ainsi que le souci des droits des générations futures inspirent les conventions internationales évoquées ci-dessus.

Le rôle du PNUE et la création de secrétariats chargés de promouvoir et d'assurer le suivi de tous ces traités indiquent que la protection de l'environnement à l'échelle internationale, est en train de devenir une nouvelle branche distincte du droit international.

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Induction of Cell Cycle Arrest in Tumor Tissue And Bone Marrow Of Grafted Mice Treated with Androgen and Antiandrogen.
Running title: Effect of androgen and antiandrogen on leukemia cell line

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ABSTRACT: *Background:* These works were designed to investigate the influence of androgens (by castration and testosterone treatment) on growth and development of murine leukaemia cell line P388 *in vitro* and *in vivo*. To approach the mechanism of this hormone, the cell cycle was analysed in bone marrow cells and tumour tissue in vitro and on murine leukaemia cell line (P388) in culture. The anti-androgen CA was used to provide additional information concerning the androgen receptor in leukaemia cells.
Materials and methods: The effect of Depo-Testosterone (DT) and Cyproterone-Acetate (CA) were studied on growth tumour and cell cycle progression, in bone marrow and tumour tissue of intact or castrated P388 tumour-bearing BDF1 mice. In parallel the effect of various concentrations of DT (10^{-8}, 10^{-7}, 10^{-6}, 10^{-4} M) was investigated on the proliferation and cell cycle of P388 leukaemia cell line *in vitro.*
Results: In P388 tumour-bearing mice, DT (0.5mg/100g body weight) treatment reduced strongly the weight and the appearance rate of tumour in non-castrated (NC) and castrated animals. In NC animals, the cell cycle analysis showed a significant decrease in the number of cells in S phase in tumour tissue under DT or CA treatment. Same results were obtained in bone marrow with DT only. The cells accumulate into G2/M and G0/G1 phases respectively. In vitro testosterone can inhibit the proliferation of leukaemic cells with a pharmacological dose of 10^{-7}M. This growth inhibition was associated with cell cycle arrest in G0/G1 phase. This effect was dose and time dependent.
Conclusion: The data demonstrated that both *in vivo* and *in vitro*, testosterone prevent the growth of P388 leukaemia cells and induce changes in their cell cycle. The similar effect of CA and DT on tumour growth inhibition, in cell cycle of bone marrow and tumour tissue may suggest differences between androgen receptors of sexual organs and leukemic cells.

KEYWORDS: Testosterone, Cyproterone-Acetate, P388 leukaemia cell line, Cell cycle, Tumour tissue, Bone marrow cells.

1 INTRODUCTION

A characteristic of acute leukaemia cell is to loose the ability to differentiate into mature, functional cells and remain in a high proliferative status over their normal counterpart. One possible approach to treat patients with acute leukaemia is to use agents that can induce differentiation of leukaemic cells and inhibit their proliferation [1], or by cell cycle alteration that leeds to apoptosis [2]. Recent studies reported that E2 inhibits apoptosis in different cell types, whereas androgens have been found to induce apoptosis [3].

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The works of H. Everaus [4] proved that abnormalities in the immune system observed in CLL (Chronic Lymphocytic Leukaemia) may be connected with an imbalance of endocrine regulation. The underlying mechanism for disorder in T cell function in CLL is still unknown.

In acute non-lymphocytic leukaemia (ANLL), marrow transplantation offers some survival advantage. Among therapeutic agents, the sex steroids have been reported to have some effect on ANLL [5]. A study [6] about two homo-azo steroids (Androgens and Oestrogens derivatives class) indicated that these two agents exhibited stimulatory effects on the proliferation of ANLL cells, especially in blast cells with low degrees of differentiation. However, the mechanisms implicated in this regulation were not clear.

The 2beta-(4-methylpiperazinyl)-5alpha-androstane-3alpha, 17beta-diol was recently reported for its ability to inhibit the proliferation of human leukemia HL-60 cells [7].

Cell cycle control in G1 phase has attracted considerable attention in recent cancer research, because many of important proteins involved in G1 progression, or G1/S transition have been found to play a crucial role in proliferation, differentiation, transformation and programmed cell death (apoptosis) [8].

Cyproterone Acetate (CA) is a potent, synthetic steroid that possesses anti-androgenic, anti-oestrogenic, anti-gonadotrophic and anti-progestational activity. Its anti-androgenic activity is due to competitive inhibition of androgen binding receptor [9].

Based on these findings, we investigated the effect of testosterone (DT) on growth tumour and proliferation of lymphoid leukaemia cell line (P388) *in vivo* and *in vitro*. We have followed the cell cycle progression in bone marrow, tumour tissue and in leukaemia cell line in culture, with or without DT. Furthermore the effect of CA was studied to provide additional indirect information on androgen receptors.

2 MATERIALS AND METHODS

2.1 ANIMALS

BDF1 male mice (C57BL/6 x DBA/2) F1, 3 weeks old, (IFFA-CREDO, Les Oncins, France), were housed in air-conditioned room (temperature 21±2°C) in standard cages each housing 5 animals. Food and water were available *ad libitum*. The mice were kept on a 12h light-dark cycle (L/D, 12:12 hours).

2.2 CASTRATION

Male mice were castrated at four weeks old. They were anaesthetised with ether and castrated by making an abdominal incision, removing the testes and closing the incision with 6-0 silk sutures. As controls there were two groups: sham-operated and non-operated (intact) animals. It was found that the sham-operated group was indistinguishable from non-operated controls; hence the data from these two groups were pooled.

2.3 STEROIDS

Depo-testosterone (DT, Testosterone17 beta-cypionate, Sigma-Aldrich, L'IsleD'AbeauChesnes, France) or Cyproterone Acetate (CA, generously provided by Schering, West Berlin, Germany) in sterile peanut oil (PNO) were administered subcutaneously in mice at a dose of 0.5mg/100g body weight, in a final volume of 0.2 ml. The same volume of PNO was injected in castrated and in intact control group. DT was administered to animals on alternate days for a period of two weeks. CA was given to mice on five consecutive days of each week over a period of two weeks. Steroids were injected in treated animals one week after castration. Dose, route and frequency of DT and CA administration were chosen according to the works of Ahmed *et al.* [10]. The experimental groups are summarised in Table I. 7 to 12 animals per batch were used.

2.4 CELL LINE

P388 leukaemia cell line, from a DBA/2 mouse, was obtained from Flow, France. Cells were maintained in culture in Fisher medium supplemented with 5% foetal bovine serum, 1% glutamine (2mM) and 1% penicillin-streptomycin, at 37°C in a humidified atmosphere of 5% CO_2. The cells were counted with an automate (Coulter Argency, France). Trypan blue exclusion test indicated that the viability always exceeded 90%.

2.5 TRANSPLANTED MICE

The P388 cells were injected subcutaneously at 10^5 cells per mouse and the mice were examined daily to monitor survival and tumour growth. The P388 tumours could only be followed for approximately two weeks after which the animals developed leukaemia and died. For that reason, the mice were distributed in two batches and killed after 15 days or 30 days after grafting. Control mice were injected with Fisher medium, or with peanut oil, no difference was observed between the two batches. In grafted mice, the injections of drug (DT and CA) start in the same day of inoculating mice with leukaemia cells.

2.6 IN VIVO PROTOCOLS

There are 2 batches of mice castrated and none castrated (NC or intact). Each batches containing 4 groups: untreated; grafted with leukaemia cell line; transplanted treated with DT; transplanted and treated with CA.Seven to twelve animals were used per experimental condition.

2.7 DT *IN VITRO* EFFECT

P388 leukaemia cells were seeded at 2-5 x 10^5 cells/ml in culture flask, in Fisher medium supplmented with DT diluted in ethanol; vehicle was less than 0.05%. The DT (10^{-8}, 10^{-7}, 10^{-6}, 10^{-4} M) was added to the cell culture on day 0 and the cultures were monitored for 3 days. Numeration of cells was performed by the Coulter counter automate. The viability was determined by trypan blue exclusion test and by flow cytometry.

2.8 PLASMA TESTOSTERONE

Mice were killed by cardiac exsanguination. The blood was collected in heparinised syringes and the plasma was separated by centrifugation. The plasma testosterone concentration was measured by radioimmunoassay (Dr.Baudin, Department of Nuclear Medicine, CHU-Nimes).

2.9 CELL PREPARATION

Bone marrow cell suspensions were prepared by flushing phosphate buffered saline (PBS) through the femur. The thymus, spleen, seminal vesicle and tumour tissue were removed from each mouse and weighed. The weight of the organs was expressed in mg/100g body weight. The tumour tissue was placed in Petri dishes containing PBS; cells were then suspended by fine needle aspiration. The cells were stained with propidium iodide (IP) by the 3 steps method of Vindelov*et al.* [11].

2.10 FLOW CYTOMETRIC ANALYSIS

Samples were run in a flow cytometer (cytofluograph IIS, OrthoDiagnostic Instruments, Westwood, Massachusetts, USA) equipped with an innova 90-5 argon ion laser (Coherent PaloAlto, California, USA) operating at 488nm and 500mW in light-regulated mode. The cytometer was calibrated with fluorescent microbeads before each run. Data from the forward angle scatter and fluorescence parameters (peak and area signals of fluorescence emission) were collected by user-defined protocol and stored in an Ortho 2151 computer system (Ortho Diagnostic Instruments) in list mode.

The DNA content histograms (red fluorescence emission area versus number of cells per channel) were established from 20,000 events gated on 'red fluorescence area peak' cytograms in order to discriminate doublets. The proportion of cells in the G0/G1, S and G2/M phases of the cell cycle was calculated from the histograms by the parametric method.

2.11 STATISTICAL ANALYSIS

The data were analysed with student's t-test. A p value of less than 0.05 was considered significant.

3 RESULTS

3.1 IN VIVO STUDY

3.1.1 TUMOUR GROWTH *(TABLE 1)*

The percentage of mice that developed tumours was higher in castrated mice (70%), than in non-castrated (NC) mice (62.5%). The NC mice survived longer (87.5%) than castrated mice (50%). Compared to non treated NC mice, the DT and CA injection reduced strongly the tumour growth; less than 10% showed a tumour. A lower tumour decrease was observed in castrated mice treated by steroid hormones (40% for DT; 50% for CA).

3.1.2 TUMOUR WEIGHT *(TABLE 1)*

In castrated mice the tumour weight was more important than in NC grafted mice (12.5±4.5 against 9.5±2.3, $p<0.05$). The injection of DT and CA reduced significantly ($p<0.05$) the tumour weight in NC mice. In castrated mice, though there was a decrease in tumour weight under steroid treatment, the difference was not significant compared to non treated animals.

3.2 ORGANS WEIGHT *(TABLE 1)*

3.2.1 SEMINAL VESICLE

The weight of the seminal vesicles was initially determined in NC mice and in castrated mice. The castration and CA administration reduced significantly ($p<0.01$) the weight of the seminal vesicles compared to control. DT treatment induced a significant ($p<0.01$) increase in the weight of seminal vesicle in intact and in castrated mice.

3.2.2 THYMUS

As expected, the weight of the thymus in castrated mice was greater than in intact mice ($p<0.001$). No significantly difference was observed between transplanted mice and control mice. Compared to control, the weight of thymus decreased significantly both in intact and in castrated mice when either DT ($p<0.001$) or CA ($p<0.01$) were injected.

3.2.3 SPLEEN

The weight of the spleen was significantly higher in P388 tumour-bearing NC mice than in controls ($p<0.01$). There was no significant change in the weight of the spleen after DT injection.

3.3 PLASMA TESTOSTERONE LEVEL

The plasma testosterone concentration was significantly decreased ($p<0.001$) in castrated mice. Compared to control, the plasma testosterone level was increased after DT injection in NC ($p<0.01$) and castrated mice ($p<0.001$). Whereas, the CA treatment decreased significantly ($p<0.001$) the testosterone level in NC transplanted mice, no change in testosterone level was observed in castrated ones, since it was already low (Table 1). There was a significant regressive curve between tumour weight and testosterone level ($r=0.9$, $p<0.01$, Figure 1).

3.4 CELL CYCLE ANALYSIS

3.4.1 BONE MARROW

As bone marrow cells have been collected under the same conditions, the number of cells/ml (Table 1), was almost the same between NC and castrated grafted mice. A decrease was observed after DT and CA treatment with a higher effect with DT on NC animals and with CA on castrated mice.

Compared to non grafted animals, in leukaemic NC and castrated mice, the cell cycle analysis showed a significant ($p<0.05$) increase in the number of cells in S phase and a significant ($p<0.05$) decrease in G2/M phase in bone marrow (Figure 2). In NC leukaemic mice, DT ($p<0.01$) and CA ($p<0.05$) treatment reduced the percentage of cells in S phase and increased

the relative number of G2/M cells. DT and CA injection have no effect on cell cycle of leukaemic castrated mice compared to non-treated mice.

3.4.2 TUMOUR TISSUE

Compared to untreated animals, the DT and CA administration increased significantly the percentage of G0/G1 cells (Figure 3) which was balanced by a diminution in S phase. The percentage of proliferating cells showed a significant reduction in both NC ($p<0.01$) and castrated ($p<0.05$) mice. In DT treated castrated mice, a correlation was observed between the percentage of proliferating cells ($r=0.86$; $p<0.01$), the relative number of cells in G0/G1 phase ($r=0.85$, $p<0.01$) and tumour weight (Figure 4).

3.5 IN VITRO STUDY (P388 CELL CULTURE)

3.5.1 CELL GROWTH

Figure 5 shows the growth curve of P388 cells, with a doubling time of approximately 24 hours. DT treatment greatly reduced cell growth; its effect was time and dose dependent. Growth inhibition started after 24 hours of culture with the two highest DT concentrations (10^{-6} and 10^{-4} M).

3.5.2 CELL CYCLE ANALYSIS

In exponentially growth culture, P388 cells were mainly in G0/G1 and S phase (57.9±3.1 and 35.9±3 % respectively), the proportion of cells in G2/M phase was low (7.6±2 %) (Figure 6). According to growth inhibition, DT treatment induced a significant decrease in the number of cells in S and G2/M phases and an increase of cells in G0/G1 phase. DT treatment efficacy was observed up to 10^{-7} M concentration.

4 DISCUSSION

These works were designed to investigate the influence of androgens (by castration and testosterone treatment) on growth and development of murine leukaemia cell line P388 *in vitro* and *in vivo*. To approach the mechanism of this hormone, the cell cycle was analysed in bone marrow cells and tumour tissue in vitro and on murine leukaemia cell line (P388) in culture. The anti-androgen CA was used to provide additional information concerning the androgen receptor in leukaemia cells.

The DT and CA treatment reduced strongly the weight and the rate of tumour in BDF1 NC or castrated mice grafted with murine leukaemia cell line (P388). Cell cycle analysis showed that DT or CA induces a decrease in the number of S phase cells in bone marrow and tumour tissue; the cells accumulate in G2/M phase in bone marrow and G0/G1 phase in tumour tissue in NC mice.

A recent report demonstrated that testosterone inhibits the *in vivo* tumourigenic properties of the 1246-3A cells. Castrated male mice receiving injections of 1246-3A cells developed larger tumour at a higher frequency than sham-operated animals. Administration of testosterone to castrated male mice resulted in a dramatic decrease in tumour development [12]. In human, a decrease in serum level of DHEA may be associated with patients who have some clinical subtypes of ATL [13]. The 17β-estradiol/ Testosterone ratio was considerably higher in men with CLL [14]. Chronic lymphocyte leukaemia (CLL) is the most common lymphoproliferative disease. Normal hematopoiesis is a tightly regulated process involving a balance between signals that stimulate and those that inhibit the proliferation and differentiation of hematopoietic progenitors. In leukaemia patients there is a perturbation of these controlling elements, resulting in overgrowth of leukaemic cells in bone marrow and spleen cells [15].

In our results, the cell cycle analysis showed that testosterone or CA treatment decreased the proliferation observed in bone marrow cells of transplanted mice with cell cycle arrest at the G2/M phase. Previous studies showed that androgens can directly stimulate healthy bone marrow cells to proliferate and differentiate [16]. In healthy mice, DT decreased strongly the percentage of bone marrow cells in G2M phase [17] whereas in our experiment with P388 tumour-bearing mice the sex hormone increased the relative number of bone marrow cells in G2/M phase. The bone marrow was probably overrun by leukaemia cells. In fact, in rats inoculated with leukaemic cells, the fraction of RRM 124+ cells (the RRM 124 antibody

identifying the leukaemic cells) was significantly increased in bone marrow and spleen [18]. However, DT treatment acted differently in the proliferation of healthy bone marrow or overrun with leukaemia cells.

In the present findings, the cell cycle analysis in tumour tissue showed that DT decreased both the S and the G2/M phases, with accumulation of cells into G0/G1phase. CA treatment gave same results as DT treatment. There is a correlation between tumour weight and the percentage of cells in G0/G1 (Figure 4). These data showed that testosterone prevent the proliferation of leukaemic cells both in bone marrow and tumour tissue.

CA decreases seminal vesicle weight in the intact and castrated mice. It is one of the most active antiandrogenic steroids blocking the peripheral action on sexual organs of both endogenous and exogenous testosterone [19]. The similar effect of CA and testosterone in the reduction of the weight and rate of tumour, and a decrease in the proliferation of cells in bone marrow and tumour tissue suggests a similar specificity in the biological activity of these two steroids.

Three explanations might be put forward. Firstly, that CA and DT may act through the immune system on leukaemia cells. In fact, testosterone and CA increases the % of CD4+ thymocytes and CD8+ splenocytes [19]. The inhibition of tumour growth is strongly associated with the level of CTL (Cytotoxic T lymphocyte) activity present in CD8+ cells derived from the spleen. The level of CD8+ CTL activity is directly correlated with the degree of inhibition of tumour growth [12, 20]. Second, testosterone could inhibit cell proliferation by blocking vessel development, by enhancing apoptosis in vascular endothelial cells [3]. Third, these two steroids act directly on leukaemia cells through a common receptor. To check the direct action of testosterone on leukaemia cells, we investigate the growth of murine leukaemia cell line (P388) and studied the modulation of cell cycle changes with this hormone.

Our experiments showed that testosterone can inhibit the proliferation of leukaemic cells with a pharmacological dose (10^{-7}M). Lower dose was ineffective. This growth inhibition, dose and time dependent, was associated with cell cycle arrest; P388 cells accumulates in G0/G1 phase. Our finding are in agreement with Mossuz*et al.* (4) who reported that the testosterone can inhibit the proliferation and the clonogenic potential of the human monoblasticleukaemic cell line U937. The growth inhibition was associated with cell cycle arrest, U937 cells accumulating in G2/M phase.

Many anti-tumoural compound act by the way of cell cycle arrest, leading to accumulation of cells in G2/M or G0/G1 phases and cell growth inhibition [21]. In P388 murine leukaemia cells, a potent anti-tumour marine steroid (YTA0040) suppresses nucleic acid and protein synthesis. Cell cycle analysis revealed that this steroid blocked the cells into S phase leading to arrest in the late G1 phase [22].

The novel aminosteroid 5alpha-androstane (HY) inhibit the proliferation of the human promyelocytic leukaemia cell line HL-60. This aminosteroid HY was a derivative of 5 alpha-androstane and posses some structural similarities with an androgen steroid [23]. Methoxyestradiol (2-ME2) markedly suppressed proliferation of human acute T lymphoblastic leukemia CEM cells in a time- and dose-dependent manner. Exposure to 2-ME2 led to G2/M phase cell-cycle arrest, which preceded apoptosis characterized by the appearance of a sub-G1 cell population [24].

Cyproterone Acetate (CA) is a potent synthetic steroid exhibiting anti-androgenic effect, blocking the peripheral action on sexual organs of both endogenous and exogenous testosterone [19] and also progestational activity [9]. The progesterone is a potent cytostatic agent [25].

DT and CA could act through a receptor common to steroid compounds, but different from the androgenic receptor found in sexual organs. Specific androgen receptors were detected in non-Hodgkin's lymphoma cells [26].

Data demonstrated the presence of binding sites in acute lymphoid and myeloid leukaemia, named Type II ER binding sites (type II EBS) [27].

The works of DY Jun and al (2008) [28] reported that the cytotoxicity of 17α-E2 toward Jurkat T cells is attributable to apoptosis mainly induced in G2/M-arrested cells, in an ER-independent manner, via a mitochondria dependent caspase pathway regulated by Bcl-2.

The present *in vivo* experiment showed that testosterone inhibits tumour growth and cell proliferation both in bone marrow and tumour tissue. *In vitro* study demonstrated that testosterone can also inhibit the proliferation of the murine leukaemic cell line P388 in a dose and time dependant manner.

The similar effects of DT and CA give two informations : the androgenic receptor that mediates these steroid effects is different from the receptor of sexual organs and this receptor is probably specific to steroid compounds.In fact, the cytotoxic effect of 17α-E2 against human leukemias Jurkat T and U937 cells was not suppressed by the ER antagonist ICI 182,780 [29].

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ANNEX

Table I: Effect of DT or CA on the plasma testosterone concentration (nmol/l), thymus, spleen, seminal vesicle (mg/100g) and tumour (mg) weights of non-castrated (NC) and castrated mice.

		Thymus mg/100g ± sem	Spleen mg/100g ± sem	Seminal vesicle mg/100g± sem	Testosterone nmol/l ± sem	Tumour weight mg ± sem	Tumour appearence %	Survival %	Bone cells/ ml x10^6
NON-CASTRATED	Untreated	246 ± 68.1	336.5 ± 24.3	372 ± 63.2	22.4 ± 1				2.5±0.3
	TM	200.1 ± 46.1	437.1 ± 68.9 **	374.6 ± 68.9	20.5 ± 2	9.5 ± 2.8	62.5	87.5	3.3±1.1
	DT	86.9± 36.8 **++	508.9 ± 17.6**	514.8 ± 72.0 **++	50.8 ± 11.1 **++	6.5 ± 2.3+	8.3	83.3	0.95±0.5 p<0.005
	CA	153.9 ± 35.9 **+	290.2 ± 39.1 *++	240.5 ± 70.6 **++	5.8 ± 1.2 **++	6.8 ± 2.8+	9	80	1.6±0.8 p<0.05
CASTRATED	Untreated	330.1 ± 36.8°°	384.2 ± 47.9	228.1 ±67.9°°	0.03 ± 0.01°°				3.2±0.5
	TM	300.0 ± 25.5°°	400.5 ± 30.8	230.0 ± 65.2	0.02 ± 0.008	12.5 ± 4.5	70	50	3.4±1.6
	DT	170.0 ± 50.5 p < 0.001	470.9 ± 60.0	480.3 ± 76.3 p <0.01	20.5 ± 7.5 p< 0.001	8.5 ± 3.5	40	40	1.15±0.7 p<0.05
	CA	200.5 ± 6 0.8 p<0.01	350.0 ± 58.9	220.9 ± 75.9	0.03 ± 0.005	9.0 ± 2.4	50	40	0.53±0.3 p<0.05

Values are the means ± SEM. The transplanted mice were compared to animals without tumour. The transplanted DT or CA treated-mice were compared to grafted untreated mice.

TM: NC or castrated transplanted mice
DT: NC or castrated transplanted mice treated with DT.
CA: NC or castrated transplanted mice treated with CA.

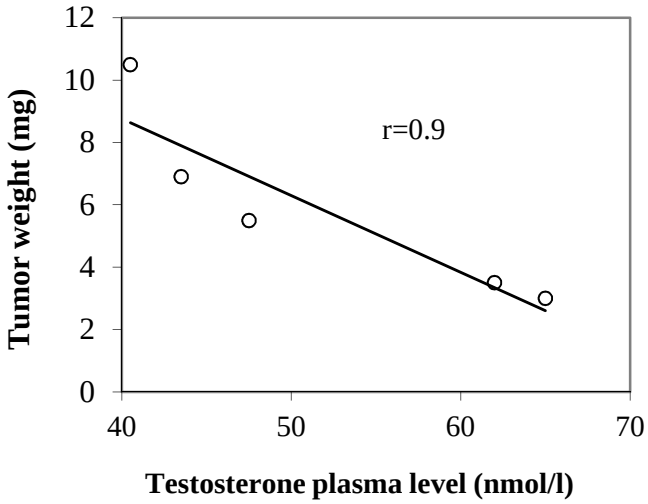


Fig.1. Correlation between the plasma testosterone level and tumour weight (r= 0.9) in NC DT treated mice.

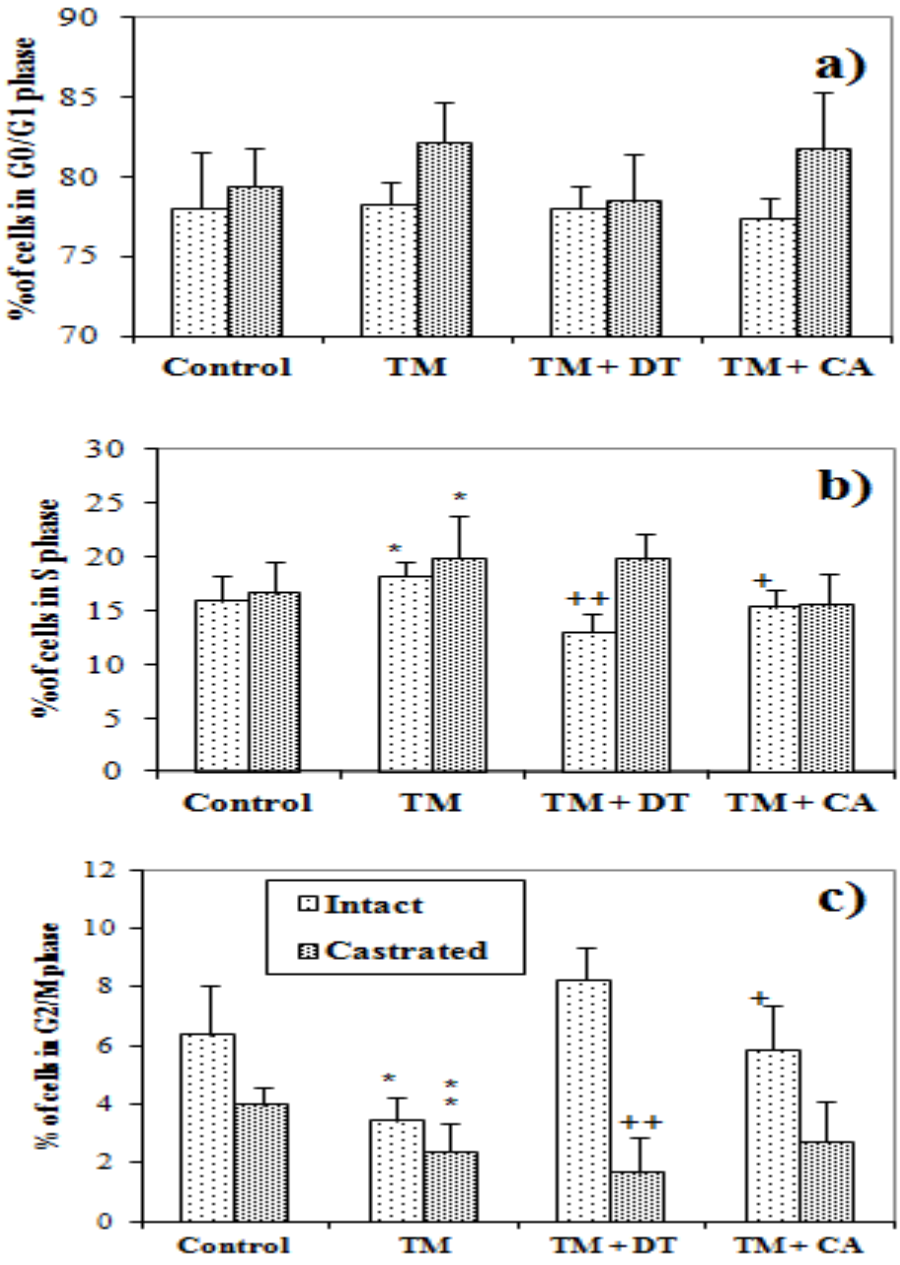


Fig. 2. ***Effect of DT or CA (0.5mg/100g body weight) on the cell distribution among the phases of the cell cycle: G0/G1 (a), S (b), G2/M (c) in bone marrow cells of NC and castrated control mice or with tumour. Data are means ± SEM.***

*p<0.05 compared to NC or castrated mice without tumour.
+ p<0.05, ++ p<0.01, compared to tumour-bearing mice without treatment.

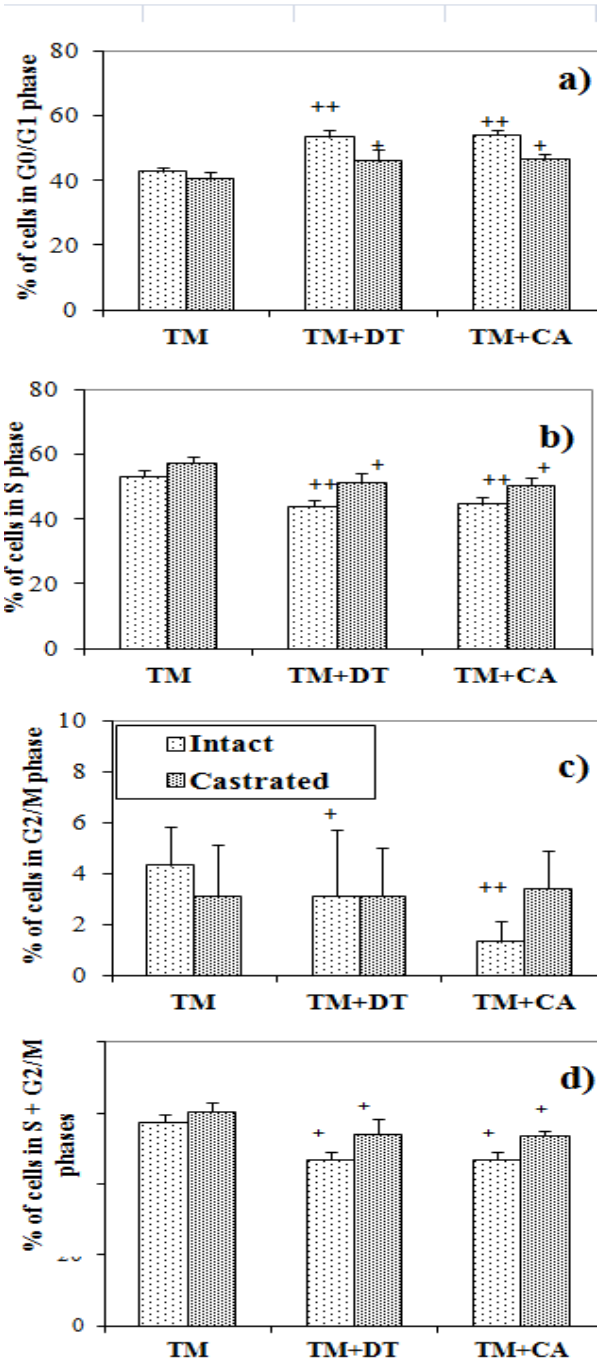


Fig. 3. Effect of DT or CA on the repartition of cells among the phases of the cell cycle (G0/G1 (a), S (b), G2/M (c) and proliferative phase (d) in tumour tissue of NC and castrated transplanted mice.

Data are means ± SEM. + $p<0.05$, ++ $p<0.01$, compared to tumour-bearing mice without treatment.

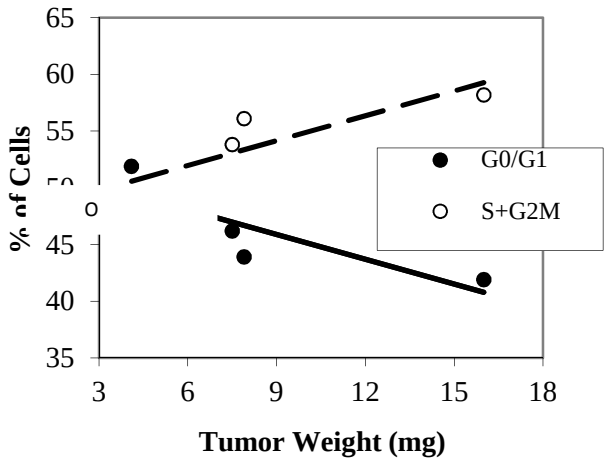


Fig. 4. Regression Curve between the tumour weight and the percentage of cells in G0/G1 phase (r=0.86, p<0.01) and in proliferative phase (r=0.85, p<0.01), in castrated P388 tumour-bearing mice treated with DT.

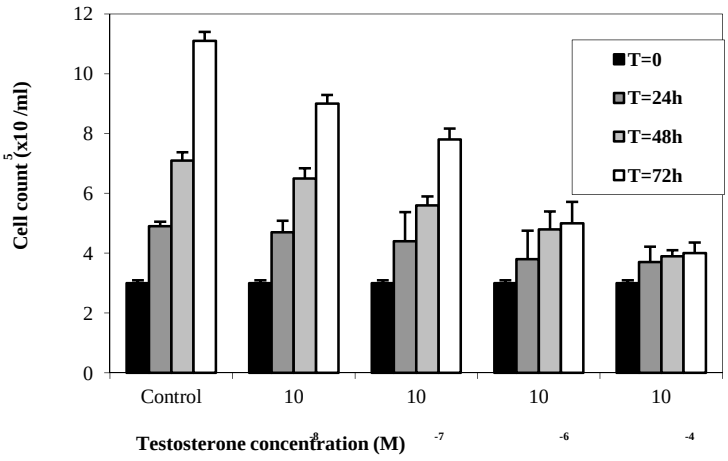


Fig. 5. Effect of DT concentration on P388 cell growth in vitro.

DT was added in the medium at the beginning of the culture. Culture was followed during 3 days. Data are mean cell count ± SEM.

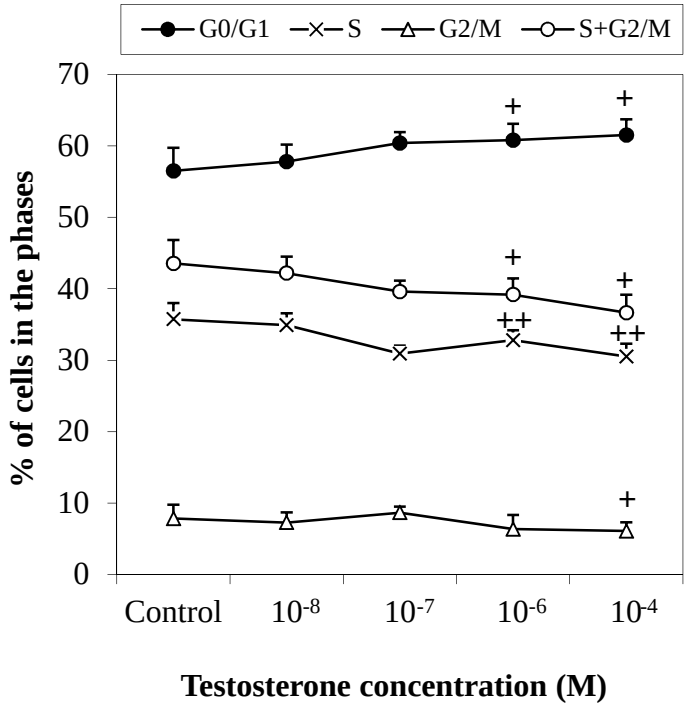


Fig. 6. In vitro effect of DT concentration on the proportion of P388 cells in the different phases of the cell cycle.

Data are mean ± SEM.
+ p<0.05, ++ p<0.01 compared to untreated cells.

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Manufacturing Computer Aided Process Planning For Rotational Parts. Part 2: A New Approach for Optimizing Multiple Interpretations of Interacting Features Based on Manufacturing Rules and Metal Removal Principals

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ABSTRACT: Automatic Feature Recognition (AFR) has played a crucial role linking Computer Aided Design (CAD) activities and Computer Aided Process Planning (CAPP) activities. For the purpose, many methods have been developed to recognize form features from CAD files, taking into account features interactions. Among one of the most efficient approaches that can handle features interactions is the Cell-based volume decomposition approach. However, on the one hand, this method suffers from computational combinatorial explosions when multiple interpretations of sets to remove volumetric features from a same part are generated. On the other hand, not all interpretations are rational from a machining point of view in the real manufacturing environment. This paper describes a new approach to eliminate the undesirable interpretations of features, according to manufacturing rules and metal removal principals. A Features Suppression system is elaborated, and which consists in adding or removing material rings matching to some volumetric features of the part. By this way, the part and the stock are modified, and the number of interacting features that are used to generate multiple interpretations of features is remarkably reduced. A simple example part has been processed through this paper to validate the approach.

KEYWORDS: Automatic Feature Recognition, Features Interactions, STEP, CAD/CAPP/CAM, Optimization, Turning Process.

1 INTRODUCTION

Due to the high industrial competitiveness, manufacturing companies are forced to produce high quality products at the lower possible cost. Process planning is an activity that consists in selecting the necessary tools, machines, processes, operations and instructions, to transform industrial materials from raw materials into finished parts, according to the requirements of the designer. The traditional way to solve process planning problems is to leave it to the manufacturing experts, who translate the global geometry of the part into a group of machining features, well adapted each to a defined machining process, relying on their own experience and knowledge of production facilities, equipment, their capabilities, and tooling. As a part may contain many features, proper sequencing of machining these features is crucial in achieving efficient and high-quality manufacturing of the part [1]. This manual approach is time consuming and also considered as a poor use of engineering skills, because of the high clerical content in most of its functions [2]. To overcome these issues, and to ensure significant reduction of time needed for elaboration of manufacturing process planes, manufacturing companies need more automation from design activities to manufacturing activities, ensuring an easier, a faster and a flexible workflow [3]. As the design process is reinforced by many Computer Aided Design tools, Computer Aided Process Planning (CAPP) has evolved to simplify and improve process planning, and achieve more effective use of manufacturing resources. In the recent years, the integration of Computer Aided Process Planning (CAPP) has received significant attention, since it represents the main bridge between Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM). One of the core tasks in CAPP systems is to extract and identify the information such as machining features directly from a CAD neutral file, because CAD systems do

not provide part feature information. Thus, in order to insure an efficient interfacing between CAD and CAPP systems, feature recognition is one of the most competent approaches.

Over the past decade, automatic feature recognition has steadily advanced, and many commercial feature recognition systems have appeared in the marketplace. However, most of current feature recognition systems have not yet been significantly implemented in real industrial activities [4]. The majority of these systems can interpret and process only isolated features, but proper handling of interacting features often has a wide range of consequences and effects on a feature model, in the way it is to be interpreted and utilized in process planning activities. On the one hand, feature interactions can cause feature validity to be violated because they not only change the predefined feature geometric form and its topology, but also alter its attributes such as Geometric Dimensioning and Tolerancing (GD&T), or even completely leads to the suppression of some features surfaces [5]. From a machining point of view, the machining of certain features may accidentally destroy the necessary entities such as fixturing surfaces, locating surfaces, and supporting surfaces required for machining other features [6]. As a result, it is hard to identify features and hard to sequence them properly in process planning. On the other hand, despite the fact that some robust methods such as Convex Decomposition and Volume Decomposition methods have been developed so as to handle features interactions, these methods are computationally intensive [7]. A large number of possible combinations of cells (up to n!) have led to an enormous time complexity. Adding to that, not all the interpretations of interacting features were reasonable from a machining point of view [8].

In the literature, in volume decomposition approach, generating multiple interpretations of interacting features, and creating new form features is done by extending material surfaces of the interacting features until the stock [7], [8], [9]. The data used to build these new features are only form feature information: geometric, dimensional and topological data extracted from a CAD neutral data file such as STEP [10]. Besides, Geometric Dimensioning and Tolerancing (GD&T), economic and technological constraints, are not taken into account during feature recognition and especially generation of multiple interpretations of interacting features. These tolerancing requirements and constraints are usually used by downstream activities such as automatic tool selection, adding to features and operations sequencing. When we talk about multiple interpretations of interacting features, we talk about multiple combinations that correspond to all the possible sets of machining features that can be recognized from the part. It represents multiple ways to decompose the total machinable volume into features volumes. It is known that GD&T and economic and technological constraints create implicitly precedence between features, which can lead to the elimination of some combinations for which the order to machine features violates precedence constraints. However, extraction of GD&T data from CAD systems has been a major problem. These data are embedded as a drawing in the most of CAD systems [11]. Thus, the only scope to reduce the number of multiple interpretations of interacting features, without recurring to (GD&T), economic and technological constraints, is to focus on eliminating all the interpretations of interacting features that are not reasonable from a machining point of view, by unifying machining parameters according to manufacturing rules and metal removal principals [12], and which is the main objective of this manuscript.

This paper is organized as following: In Section 2, we describe previous works on Automatic Feature Recognition and features sequencing. Section 3 briefly describes a feature recognition system for rotational parts which adopts STEP AP203 Ed2 as an input. Section 4 provides details about a new concept of Features Suppression, based on the work done by Ersan Aslan [12], and which consists in eliminating the unwanted combinations by adding or removing material rings corresponding to some volumetric features of the part, according to manufacturing rules and metal removal principals. In section 5, we give an overview of a Features Generator system capable of generating multiple interpretations of interacting features. Section 6 treats machining features sequencing. In section 7, a simple workpiece is presented for explanation of the proposed methodology. Finally, concluding remarks and recommendations are presented in Section 8.

2 LITERATURE REVIEW

- Automatic Feature Recognition (AFR)

There have been many previous attempts leading to the development of successful feature recognition methods for manufacturing purposes, and which can be broadly classified into many approaches: graph-based, hint-based, convex volume decomposition, volume decomposition-recombination, rule-based, and other methods.

Graph-based approaches are most efficient in recognizing canonical instances of feature patterns, but generally cannot handle interacting features and multiple interpretations [8]. Rahmani & Arezoo [4], made a hybrid graph based and hint-based analysis techniques to recognize interacting features for prismatic parts. The graph-based aspect of the current

approach is aimed at extracting feature hints, but the feature is completed geometrically. This method uses an AAG which is decomposed to limit and organize the search space for feature hints. Hints, in sub-graph forms, are extracted from the decomposed graph components. A completed volume is then generated for each feature hint using geometric and topological properties of the part.

Convex decomposition and maximum volume decomposition methods are more robust in handling features interactions, but are computationally intensive, and lead to a large number of possible features interpretations. Wang & Kim [7], described a hybrid feature recognition method capable of handling interacting features for prismatic parts, and which combines three feature recognition technologies: graph-based, convex volume decomposition, and maximal volume decomposition method. These methods are combined so as that they mutually complement each other's capabilities, without compromising performance and completeness. The graph-based method (GRP) efficiently simplifies the volumetric connectivity of the resulting part. The maximal Volume Decomposition method (MVD) removes features with toroidal faces, while addressing MVD's combinatorial complexity. Negative Feature Decomposition method (NFD) handles interacting features, and generates rich feature information. Anomalies caused by MVD's maximal volume growing have been identified, and are cured by introducing limiting half-spaces.

Jaider and El Mesbahi [9] developed a feature recognition system for rotational parts by taking STEP file as an input to the system. The first module of this system uses the rule-based approach for recognizing both isolated and interacting features. This module consists in analyzing geometric and topological data extracted from STEP AP203 Ed 2 data file, and recognizes each feature according on certain pre-specified rules that are characteristic to the feature. The second module takes the recognized features, and uses a circular volume decomposition approach to generate multiple combinations of possible machining features. For each combination, an order to build features is well defined. Each Feature is built by extending its material surfaces until the stock or material surfaces of the part. It has been concluded that this system is reliable in recognizing turning features and generating multiple interpretations of interacting features, nevertheless, according to manufacturing rules and metal removal principals applied in real manufacturing environment, it is no use to generate some interpretations of features, for which the order of machining these features is not reasonable.

- Machining features sequencing:

Liu & Wang [1] used a hybrid approach combining both knowledge-based rules and geometric reasoning rules to determine feature sequence for prismatic parts with interacting features. The developed approach consists of three steps. The first step involves determining machining precedence constraints by a set of defined knowledge-based. These precedence constraints can be classified as Fixture interactions, Tool interactions and Tolerance/datum interactions. In the second step, machining features are grouped into setups based on determining a primary locating direction of a setup, and the appropriate machining features are grouped into the setup according to their tool approaching directions (TADs). In the last step, features are sequenced within each setup through geometric reasoning. The advantage of this approach is that both manufacturing interactions and geometric interactions can be handled simultaneously during feature sequencing.

Ersan [12] developed a system that aimed to extract information from DXF files to determine features existing on rotational parts, machined on horizontal machining centers. During features extractions, and by applying production rules, some features are modified based on analyzing their neighborhood. The definition of process neighborhood should be considered as an obligation for maintaining of tools, shortening of tool path and part programming and preventing of tool crashing into the part material. By this way, machining parameters are unified, new features were re-created and new processes were established. The processes are put into order according to manufacturing rules and metal removal principles, becoming prior and secondary. The number of factors starts with 100, which belongs to facing. The bigger confident factor describes the first process to be performed. This system is powerful when isolated features occur, however, it cannot handle multiple interpretations of interacting features.

3 AUTOMATIC FEATURE RECOGNITION FROM STEP AP203 ED2

3.1 GEOMETRIC AND TOPOLOGICAL DATA EXTRACTION

Being an emerging international standard protocol for the exchange of technical product data, STEP is a text file containing strings and entities that describe geometrically and topologically 3D models. The high level of description in STEP is the shell. A Closed-shell is a topological item that is constructed by joining faces along edges. A face in STEP file is denoted as ADVANCED_FACE, characterized by its surface type, and bounded at least by one loop of edges. Each loop is formed by a set of edges connected by vertex points, each vertex point, circle center, cylinder center, and so on, is marked by its

coordinates. As cited implicitly above, the STEP file starts with a string CLOSED_SHELL and ends with coordinates of points, such as vertex points coordinates and circle centers coordinates. Extraction of geometric and topological information is done according to the hierarchical structure of STEP file, where C++ language is used to locate various strings and entities in the STEP file, and to store them in a database in such a way that the extracted data are coherently ordered. The command string::size_type loc = str.find(" CONICAL_SURFACE ", 0) is an example of one of the functions that can be used to locate a specified text string.

3.2 AUTOMATIC FEATURE RECOGNITION

Taking the fact that geometric and topological data are extracted from the STEP file, these data are analyzed by the rule-based approach in order to identify each feature according on certain pre-specified rules that are characteristic to the feature. In this paper, the recess feature illustrated in Fig. 1 has been chosen for explanation of above rules. It must be noticed that the coordinate system that was adopted is YZ, Y for the diameter, and Z for the length since it is the same axis taken In CNC machining operations.

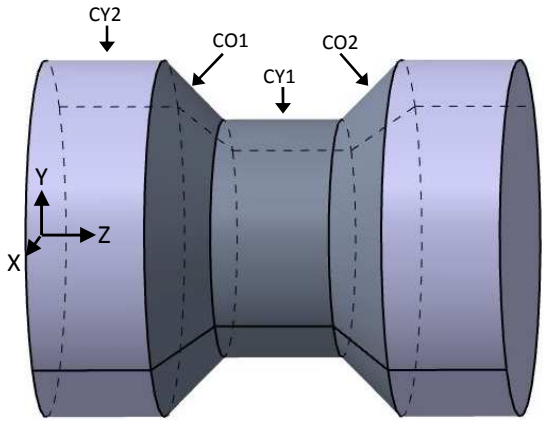


Fig. 1. A cylinder containing an angled recess feature

The set of heuristic rules used to describe recognition of this type of recess depicted above is as following:

Rule 1:
The STEP data must contain two CONICAL_SURFACEs (CO1, CO2) and two CYLINDRCAL_SURFACEs (CY1, CY2) having different diameters, and circle centers of the cylinder with minor radius lie between four circles centers of the cylinder with major radius.

Rule 2:
X and Y coordinates of cylinders centers, tapers centers and circles centers must be the same, and Z coordinate may be different.

Rule 3:
X, Y, Z coordinates of each taper center and two circles centers of the cylinder with minor radius are same.

Rule 4:
The left taper to the minor cylinder must be a right hand taper (major radius at the left end of the cone), and the right taper to the minor cylinder is a left hand taper (major radius at the right end of the cone). The angle of taper is equal to the last value in the line of CONICAL_SURFACE in the STEP text file. The depth of the recess is equal to the difference between the big and the small radius of cylinders.

Rule 5:
Edge curve construction of CYLINDRICAL_SURFACEs and CONICAL_SURFACEs must be; line, circle, line circle, or; circle, line, circle, line.

Rule 6:
Every CYLINDRICAL_SURFACE and CONICAL_SURFACE shares two common linear edges with another of the same type.

Rule 7:
Circles with minor radius of tapers and circles of the cylinder with minor radius are same. Circles with major radius of tapers and four circles among eight of the cylinder with major radius are same.

The system for feature recognition processes a database of fifty predefined manufacturing features and capable of recognizing external features, internal features, and special features such as threads.

4 FEATURES SUPPRESSION

After recognizing turning features, an analysis is made to handle interacting features, since when many interacting features occur, multiple combinations of features to be removed from the stock in order to machine a same workpiece are generated, which can lead to a computational combinatorial explosion. For the purpose, we have developed a Features Suppression system, to reduce the number of combinations generated by a Feature Generator system, by adding and removing material rings to the part and from the stock respectively. The advantage of this method is that the part is simplified and interactions between the suppressed features and the remaining features are avoided. This Features Suppression system is based on the work done by Ersan [12], which treats unification of machining parameters for rotational parts according to manufacturing rules and metal removal principals, and which consists in defining priority of the processes based on analyzing neighborhood of some features.

4.1 FEATURES SUPPRESSION BY ADDING MATERIAL RINGS TO THE PART

In this step, a judicious analysis is done to neighbor surfaces of some usual turning features. Features processed in this sub-section are: grooves, recesses, tapers, rounds and chamfers.

- **Neighborhood of grooves and recesses**

From the point of manufacturing rules applied by experts in the real manufacturing environment, two cylinders having a same diameter will be machined sequentially, which causes long tool path into blank diameter of the groove. Hence, when a groove lies between two cylinders having the same diameter (Fig. 2a), these cylinders are unified to form a new cylinder length, and a groove is stored to be performed after machining that new cylinder. Otherwise, a material ring corresponding to the groove dimensions, topology and geometry can be added to the part. This is done by extending an adjacent cylindrical surface (ADVANCED_FACE) to the groove by a length matching to the length of the blank diameter of the groove. It must be highlighted that all geometric and topological data related to the groove, and the cylinder are modified or deleted from STEP text file. For example, ADVANCED_FACEs representing the two plans and the cylinder with minor radius that form the groove of Fig. 2a, loops, circular edges, vertex points, and so on, are deleted from STEP file. In the case when neighbor cylinders of the groove have different diameters (Fig. 2b), the cylinder with minor radius is extended until reaching a material surface representing a plan of the groove.

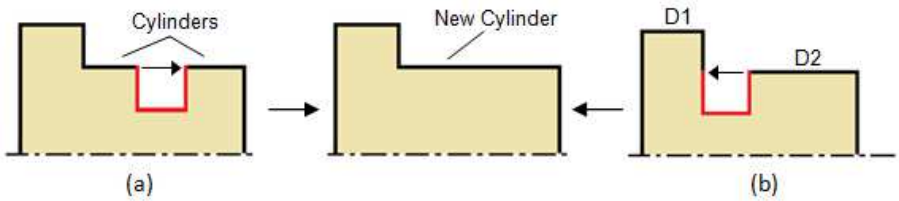


Fig. 2. Rings addition for grooves

In the case of nested grooves (Fig. 3), material rings addition is done by the same manner, starting from small diameters to big diameters, and repeated until that no groove remains in the workpiece. Material rings addition for grooves can be applied also for many types of recess and nested recess, such as angled recesses and filleted recesses. It seems clear that the order to add material rings corresponding to recesses and grooves is the contrary order to machine these features.

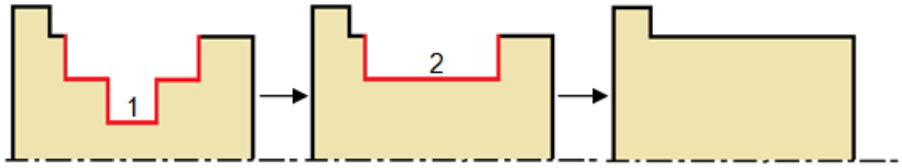


Fig. 3. Rings addition for nested grooves

- **Neighborhood of tapers**

Concerning tapers, author [12] has described how to create a new cylinder based on neighborhood between cylinder and taper, by extending the cylinder. However, the cylinder may interact with other neighbor features. Features interactions generate multiple interpretations of features, as a result, the length of that new cylinder may take many values (Fig. 4). Thus, it is preferable to add a material ring from the taper, in such a way that the neighbor minor cylinder to the taper becomes a simple shoulder feature, formed by joining a plan and a cylinder along a circular loop. By this way, the shoulder can interact easily with other simple features (Fig. 5). In this case, a material ring is formed by creating two virtual surfaces (Fig. 6). The first surface is obtained by extending the neighbor cylinder with major radius by the length of the taper. The second surface is a plan bounded by two loops. The inner loop of that plan is the same loop formed by circles with minor radius of the taper. The outer loop of that plan is the same loop formed by two circles of the extended cylinder.

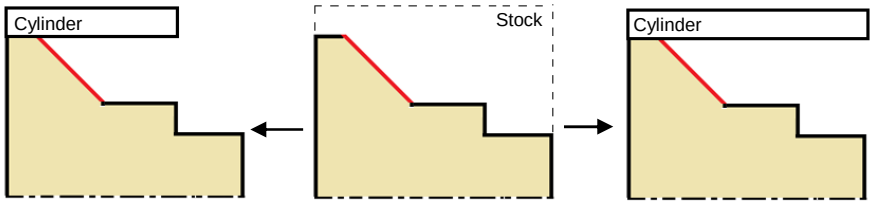


Fig. 4. Cylinder created from a taper (Ersan, 2005)

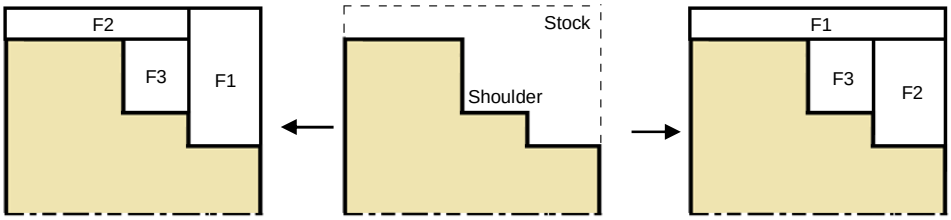


Fig. 5. Some interacting features resulting after adding a ring to the taper

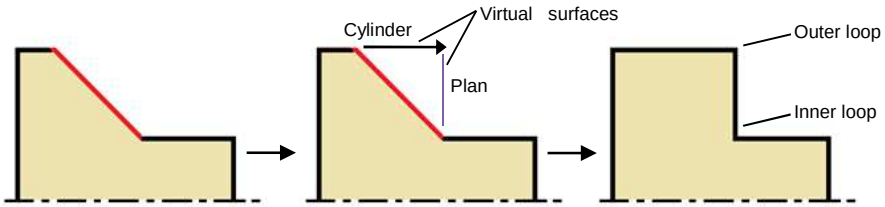


Fig. 6. Ring addition for a taper

- **Neighborhood of chamfers and rounds**

It is known that adjacent surfaces of a chamfer are almost a plan and a cylinder. Author [12] has explained how to create a cylinder neighbor to a chamfer, for which the length is calculated by the sum of the old cylinder length and the first chamfer length. However, the neighbor face to the chamfer was not treated. Adding to that, the adjacent face and the

adjacent cylinder to the chamfer can interact between each other and with other features. As a result, the length of that new cylinder, and the diameter of circles that form the outer loop of the face may take many values (Fig. 7). Thus, it is advantageous to add a material ring from the chamfer in order to facilitate handling of interacting features adjacent to the chamfer (Fig. 8).

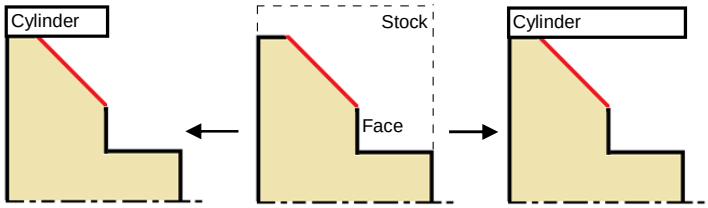


Fig. 7. Cylinder created from a chamfer (Ersan, 2005)

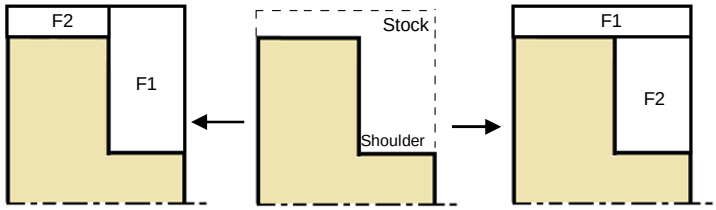


Fig. 8. Interacting features resulting after adding a ring to the chamfer

In this case, a material ring is formed by extending adjacent surfaces to the chamfer (Fig. 9). The adjacent cylinder to the chamfer is extended by the first chamfer length, and the adjacent face to the chamfer is extended by the second chamfer length.

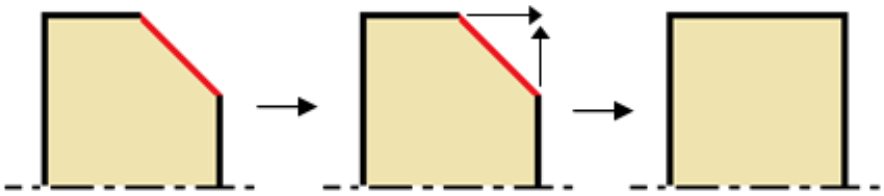


Fig. 9. Ring addition for a chamfer

Material rings for rounds are also created by extending adjacent surfaces to the round. The difference between rounds and chamfers is that both adjacent surfaces to the round are extended by the round radius.

4.2 FEATURES SUPPRESSION BY REMOVING MATERIAL RINGS FROM THE STOCK

It is known that workpiece zero point is generally taken on the face in CNC machining operations. So, facing is considered to be the first operation in any turning process. The second operation is considered as the operation from stock diameter to the maximum diameter of the finished product [13]. Thus, it will be necessary to remove the face and the cylinder features from the stock cylindrical bar, if they exist, in order to avoid interactions between the face and the cylinder with maximum diameter with other features. A face feature exists, if the difference between the length of the stock and the final part length is different to zero. Besides, a cylinder exists if the difference between the diameter of the stock and the final diameter of the finished part is different to zero. The face and the cylinder can be removed by extending the face until the stock, and followed by extending the cylindrical surface with maximum diameter until the extended face (Fig. 10). And then, a cylinder to the face and a hollow cylinder to the cylinder with maximum diameter are removed from the stock. By this way, the length of the new cylindrical stock bar becomes smaller by the length of the removed cylinder to the face, and the diameter of the new stock becomes smaller by the difference between the old stock diameter and the maximum diameter of the part.

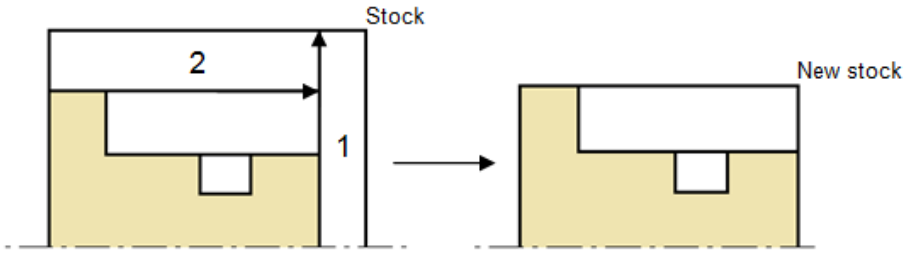


Fig. 10. Suppression of the face and the cylinder features from the stock

4.3 FEATURES COMBINATIONS ELIMINATION

The workpiece of Fig. 11 is taken on one hand, to recapitulate and to clarify the methodology above for adding and removing material rings, and on the other hand, to explain and to show how systematically, the number of multiple combinations resulting from interacting features is reduced. The workpiece in divided into two regions, internal region and external region since the maximum diameter for both internal and external features, is at one end of the part [9], [14]. Each region must be treated separately in order not to confuse interactions between features from different regions.

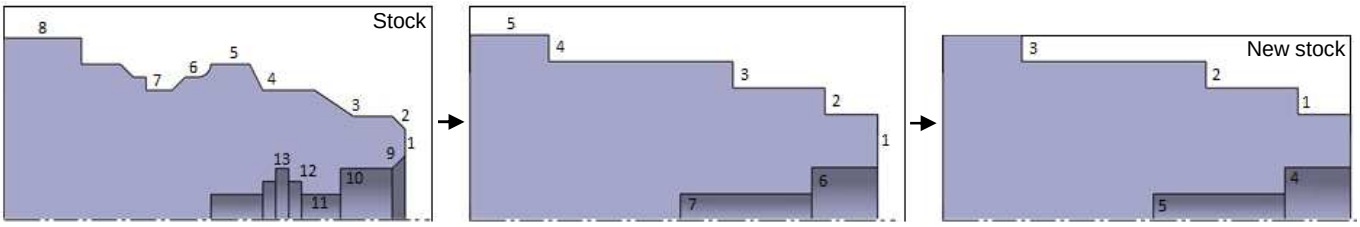


Fig. 11. Simple workpiece

For the workpiece left in the figure above, eight features are interacting for external turning, and five interacting features for internal turning. Taking the fact that chamfers represent covering features, the chamfers 2 and 9 are excluded from interactions. This means that 7! Combinations of features to machine the external shape of the part are resulting by external features, and 4! Combinations are resulting by internal features. By applying the method of material rings addition, shoulders 3 and 4, face 1 and the adjacent cylinders to chamfers are modified. Recesses 6 and 7 are excluded from interactions with other features such as the shoulder 5. The same case for grooves 12 and 13. This means that the number of combinations is reduced to 5! combinations for external turning, and 2! combinations of internal turning. By removing the face 1 and cylinder 5 from the stock, the number of combinations is reduced to 3! combinations for external turning. It must be noticed that all material rings that were added to the part or removed from the stock, that correspond to machining features, are stored in a database, since they will be used for machining features sequencing. So after covering the workpiece by adding material rings matching to features processed in section 4.1, and after reducing dimensions of the stock cylinder by removing the face and the cylinder with major radius from it, the modified part and the remaining features will be addressed in the Feature Generator system, also, the new stock will be used to generate possible interpretations of interacting features.

5 FEATURES GENERATOR

Before describing the methodology followed for generating new manufacturing features, it will be important at this stage to define the following terms: Perfect Manufacturing Feature (PMF), and Imperfect Manufacturing Feature (IMF). A PMF is simply an isolated feature, for which frontier surfaces of the feature surfaces are blank surfaces. Whereas, an IMF is an interacting feature, wherein, at least one frontier surface of the feature surfaces is not a blank surface. Thus, the Features generator system analyses frontier surfaces of each feature surfaces, to locate the IMF that will be used to build new manufacturing features. Construction of a new manufacturing feature (MF) is based on extending material surfaces of the IMF until blank surfaces of the part. By this way, an IMF is transformed to a PMF. Once a feature is built, it is removed from the stock, and after, material surfaces of a following feature are extended until the last new stock. The operation is repeated

until that the stock becomes the final part. It must be noticed that the order in which features are build, is the same order in which features are machined. For the example part of Fig. 12, only one combination to build features in a specific order is illustrated, many combinations are valid.

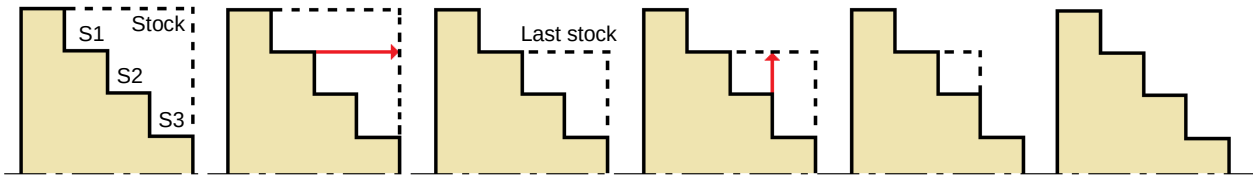


Fig. 12. Generation of features by extending their material surfaces until the stock surfaces

Combinations of features can be obtained according to the number of IMF. If the number of intersecting imperfect manufacturing features is N, there are N! combinations to build N features. Otherwise, there are N! manners to machine N features. So, after construction of new perfect manufacturing feature, which are considered as isolated features, the Features Generator is called to extract new dimensional parameters of features. These features are also stored in the same database where material rings were stored.

6 MACHINING FEATURE SEQUENCING FOR PROCESS PLANNING

It must be observed that all the stored features are in an incorrect order from a machining point of view. Features are put into order according to metal removal principles, becoming prior and secondary and usability of the tool for many features as given in Table 1. The features below have got confident factors to put them in order [12]. The number of factors starts with 100, which belongs to facing, the bigger confident factor describes the first process to be performed. Facing is followed by longitudinal turning of the maximum diameter of the part. Both these features belong to the removed features from the stock. Next, features to be performed are features of a combination among those generated from interacting features by the Feature Generator system, which are simple shoulders that can be also classified as cylinders with a same confident factor (90).

In our system for feature recognition, a shoulder can be identified as a junction between a plan and a cylinder (Fig. 13a), or between a conical surface and a cylinder (Fig. 13b). We can consider that a taper is the association of a simple shoulder (junction of a plan and a cylinder) and a material ring to the cone (Fig. 13c). Thus, it will be advantageous to unify this ring and the simple shoulder in a single roughing operation [13], with respect of the priority of process, and taking into consideration features interactions. Taking the taper shown in Fig. 14b. Due to features interactions, the ring to the taper can be associated only with one feature respecting machining passes.

- If the adjacent cylinder (1) to the taper is extended first, then, the ring is unified with the adjacent shoulder (2) of Fig. 14a, in a single roughing operation.
- If the adjacent face to the taper is extended first, then, the ring is unified with the adjacent cylinder (2) of Fig. 14c, in a single roughing operation.

Taking the fact that the previous features are removed from the stock, features that were added as material rings to the part are machined according to their confident factors. As cited above in Section 4, the order in which nested grooves and nested recesses are added to the part from small to big diameters, is the contrary order to machine these features.

Table 1. Features and their confident factors for machining purposes (Ersan, 2005)

Feature name	Confident factor	Feature name	Confident factor
Face	100	**Angled recess**	50
Cylinder	90	**Filleted recess**	40
Taper	80	**Groove**	30
Chamfer	70	**Thread**	20
Fillet and round	60	**Parting off**	10

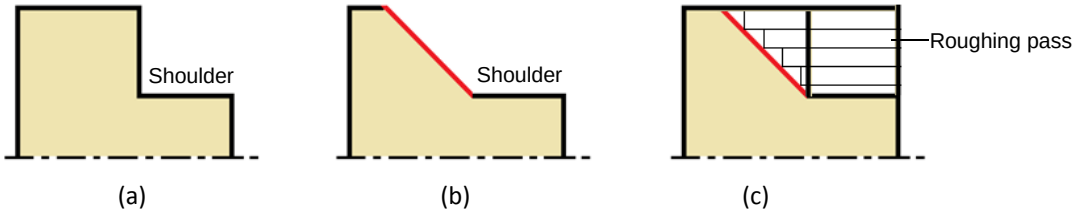


Fig. 13. Classification of a shoulder

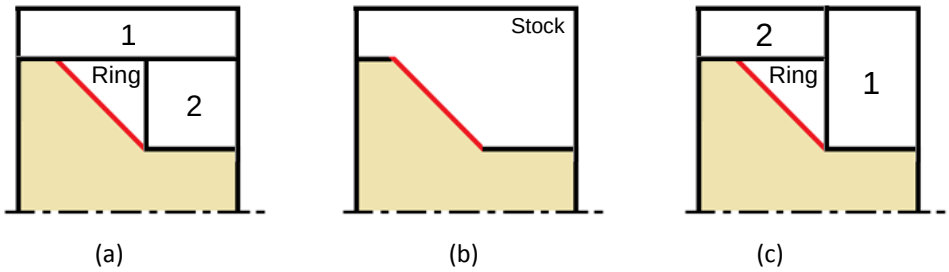


Fig. 14. Association of the ring to the taper with enveloping features

7 CASE STUDY

In this section, we took the same example part shown in Fig. 11. This part is used on one hand, to clarify the method for generating new manufacturing features from interactions between features, and on other hand, to recapitulate the chronological order in which features are sequenced for machining, based on their confident factors.

After extraction of geometric and topological data of the part from STEP AP203 Ed2 data file, these data are analyzed by the Automatic Feature Recognition system to extract features. The Feature Suppression system eliminates some features by adding material rings to the part, and stores them in a database. Other features are removed from the stock and also stored in the same database. The Features Generator system takes the new stock, the modified workpiece, and the remaining features (three shoulders) as input. After distinguishing between PMF and IMF, material surfaces of IMF are used to build new PMF. Taking the fact that three shoulders are recognized, 6 (3!) combinations to machine the external shape of the part are generated. For each combination, the order in which features are modified and their surfaces are extended until the stock to form PMFs, is the same order in which features are machined. Two combinations are similar since features are the same in a dimensional point of view. Thus, only five combinations remain. To machine the internal shape, two combinations are generated. This means that the total number of combinations to machine the part is equal to the product of numbers of combinations for external turning and internal turning. Thus, ten combinations are generated as illustrated in Fig. 15. At a last stage, the Features Generator system stores the generated features and their new dimensional parameters in the database.

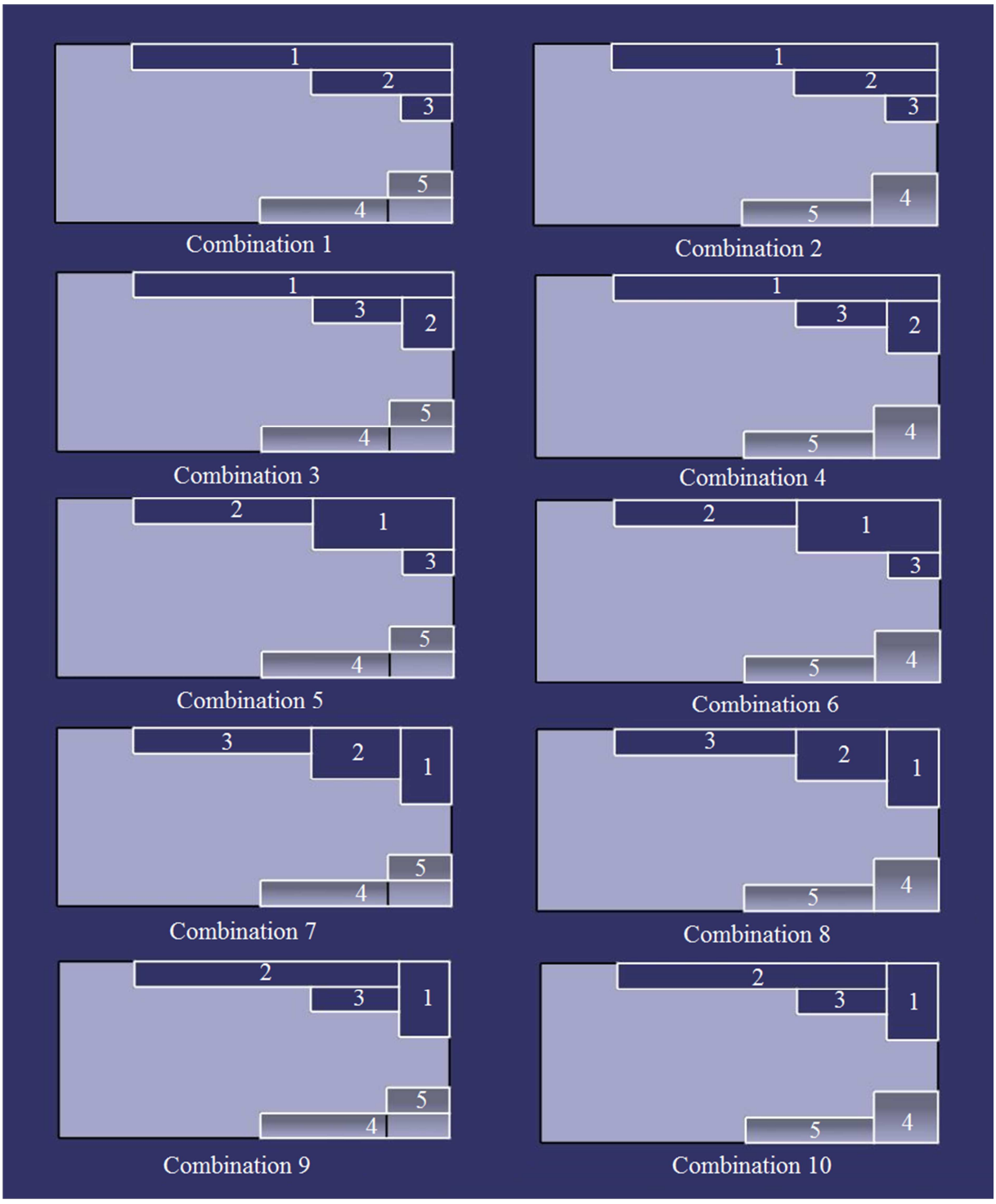


Fig. 15. Combinations of features generated by the Feature Generator system

It must be noticed that sequencing of features that were generated by the Feature Generator system was not treated. However, all combinations are valid. For this reason, and for explanation, we chose combination 1 to illustrate the chronological order in which all stored features are machined (Fig. 16).

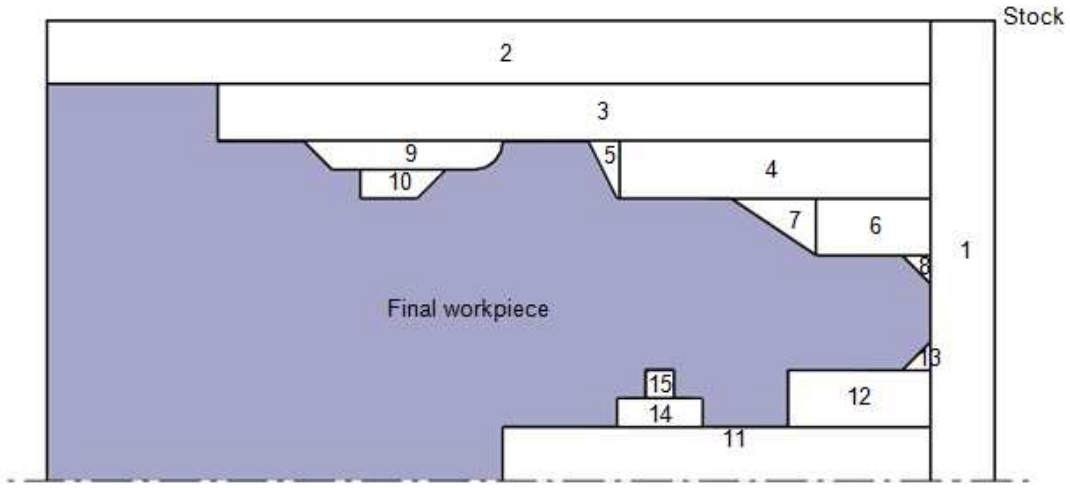


Fig. 16. Chronological order to remove machining features from the stock

8 CONCLUSION AND RECOMMENDATIONS

In the present work, we have introduced a new methodology interlinking CAD and CAPP systems, based on features recognition for rotational parts. The Automatic Feature Recognition system extracts geometric and topological data of the part from STEP AP203 Ed2 to recognize manufacturing features. According to manufacturing rules, some features such as grooves and recesses are excluded from features interactions and can be added as materiel rings to the part, to avoid interactions with other features. Others such as end faces and the cylinder with maximum diameter of the part are deleted from the stock, according to metal removal principles. As a result, the number of combinations generated by the Features Generator system (FG) is reduced. The new stock, the modified workpiece, and the remaining features are transferred to the Feature Generator system, which analyses the transferred features and builds new features from material surfaces of interacting features, by extending their material surfaces until black surfaces of the new stock. All features that was added to the part or removed from the stock, adding to the new features generated by the FG system, are stored in a database. Finally, the stored features are sequenced for process planning purposes according their confident factors.

It is clear that despite the fact that the number of combinations of interacting feature is remarkably reduced, the Features Generator system can give multiple combinations when many interacting shoulders occur, which can lead to a computational combinatorial explosion, and time consuming at tool selection stage. The combination 1 of Fig. 15 has been chosen purposely, since it respects an economic constraint that consists in organizing machining passes for a lower machining time. Thus, it will be benefic to take into consideration economic and technological constraints, Geometric Dimensioning and Tolerancing (GD&T) during generation of multiple interpretations of interacting features. Taking the fact that surfaces of each feature are known, GD&T, economic and technological constraints create precedence between surface of the part and then, between features. By this way, some combinations of feature for which the order to machine features violates these constraints will not be processed, and only the remaining combinations will be transferred to downstream activities such as automatic tool selection. These issues will be addressed in a future work.

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Etude de quelques facteurs influençant l'efficacité de l'activité insecticide de *Boscia senegalensis* Lam (Ex. Poir) dans le contrôle de *Callosobruchus maculatus* F. (Coleoptera-Bruchinae), ravageur du niébé (*Vigna unguiculata* (L.) Walp.

[Study of some factors influencing the efficacy of insecticidal activity of *Boscia senegalensis* Lam (E.g. Poir) in the control of *Callosobruchus maculatus* (Coleoptera-Bruchinae), pest of Cowpea (*Vigna unguiculata* (L.) Walp.]

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ABSTRACT: In Sahel, *Callosobruchus maculatus* (F.) (Coleoptera: Bruchinae) is one of the most fearsome pest of Cowpea (*Vigna unguiculata* Walp). To effectively combat this pest, many authors have advocated leaves *Boscia senegalensis*, plant commonly used by African producers in the protection of stored products. In this study, the factors that may influence the insecticidal activity of this insecticide plant in the Cowpea storage structures were examined. It is the effect of an increase in the mass of stored seeds, the effect of an increase in the numbers of insects and the effect of shelf life of broyât green leaves on the toxicity of the product. The tests showed that the strong insecticidal activity of *B. senegalensis* is influenced by the amount of stored seeds, the number of individuals in the stock and sex. Thus the results showed that, for a given dose of *B. senegalensis*, plus the amount of stored seed or insect density increases, more the efficiency of the product decreases. Also, males appear to be more sensitive to the product than females. Furthermore, analysis of the persistence of the insecticidal activity of the plant shows that the remanence of the product is a function of the applied dose. Indeed, more is high over the product continues to have an effect on insects. This study shows that the insecticidal activity of *B. senegalensis* is significantly influenced by factors related to the storage environment.

KEYWORDS: Cowpea; *Callosobruchus maculatus*, *B. senegalensis*, biopesticide, protection of stocks.

RESUME: En zone sahélienne, *Callosobruchus maculatus* (F.) (Coleoptera: Bruchinae) est un des ravageurs les plus redoutables des graines de niébé (*Vigna unguiculata* (L.) Walp). Pour lutter efficacement contre ce ravageur, de nombreux auteurs ont préconisé les feuilles de *Boscia senegalensis*, plante couramment utilisée par les producteurs africains dans la protection des denrées stockées. Au cours de cette étude, les facteurs susceptibles d'influencer l'activité insecticide de cette plante insecticide dans les structures de stockage du niébé ont été examinés. Il s'agit de l'effet d'une augmentation de la masse de graines stockées, l'effet d'une augmentation des effectifs d'insectes et l'effet de la durée de conservation du broyât de feuilles vertes sur la toxicité du produit. Les tests réalisés ont montré que la forte activité insecticide de *B. senegalensis* est influencée par la quantité de graines stockées, le nombre d'individus dans le stock et le sexe. Ainsi les résultats obtenus ont montré que, pour une dose donnée de *B. senegalensis*, plus la quantité de graines stockées ou la densité des insectes augmente, plus l'efficacité du produit diminue. Aussi, les mâles semblent être plus sensibles au produit que les femelles. Par ailleurs, l'analyse de la persistance de l'activité insecticide de la plante montre que la rémanence du produit est fonction de la dose appliquée. En effet, plus la dose est importante plus le produit continue à avoir un effet sur

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les insectes. Cette étude montre que l'activité insecticide de *B. senegalensis* est considérablement influencée par les facteurs liés à l'environnement de stockage.

MOTS-CLEFS: Niébé; *Callosobruchus maculatus*, *B. senegalensis*, biopesticide, protection des stocks.

1 INTRODUCTION

Le niébé, (*Vigna unguiculata (*L*.)* Walp.) est une légumineuse alimentaire largement cultivée dans le monde avec une production estimée à 3,3 millions de tonnes (FAOSTAT, 2004) de graines sèches dont 64% sont réalisés en Afrique (Nkouanessi, 2005). Les graines de cette légumineuse constituent la source de protéines la moins onéreuse pour la plupart des populations africaines. En effet, les graines de niébé contiennent la plupart des acides aminés nécessaires à l'alimentation humaine, à l'exception des acides aminés soufrés (Smart, 1964). C'est donc un aliment de haute valeur nutritive qui pourrait aider les populations locales dans leur effort vers l'autosuffisance alimentaire.

Cependant, la production du niébé, déjà touchée par les aléas climatiques, est limitée par les pertes occasionnées par des Coléoptères Bruchinae qui rendent très difficile sa conservation après la récolte. En effet, les stades larvaires de ces insectes ravageurs se développent à l'intérieur des graines et consomment les réserves contenues dans les cotylédons.

Il s'agit surtout de deux espèces sympatriques, *Bruchidius atrolineatus* Pic. et *Callosobruchus maculatus* Fab. dont les adultes apparaissent dans les cultures à la fin de la saison des pluies et s'y reproduisent lors de la période de fructification du niébé (Alzouma *et al*., 1985).

Pendant l'entreposage des récoltes du niébé, le taux d'infestation initial par les bruches est généralement inférieur à 5% (Ouedraogo, 1991 ; Sanon *et al.*, 2005). Ce taux passe à 30% après 1 mois de conservation, puis 80 à 100% en l'espace de 5 à 6 mois de stockage si aucune mesure de contrôle n'est entreprise (Nuto et Glitho, 1990 ; Seck *et al.*, 1992 ; Ouedraogo *et al.*, 1996 ; Sanon *et al.*, 1998).

Par l'intermédiaire de sa forme non voilière, *C. maculatus*, arrive à se maintenir dans les stocks durant toute la période de stockage alors que *Bruchidius atrolineatus* disparaît des stocks après quelques mois en raison d'une diapause reproductrice. Plusieurs générations de *C. maculatus* se succèdent alors dans les stocks entraînant d'énormes dégâts. Cette espèce est donc la plus destructrice des graines de niébé en stockage.

Dans le souci de pallier aux pertes dues aux coléoptères bruchinae et particulièrement *C. maculatus* qui est l'espèce qui se maintient dans les stocks durant toute l'année, les producteurs de niébé ont le plus souvent recours à la lutte chimique, dite classique qui, malgré son efficacité, a vite montré ses limites (persistance des attaques d'insectes nuisibles) et ses conséquences néfastes.

Face à cette situation, des efforts importants ont été déployés en vue de mettre au point des méthodes alternatives de lutte contre ces bruches. Dans cette optique, l'utilisation des insecticides botaniques représente de nos jours une alternative aux insecticides chimiques dans la protection des végétaux, mais aussi un moyen de lutte non polluant pour l'environnement (Sanon *et al.*, 2005; Ketoh *et al.*, 2005; Nyamador, 2009 ; Ilboudo, 2009).

Cependant, les études menées jusque là se sont, pour l'essentiel, intéressées à l'effet de ces méthodes sur la dynamique des populations de bruches au cours de la conservation des stocks de niébé. Or, pour permettre aux exploitants agricoles de bénéficier de tout le potentiel de ces biopesticides, il s'avère important d'examiner l'influence des facteurs liés à l'environnement du stockage sur l'efficacité du produit dans les structures d'entreposage.

Ainsi, la présente étude se propose d'étudier l'évolution de la persistance de l'effet de *B. senegalensis* et l'influence de quelques facteurs liés à l'environnement de stockage sur l'activité insecticide de la plante dans les stocks traités.

2 MATERIEL ET METHODES

2.1 CONDITIONS EXPÉRIMENTALES

Toutes les expériences ont été réalisées dans les conditions climatiques naturelles au laboratoire d'entomologie de la faculté des sciences de l'Université Abdou Moumouni de Niamey. Elles ont été réalisées entre novembre et février où les températures moyennes (entre 27,25°C et 29,33 °C) et l'hygromètrie moyenne (entre 17,33 % et 30% HR) sont les plus basses de l'année

2.2 ELEVAGE DE CALLOSOBRUCHUS MACULATUS

Les adultes de *C. maculatus* utilisés au cours de cette étude proviennent des gousses infestées achetées au marché auprès des commerçants. Les adultes obtenus sont introduits dans un bocal contenant environ 100 g de graines saines de niébé de la variété TN 5-78.

Quarante huit heures après, les insectes sont retirés et les graines contaminées sont laissées en incubation jusqu'à l'émergence des adultes qui sont utilisés pour l'expérience.

2.3 MÉTHODOLOGIE EXPÉRIMENTALE

2.3.1 ETUDE DE LA RÉMANENCE DU BROYÂT DES FEUILLES DE *B. SENEGALENSIS* SUR LES ADULTES DE *C. MACULATUS*

Pour chacune des doses suivantes (2 g/l ; 4 g/l ; 6 g/l ; 8 g/l ; 10 g/l, 20g/l), huit (8) lots de trois (3) bouteilles en verre de 1 l contenant chacune 50 g de graines saines de niébé sont préparées. Vingt-quatre heures après, 20 couples de *C. maculatus* âgés d'au plus 48 h sont introduits chaque jour dans chaque lot. Au bout de 24h, les insectes sont retirés et 20 couples sont immédiatement introduits de nouveau. Dans chaque situation expérimentale répétée quatre fois, les insectes retirés sont d'abord conservés au laboratoire pendant 24 avant de dénombrer les adultes morts.

Pour chaque dose, l'expérience est arrêtée lorsque la mortalité dans le lot traité est identique à celle du témoin qui est constitué de lot non traité.

2.3.2 IMPACT DE LA DURÉE DE CONSERVATION DES FEUILLES DE *B. SENEGALENSIS* SUR L'ACTIVITÉ INSECTICIDE

Des feuilles de *B. senegalensis* sont récoltées et conservées au laboratoire en milieu ambiant. Tous les deux jours, une quantité est prélevée et pilée et une dose de 4 g/l de broyât est introduite dans une bouteille d'1 litre renfermant 20 couples de *C. maculatus* âgés d'au plus 24h et 50g de graines saines de niébé.

L'expérience est poursuivie jusqu'à ce que la mortalité dans les lots traités devienne égale à celle du le témoin.

Pour chaque durée de conservation, les insectes sont exposés pendant 24h. Puis ils sont retirés et conservés au laboratoire pendant 24h au bout desquelles la mortalité est déterminée

2.3.3 EFFETS DE L'AUGMENTATION DE LA QUANTITÉ DE GRAINES STOCKÉES SUR L'EFFICACITÉ DE *B. SENEGALENSIS*

20 couples de *C. maculatus* âgés d'au plus 24h sont introduits dans une bouteille contenant une masse donnée de graines saines de niébé et traitée avec une dose de 2,5 g/l de broyat de feuilles fraiches de *B. senegalensis*. Les densités de graines testées sont respectivement 10g ; 20g ; 30g ; 40g et 50g. Chaque traitement est répété 4 fois.

Pour chaque situation expérimentale, les insectes sont exposés pendant 24h. Puis ils sont retirés et conservés au laboratoire pendant 24h au bout desquelles la mortalité est déterminée.

2.3.4 EFFETS DE L'AUGMENTATION DES EFFECTIFS DE BRUCHES SUR L'ACTIVITÉ INSECTICIDE DE *B. SENEGALENSIS*

Des couples de *C. maculatus* âgés d'au plus de 24h sont introduits dans une bouteille contenant 50g de graines saines de niébé et traitée avec une dose de 4 g/l de broyat de feuilles fraiches de *B. senegalensis*. Le nombre d'adultes introduits dépend du traitement. Le nombre d'adultes testés est respectivement 20 ; 40; 60 ; 80. Chaque traitement est répété 4 fois.

Pour chaque situation expérimentale, les insectes sont exposés pendant 24h. Puis ils sont retirés et conservés au laboratoire pendant 24h au bout desquelles la mortalité est déterminée.

2.3.5 SENSIBILITÉ DES MÂLES ET DES FEMELLES

20 mâles ou 20 femelles de *C. maculatus* âgés de 24h sont introduits dans une bouteille d'un litre renfermant 50g de graines saines de niébé et une dose de 2,5 g/L de broyat de feuilles fraiches de *B. senegalensis*. Pour chaque situation expérimentale, l'expérience est répétée quatre fois.

Au bout de 24h d'exposition, les insectes sont retirés et conservés au laboratoire pendant 24 h afin d'évaluer la mortalité.

2.4 ANALYSE STATISTIQUE DES DONNÉES

Toutes les données ont été soumises à l'analyse de variance et la séparation des moyennes a été faite selon le test de comparaison multiple de Duncan (p = 0.05).

2.5 RESULTATS

2.5.1 PERSISTANCE DE L'EFFET DU BROYAT DES FEUILLES FRAICHES DE B. SENEGALENSIS SUR LES ADULTES DE *C. MACULATUS*

La figure 1 montre que l'efficacité et la rémanence du broyât des feuilles fraîches de *B. senegalensis* est fonction du temps d'exposition et de la dose appliquée.

En effet, les résultats de cette figure montrent que les doses les plus élevées sont celles qui sont les plus efficaces avec une rémanence relativement longue.

C'est ainsi qu'on remarque que le broyât de feuilles fraîches de *B. senegalensis* n'a aucun effet sur les adultes de bruches à la dose de 2 g/l lorsqu'il est gardé vingt-quatre heures avant d'être appliqué. Par contre à la dose de 20 g/l, un taux de mortalité de 37,5% est observé lorsque le broyât est conservé 5 jours avant d'être appliqué.

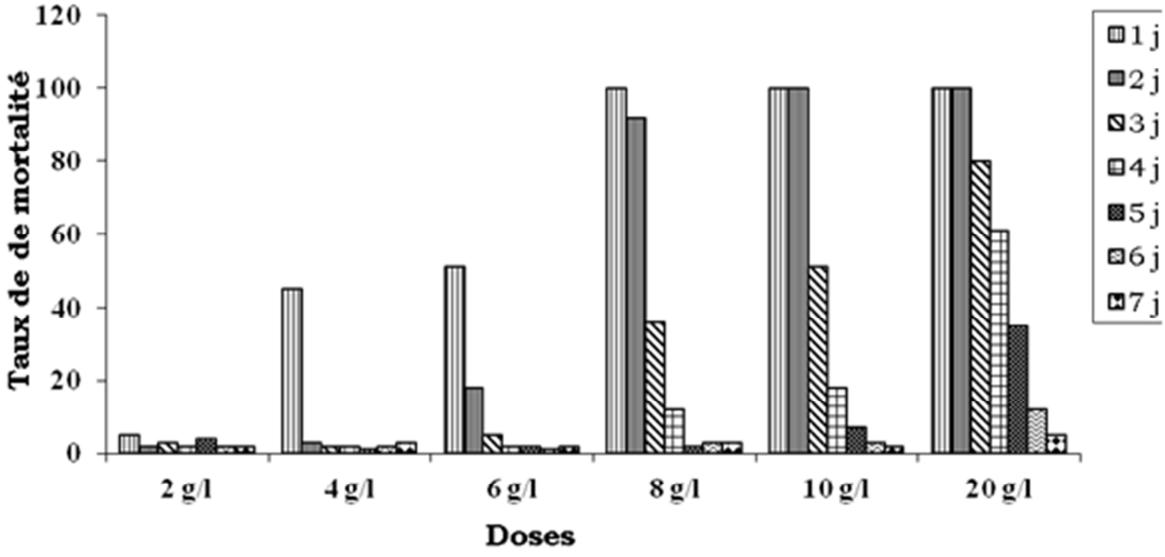


Fig. 1: Evolution de l'activité insecticide du broyât de *B. senegalensis* en fonction de la durée de conservation

2.5.2 EVOLUTION DE L'ACTIVITÉ INSECTICIDE DE *B. SENEGALENSIS* EN FONCTION DU DÉLAI D'UTILISATION DES FEUILLES RÉCOLTÉES

L'efficacité du broyât dépend de la période d'utilisation après la récolte des feuilles (figure 2).

En effet, plus les feuilles sont conservées avant d'être broyées et utilisées, plus elles perdent leur activité insecticide. C'est ainsi que la dose de 4 g/l qui entraîne une mortalité 100% d'individus lorsque les feuilles sont immédiatement utilisées après la récolte, n'entraine que la mort de 58,75 % d'individus si elles sont utilisées 2 jours après les avoir récoltées.

Dans nos conditions d'étude, le broyat des feuilles de *B. senegalensis* n'a plus d'effet sur les adultes au bout de 10 jours de conservation.

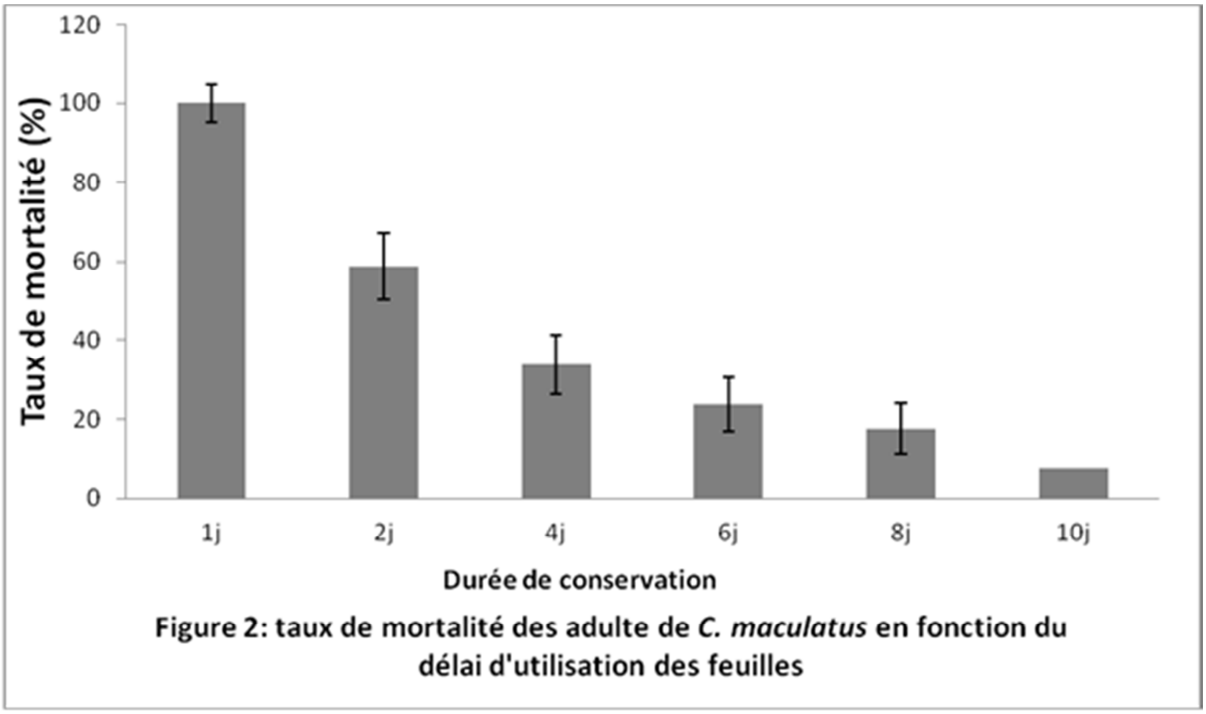


Figure 2: taux de mortalité des adulte de *C. maculatus* en fonction du délai d'utilisation des feuilles

2.5.3 EFFETS DE L'AUGMENTATION DE LA QUANTITÉ DE GRAINES STOCKÉES SUR L'EFFICACITÉ DE *B. SENEGALENSIS*

L'efficacité du broyat dépend de la densité des graines stockées (figure 3). En effet, plus la densité augmente, plus l'activité insecticide du produit diminue. C'est ainsi qu'avec une masse de 10 g de graines de niébé, on observe une mortalité de plus de 80% d'insectes alors que ce taux chute à 55 % avec une masse de 50 g de graines.

Mais à partir d'une certaine masse de graines, l'activité insecticide du produit ne semble pas varier en fonction de la quantité de graines stockées.

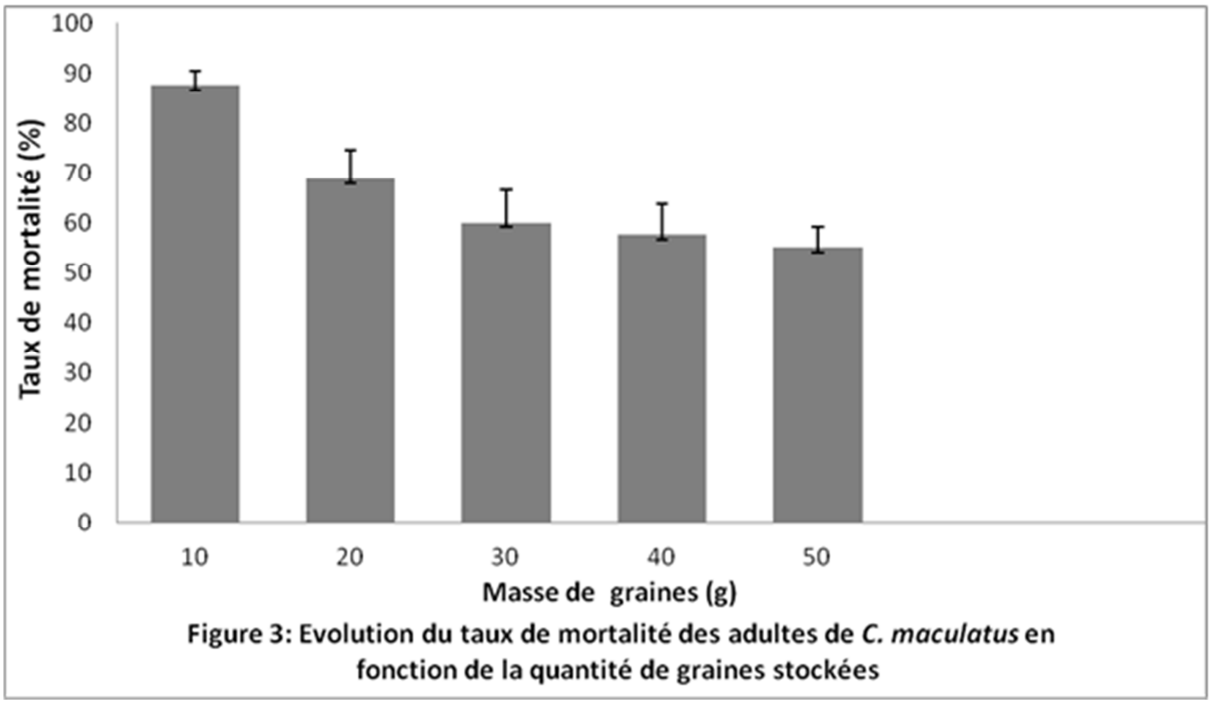


Figure 3: Evolution du taux de mortalité des adultes de *C. maculatus* en fonction de la quantité de graines stockées

2.5.4 EFFETS DE L'AUGMENTATION DES EFFECTIFS DE BRUCHES SUR L'ACTIVITÉ INSECTICIDE DE *B. SENEGALENSIS*

Le nombre de bruche présent dans le stock ne semble pas influencer l'efficacité du broyat de feuilles fraîches de *B. senegalensis* (figure 4). En effet, quelle que soit l'effectif considéré, le taux de mortalité observé est supérieur à 80%.

Nos résultats montrent que jusqu'à 40 individus, on observe une mortalité de 100% des insectes traités au bout de 24h. Il s'ensuit une baisse du taux de mortalité des insectes qui est de 80,12% lorsque les effectifs d'insectes atteignent 80 individus.

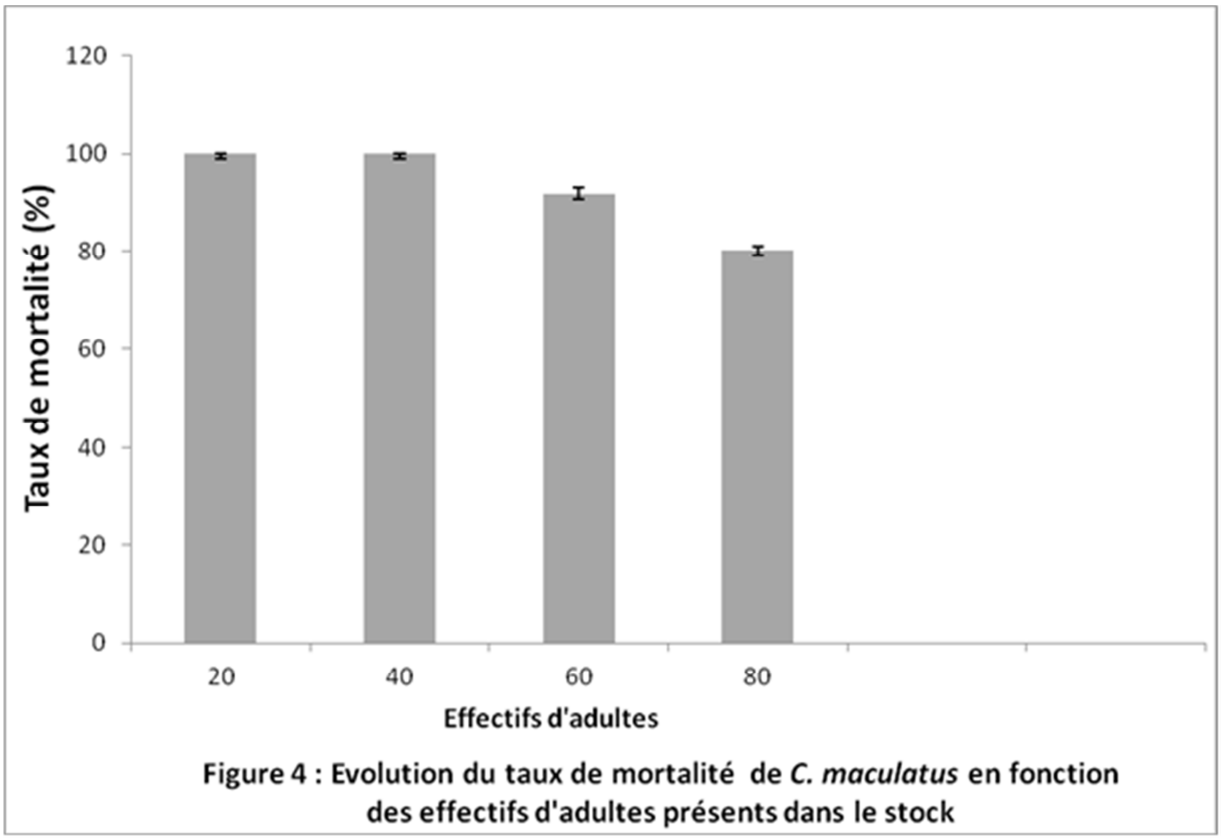


Figure 4 : Evolution du taux de mortalité de *C. maculatus* en fonction des effectifs d'adultes présents dans le stock

2.5.5 SENSIBILITÉ DES MÂLES ET DES FEMELLES

Les mâles de *C. maculatus* semblent être plus sensibles au broyât de feuilles de *B. senegalensis* que les femelles. En effet, avec une dose de 2,5 g/l on observe un taux de mortalité de 100% pour les mâles contre 37,5% pour les femelles (Tableau 1).

Tableau 1: Taux de mortalité de C. maculatus en fonction du sexe des individus

Sexe	Taux de mortalité(%)
Mâles	100±0,00**a**
Femelles	37,50±6,45**b**

3 DISCUSSION

L'utilisation de *B. senegalensis* dans la protection des stocks de niébé est une méthode employée depuis longtemps par les paysans africains.

Les tests de toxicité réalisés montrent que le broyât de feuilles fraîches de cette plante présente un effet insecticide assez marqué sur les adultes *C. maculatus.* En effet, nos résultats montrent un taux de mortalité des adultes de 100% dès le premier jour d'application à partir de la dose de 4 g/l. Toutefois, la persistance de l'action du broyât semble dépendre de la dose appliquée. C'est ainsi que pour les doses de 2.5g/l et 1.25g/l, on constate que le taux de mortalité reste relativement constant au bout de 48 h et 72 h ; par contre pour la dose de 20g/l, l'effet persiste 7 jours après l'introduction du produit comme l'indiquent les tests de rémanence. Ceci permet d'en déduire que la faible efficacité des feuilles constatée avec les

doses de 1,25 g/l et 2,5 g/l n'est pas liée à une destruction de la substance active, mais plutôt à une faible concentration des substances émises par les doses appliquées.

La rémanence dépend du délai entre la récolte des feuilles et leur utilisation. En effet, plus les feuilles sont conservées avant d'être broyées et utilisées, plus elles perdent leur activité insecticide. C'est ainsi que la dose de 4 g/l qui entraîne une mortalité de 100% d'individus lorsque les feuilles sont immédiatement utilisées après la récolte, n'entraine que la mort de 58,75 % d'individus si elles sont utilisées 2 jours après les avoir récoltées.

Dans nos conditions d'étude, le broyat des feuilles de *B. senegalensis* n'a plus d'effet sur les adultes au bout de 10 jours de conservation.

Cette rémanence dépend également de la quantité de graines stockées et des effectifs d'insectes présents dans le stock constituant des facteurs susceptibles d'influencer l'activité insecticide de la plante. En effet, en faisant varier la quantité de graines pour une dose donnée, il apparait que l'efficacité diminue en fonction de la quantité de graines stockées. Ce phénomène a été observé par Ilboudo (2009) qui a montré que la quantité de graines utilisées influence l'efficacité de certaines huiles essentielles notamment celles de *Lippia multiflora* et de *Hiptis spicigera* pour lesquelles aucune mortalité n'est observée dans un stock de 200 g de graines de niébé.

Selon Delobel et Malonga (1987), l'efficacité des plantes insecticides est relative. Elle dépend de la quantité de graines à stocker et de la toxicité réelle de plantes. Elle dépend aussi de la nature des substances actives et de la vitesse d'absorption par les graines. Ainsi les huiles à efficacité quantité-dépendante pourraient être considérées comme comportant des constituants chimiques qui présentent un degré d'absorption par les graines très élevé. Cette absorption expose alors les insectes à de faibles quantités de composés actifs et conséquemment à une mortalité réduite (Sanon et *al*., 2002). Le mécanisme d'absorption des composés a été analysé par Huignard et *al*. (2002) qui ont révélé que les composés terpéniques pénètrent moins que les composés soufrés et que pour une même huile essentielle certains composés pénètrent mieux que d'autres.

L'influence des facteurs liés à l'environnement de stockage au cours de ce travail est un résultat nouveau rarement démontré et requiert une attention particulière dans l'emploi des produits végétaux dans la protection des denrées stockées. En effet, ce résultat montre clairement que pour une conservation longue durée des stocks de niébé avec les biopesticides d'origine végétale, un certain nombre de conditions sont requises. D'abord il faut une adéquation entre la quantité de graines à stocker et la dose à appliquer. Par ailleurs, il faut tenir compte des effectifs d'insectes au début du traitement et l'évolution des populations au cours du stockage.

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Réalisation et tests d'un système automatique pour améliorer l'énergie électrique dans les installations photovoltaïques

[Implementation and tests of an automatic system to improve electrical energy in photovoltaic installations]

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ABSTRACT: This work is a contribution in the technical and instrumentation sides related to the field of photovoltaic renewable energy. It presents the details of a simple and low cost electronic realization, capable of increasing the production of photovoltaic electricity. This system is based on an electronic device developed with a microcontroller and other components available on the market. In effect, this electronic card can mechanically control the angular orientations of photovoltaic panels, with actuators connected to a power electronics developed to automatically tracking of the sun position. This system is compared with other fixed photovoltaic system, which was experimentally positioned with optimal physical and geometrical parameters. The results of tests and comparison show the energy benefits and economic and technical interest of this realization.

KEYWORDS: Renewable energy, energy optimization, automatic positioning, photovoltaic system, embedded system.

RESUME: Ce travail est une contribution dans le côté technique et instrumentation en relation avec le domaine des énergies renouvelables photovoltaïques. Il présente les détails d'une réalisation électronique et mécanique simple et de faible coût, capable d'augmenter la production de l'énergie électrique d'une installation photovoltaïque. Ce dispositif est basé sur une carte électronique que nous avons développée et réalisée à base d'un microcontrôleur et d'autres composants disponibles au marché. En effet, cette carte permet de commander mécaniquement les orientations angulaires des panneaux photovoltaïques à l'aide des actionneurs branchés à une électronique de puissance développée également, en poursuivant la position du soleil d'une manière automatique. Ce système est comparé avec une autre installation photovoltaïque fixe, qui été bien positionnée expérimentalement en cherchant ses paramètres physiques et géométriques optimaux. Les résultats du test et de comparaison montrent les avantages énergétiques et les intérêts économiques et techniques de cette réalisation.

MOTS-CLEFS: Energie renouvelable, optimisation énergétique, positionnement automatique, installation photovoltaïque, système embarqué.

1 INTRODUCTION

Parallèlement aux prévisions d'épuisement des ressources en énergie fossile dans le monde (pétrole, gaz, charbon...), la consommation mondiale d'énergie a connu une grande augmentation, elle a été multipliée par quarante au cours du siècle dernier. En parallèle, le nombre des habitants a augmenté aussi rapidement, il a passé de 2 milliards en 1950 à plus de 6 milliards en 2000, et les prévisions estiment qu'il dépassera les 10 milliards en 2050 d'où la consommation énergétique peut atteindre 30000 Mtep [1]. Les énergies renouvelables s'imposent donc, comme une solution d'avenir pour satisfaire ces

besoins énergétiques. Le soleil reste la principale source des différentes formes des énergies renouvelables, il diffuse des rayonnements d'énergie de l'ordre de 100 milliards de milliards de kilowatts heure par seconde dans toutes les directions, ce qui est équivalent à une puissance de $3{,}6.10^{20}$ Méga Watts.

La recherche scientifique s'intéresse à l'exploitation de cette énergie, en particulier dans le domaine photovoltaïque (PV) qui se base sur la conversion de l'énergie solaire en électricité à travers l'effet photoélectrique. Bien que le rendement des photovoltaïques est encore limité, ce domaine est largement exploité, et il manifeste des investissements importants. En effet, la puissance électrique produite par une cellule PV est relativement faible, elle est de l'ordre de 1 à 3W pour une tension inferieure à un volt [2], et le rendement de conversion des cellules PV est de l'ordre de 15% à 19% pour le silicium monocristallin, 12% à 16 % pour le silicium poly-cristallin et 7% à 9% pour le silicium amorphe [3].

Les cellules photovoltaïques doivent donc être reliées à d'autres dispositifs électroniques afin d'améliorer le rendement énergétique électrique. Plusieurs recherches ont été effectué dans ce domaine afin d'augmenter la production électrique des installations PV [4]. Ces recherches ciblent différents niveaux de ces installations, à savoir les méthodes de positionnement des panneaux PV, le dimensionnement, le développement de l'électronique relative, les techniques de l'adaptation des charges alimentées, les méthodes d'extraction des paramètres physiques des jonctions et autres [5], [6].

Dans ce papier nous présentons une réalisation technique pour objectif d'améliorer la production de l'énergie électrique des installations PV. Il s'agit d'un système électronique et mécanique simple et de coût réduit, capable d'augmenter la puissance électrique produite par les panneaux PV en contrôlant ces positions angulaires. Ce système se base sur une carte électronique réalisée auteur d'un système embarqué et des algorithmes originaux, que nous avons développés et programmés. Ce système est validé par la comparaison avec une installation PV fixe stand d'une manière rigoureuse en déterminant expérimentalement ses paramètres physiques et géométriques, tels que les angles optimaux, l'effet de la température, etc. La comparaison des deux systèmes cible 3 types de mesures : l'énergie électrique totale produite pendant une journée, les durées maximales des puissances électriques significatives générées, et les valeurs maximales des grandeurs électriques des PV.

2 FACTEURS INFLUENÇANT SUR LE RENDEMENT DU PV

Différents facteurs peuvent être responsables à la diminution du rendement énergétique d'une installation PV. Sur le côté positionnement des modules PV les facteurs les plus importants sont modélisés par les équations suivantes :

2.1 FACTEURS GEOSTATIONNAIRES

Pour un point fixe sur la surface de la terre, la trajectoire du mouvement du soleil est variable par rapport au temps. Il existe plusieurs paramètres géostationnaires qui interviennent dans la création de cette situation dynamique. L'orientation d'un panneau photovoltaïque par rapport au soleil est une étape important pendant le dimensionnement d'une telle installation PV, la variation de la trajectoire du soleil influence surement sur son rendement énergétique.

Pour comprendre ce problème, on fait appel aux lois astronomiques et géométriques en faisant intervenir la latitude de lieu, la déclinaison solaire, l'heure du jour et l'orientation de la surface réceptrice de l'installation PV. Il est intéressant de définir les paramètres les plus importants qui modélisent la dynamique de la trajectoire du soleil [7]:

- L'inclinaison α (ou l'angle d'élévation) est la rotation autour de l'axe horizontal z. L'inclinaison idéale d'un panneau PV par rapport à l'axe horizontale dépend du jour de l'année, et de la latitude de la position d'installation (dans notre cas c'est la ville de Béni Mellal). L'inclinaison peut être représentée par le modèle suivant :

$$\text{Inclinaison} = \text{latitude} - \text{Arcsin}\left[0{,}4 * \sin\left(N.\frac{360}{365}\right)\right]$$

Avec N étant le nombre de jours entre l'équinoxe de printemps (21 mars de chaque année) et le jour considéré.

- l'Azimut solaire (a) est l'angle horizontal formé par le plan méridien (axe 'nord-sud') et le plan vertical du vecteur du point local vers le soleil. Il est calculé par le modèle suivant:

$$\text{a} = \text{Arcsin}\left[\frac{\cos(\delta) * \sin(\omega)}{\cos(\text{h})}\right]$$

- Le paramètre (δ) est la déclinaison solaire, c'est l'angle que forme le vecteur du centre de la terre vers le soleil, et le plan équatorial de la terre. Ce paramètre peut être représenté par la formule suivante :

$$\delta = 23{,}45 * \sin\left(360 * \frac{(284 + \mathrm{m})}{365}\right)$$

Avec (m) est le numéro du jour dans l'année.

- Le paramètre (ω) est l'angle horaire du soleil, c'est l'angle formé par le plan méridien du lieu et celui qui passe par la direction du soleil, il est compris entre 0° et 360°. L'angle horaire est obtenu par l'équation suivante :

$$\omega = 180 * \left(\frac{\mathrm{TSV}}{12 - 1}\right)$$

Ou TSV est le Temps Solaire Vrai qui dépond du jour solaire apparent, qui est la durée entre deux retours successifs du Soleil au méridien local.

- La hauteur angulaire du soleil (h), ou encore l'altitude, est l'angle formé par le plan horizontal du lieu considéré et le vecteur partant du point local vers le soleil. Cette hauteur du soleil qui intervient fortement sur la valeur de l'éclairement peut être calculée selon la formule suivante :

$$\mathrm{h} = \mathrm{Arcsin}[\sin(\Phi) * \sin(\delta) + \cos(\Phi) * \cos(\delta) * \cos(\omega)]$$

Avec Φ est la longitude, c'est l'angle formé par le méridien de référence (méridien de Greenwich) et le méridien du point local.

Théoriquement, nous pouvons déterminer les deux angles Azimut et déclinaison d'une installation PV si nous connaissons ses positions géographiques et temporelles, mais ces modèles restent généraux et ne donnent pas des résultats précis, d'où la nécessité d'utiliser d'autres méthodes expérimentales pour trouver des valeurs relativement exactes.

2.2 FACTEUR DE REMPLISSAGE

Le facteur de remplissage (FF) est un paramètre important souvent utilisé dans le domaine de l'étude énergétique des PV. Ce coefficient représente le rapport entre la puissance maximale P_m que peut délivrer une cellule PV et la puissance formée par le rectangle Icc*Vco :

$$\mathrm{FF} = \frac{\mathrm{P_m}}{\mathrm{V_{co}} * \mathrm{I_{cc}}}$$

Les paramètres Icc et Vco sont respectivement le courant électrique court-circuit et la tension à vide de la cellule PV. Théoriquement, si la cellule PV est idéale ce facteur égale à 1, mais généralement il prend des valeurs entre 0,6 et 0,9 [8].

2.3 RENDEMENT ENERGETIQUE

C'est un autre paramètre très important dans le choix des panneaux solaire, il est définit comme le rapport entre cette puissance maximale produite et la puissance du rayonnement solaire qui arrive sur la surface d'un module solaire photovoltaïque.

$$\eta = \frac{\mathrm{P_m}}{\mathrm{E} * \mathrm{S}}$$

Avec S est la surface du module PV exprimée en (m²), et E est l'éclairement exprimé en (W/m²). Ce rendement est souvent mesuré dans les conditions normalisées « STC », c-à-d sous un ensoleillement égale à 1000 W/m², dans une température égale à 25°C et sous un spectre AM de 1.5.

2.4 INFLUENCE DE LA TEMPERATURE

La température est un paramètre qui influence le comportement des cellules photovoltaïques en modifiant leurs caractéristiques. La figure 1 montre la variation de la caractéristique *I(V)* d'une cellule PV en fonction de cette grandeur. L'augmentation de la température dans cette cellule provoque une augmentation du courant du court-circuit (Icc), et une

diminution de la tension en circuit ouvert (Vco) et par conséquence une diminution de la tension maximale (Vm) et un accroissement du courant max (Im), ce qui entraine par la suite une baisse relative de la puissance maximale (Pm=Vm x Im).

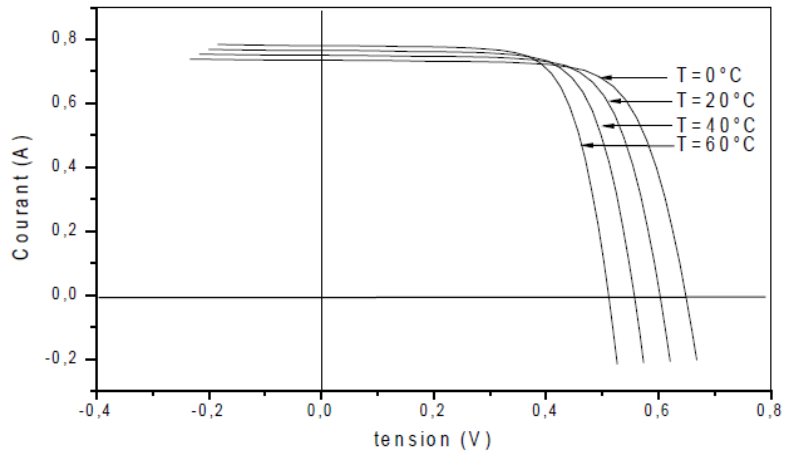


Fig. 1. Influence de la température sur la caractéristique d'une cellule PV

Plusieurs modèles mathématiques ont traité la température dans un module photovoltaïque en relation avec d'autres paramètres électriques et physiques. Le plus important de ces modèles est celui de *Jones et Underwood* qui est développé en 2002, et qui traite la production de la puissance optimale de la sortie d'un module PV [9], [10] :

$$P = FF.\left(Icc.\frac{G}{Go}\right).\left(Vco.\frac{Ln(K.G)}{Ln(K.Go)}.\frac{To}{Tc}\right)$$

Où K est un coefficient constant peut être calculé par la formule suivante :

$$K = \frac{Icc}{G}$$

G : L'irradiation solaire sur un plan incliné (W/m2).
Go : L'irradiation solaire de référence (1000W/m2).
Tc : la température de module, et peut être décrite par la relation :

$$Tc = Ta + \left[\frac{NOCT - 20}{800}\right].G$$

Avec *Ta* est la température ambiante en Kelvin, et *NOCT* est la température nominale de fonctionnement du module (Nominal Operating Cell Temperature).

3 DISPOSITIF AUTOMATIQUE REALISÉ

Il est constitué d'un système mécanique qui permet de suivre la position du solaire de manière automatique, en faisant varier deux angles du support des panneaux PV ; l'azimut selon une rotation horizontale et l'inclinaison selon une rotation verticale.



Fig. 2. Schéma explicatif du mécanisme de rotation à deux directions.

Lorsque ce système fonctionne en poursuivant la position du soleil, il permet de maintenir en permanence une puissance électrique maximale délivrée par le PV. Ce système mécanique est commandé par une carte électronique développée à base de microcontrôleur à travers deux actionneurs. Le 1^{ér} agit sur l'axe horizontal pour la variation d'élévation du panneau, tandis que le 2^{éme} commande l'axe vertical pour la variation d'azimut, comme le montre les images de la figure suivante.

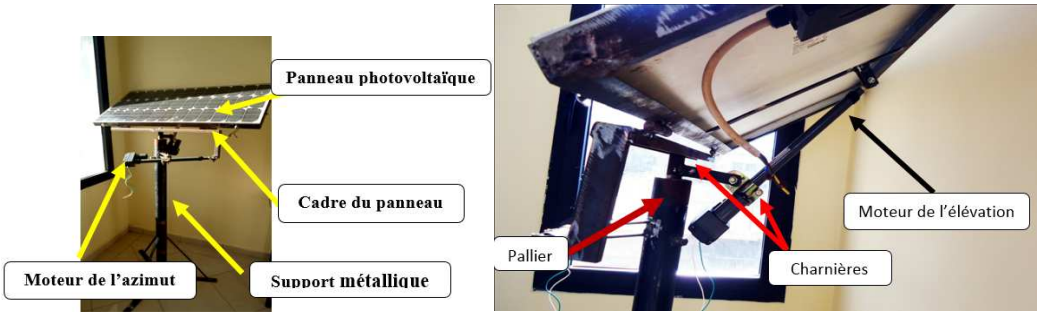


Fig. 3. Images du système mécanique commandé par les deux actionneurs.

Les actionneurs utilisés dans cette réalisation sont deux vérins électriques à base du moteur à courant continu à aimant permanant avec un réducteur. Les vérins électriques utilisés transforment le mouvement de rotation crée par un moteur électrique en mouvement de translation à l'aide d'une tige métallique. Le déplacement de cette tige varie linéairement avec la vitesse de rotation du moteur et du système de transformation de mouvement. Le choix de ce type des vérins vient grâce à sa disponibilité au marché, il est de faible coût, facile à utiliser et il ne nécessite pas d'autres articulations pendant l'utilisation. Pour commander le sens de rotation de l'un des moteurs de l'azimut ou de l'inclinaison, nous jouons sur l'inversion de la polarité de l'alimentation. La solution électronique de cette démarche, nous a conduit à utiliser des relais commandés avec des transistors de commutation sous forme du pont en H. le fonctionnement de ce mécanisme est géré par une logique binaire simple comme l'explique le tableau suivant.

Table. 1. Etats logiques de la commande du sens d'une rotation.

Commande 1	Commande 2	Etat du Moteur
0	0	Arrêt
0	1	Sens1
1	0	Sens2
1	1	Etat non réalisé

Nous avons placé des diodes aux bornes des relais pour protéger les transistors contre les surtensions produites aux bornes des bobines des relais. Pour une protection contre les échauffements et les courants excessifs, nous avons opté à une isolation galvanique de la commande entre la partie puissance et le microcontrôleur par un opto-coupleur, car la sortie logique du microcontrôleur est de l'ordre de 5V alors que les circuits de puissance sont alimentés avec des tensions élevées (> 12V).

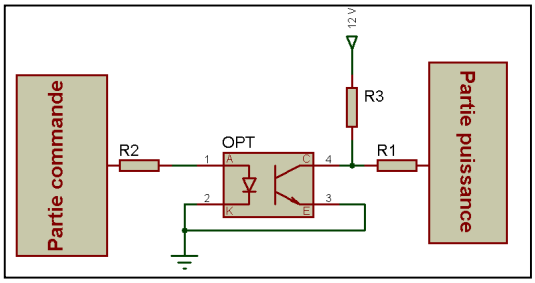


Fig. 4. Isolation des deux parties commande et puissance par opto-coupleur.

Le cœur de traitement et de contrôle dans notre carte électronique réalisée, est le microcontrôleur PIC 16f877A, il dispose de 5 ports d'E/S, de 8 entrées analogiques à 10 bits, de 3 temporisateurs « Timers », d'une mémoire EEPROM Programme de 8k lignes de mots de 14 bits, d'une mémoire EEPROM Données de 256 octets et d'une mémoire RAM de 368 octets. Cette carte est alimentée par le panneau PV à travers un régulateur de tension de 5 volts. Le panneau solaire délivre une tension (Vpv) varie entre 9V et 20V selon le moment dans la journée. Par contre, le microcontrôleur ne supporte que des

tensions entre 0V et 5V. Pour résoudre ce problème, nous avons placé un diviseur de tension de gain ajustable (k=1/4). Ce diviseur est monté en cascade avec un montage suiveur formé par un amplificateur opérationnel, pour adapter son impédance. La tension délivrée par l'AOP (Vpv/4) sera convertie par le microcontrôleur à travers la broche de l'entrée analogique AN0. L'affichage du numéro du programme exécuté est assuré par un afficheur numérique 7-segments branché sur le port B du PIC. Lorsque l'installation PV utilise un dispositif électronique de recherche automatique du point maximal de puissance (MPP) [11], le branchement de l'entrée de l'ampli-op sera relié à la sortie de ce dispositif et le programme chargé dans le µC, réalise les processus suivants :

- L'interruption du programme effectuée automatiquement ou par un bouton poussoir lié à la broche RB0/INT.
- La conversion d'une tension continue issue du diviseur de tension à travers la broche PA1/AN1, la valeur de la tension convertie permet de choisir automatiquement le numéro de programme à réaliser et par conséquence choisir le pas temporel entre deux mesures successives comme indiqué sur le tableau suivant :

Table. 2. Les pas d'acquisition des mesures par µC.

Marge de la tension convertie (V)	Numéro du programme	Pas (temps d'arrêt du panneau en état d'attente)
[0 – 1]	1	3 minutes
[1 – 2]	2	10 minutes
[2 – 3]	3	15 minutes
[3 – 5]	5	20 minutes

Lorsque le numéro du programme de travail est choisi, le microcontrôleur est remis à zéro, afin d'éviter toute anomalie de contrôle et d'acquisition. Dans le but de protéger les entrées analogiques du microcontrôleur, nous avons ajouté une diode zener (D_{z1}) de 5,6V en parallèle avec la broche AN0 de telle façon que si la tension arrivée de l'AOP dépasse 5,5V, dans le cas d'un mauvais fonctionnement ou destruction des résistances du pont diviseur, la diode zener intervienne pour stabiliser la tension d'entrée du µC à 5,6V.

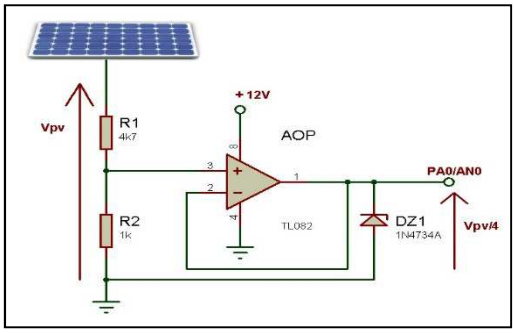


Fig. 5. Schéma du montage de référence et de protection.

Une image et le schéma électronique de la carte principale qui commande le mécanisme de rotation sont donnés sur les figures suivantes :

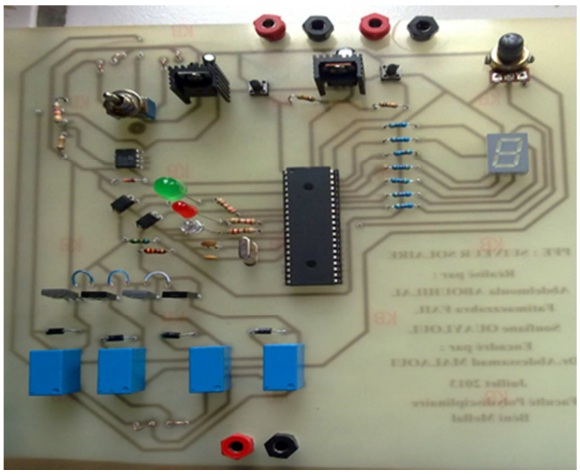


Fig.6. Circuit imprimé de la carte électronique à µC réalisée.

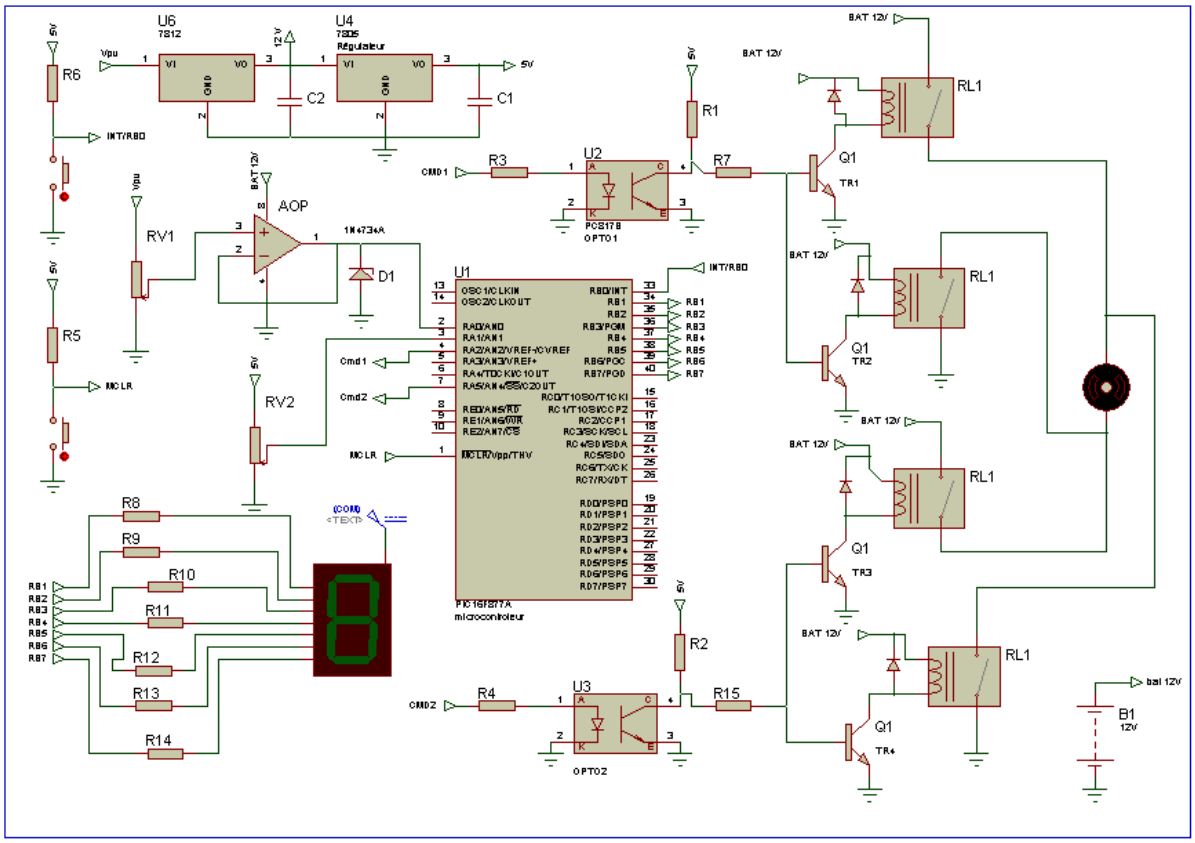


Fig. 7. Schéma électronique de la carte principale réalisée qui commande un positionneur

4 ALGORITHME D'AUTOMATISATION

4.1 METHODES SOUVENT UTILISEES

Le microcontrôleur est chargé par des sous-programmes en adoptant les méthodes de « Tracking » [12]. Les modes de l'orientation des panneaux PV les plus utilisés dans ce domaine sont les suivants :

- Mode qui utilise des capteurs optiques « photorésistance LDR par exemple».
- Mode avec temporisation.
- Mode pré calculé à l'aide des équations du mouvement apparent du soleil.

La 1ère méthode est la plus utilisée, elle est basée sur la comparaison de l'intensité lumineuse absorbée par deux LDR, en motorisant le système vers celle moins éclairée. Cette méthode présente une simplicité au niveau du montage électronique et de l'algorithme utilisé, mais elle nécessite un bloc électronique qui capte l'intensité lumineuse. La 2ème méthode utilise un temporisateur programmé pour orienter le PV de telle façon que la durée et le pas de mouvement de l'actionneur dépendent des positions temporelle et géographique du site ou il est placé le PV. Tandis que le 3ème mode est basé sur la connaissance d'avance des coordonnées de la position du soleil durant toute l'année, en tournant le système avec un programme qui comporte les équations du mouvement apparent du soleil (Azimut et inclinaison). Dans ce cas, l'orientation est basée sur des calculs et le système dirige le panneau vers le point théorique ou la puissance sera maximale sans tenir compte de plusieurs facteurs de perturbations tel que le brouillard, le climat,…etc. Ce mode est difficile à utiliser à cause de la difficulté de programmation des équations analytiques sur un microcontrôleur, et que la programmation est nécessaire chaque fois que la position du système (longitude et latitude) est changée.

4.2 NOTRE NOUVELLE METHODE

Dans notre travail, nous utilisons une nouvelle méthode originale basée sur l'utilisation du panneau solaire lui-même comme capteur, et sa tension délivrée comme grandeur de référence pour mesurer le point de puissance maximal. L'avantage de cette méthode réside sur le fait que le montage électronique correspond devient simple et réduit, et que l'acquisition des signaux analogiques est faite sur les puissances électriques réelles et ne pas sur les mesures des intensités lumineuses, comme dans le cas du premier mode, ce qui évite les erreurs relatives à la linéarisation des capteurs souvent rencontrées. L'algorithme relatif à cette méthode est basé sur la comparaison en permanence de deux mesures successives de la puissance comme le montre l'organigramme suivant.

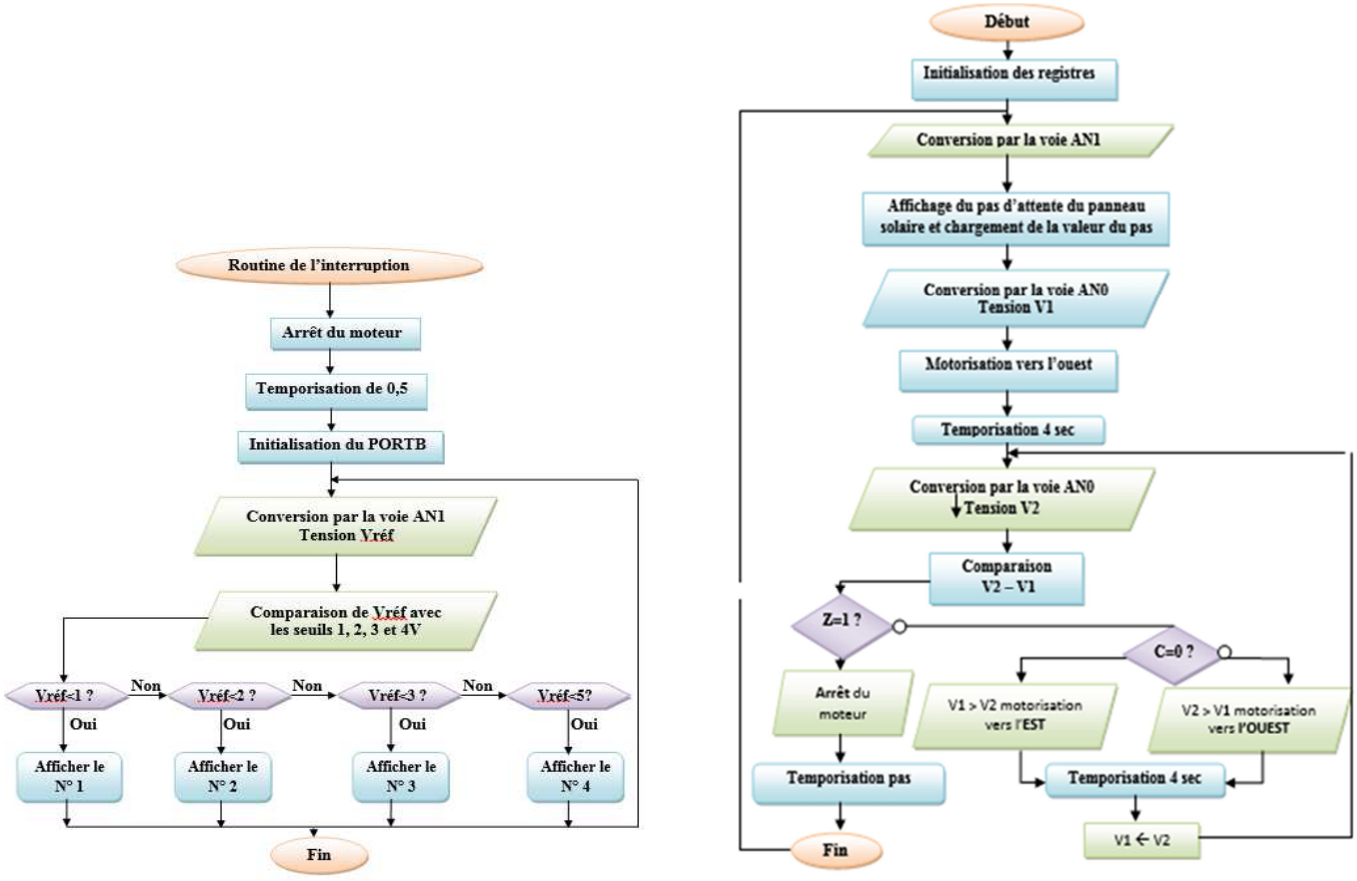


Fig. 8. Organigrammes du programme implanté dans le µC.

Afin d'améliorer le dispositif réalisé, nous avons utilisé une interruption RB0 du microcontrôleur pour faire varier automatiquement le pas d'attente du mouvement du panneau PV comme le montre l'algorithme à gauche de la figure 8. Les valeurs des pas, données sur le tableau 2, sont obtenues après plusieurs tests et elles sont classées en 4 intervalles significatifs.

5 RESULTATS ET DISCUSSIONS

5.1 DETERMINATION DE L'ORIENTATION OPTIMALE DU PANNEAU PV FIXE

Pour que la comparaison entre le système automatique développé et une autre installation PV fixe soit faible, nous devons assurer que les panneaux de cette dernière sont orientés d'une façon optimale. En effet, pour qu'une quantité maximale du rayonnement solaire arrive sur la surface du panneau PV, nous devons bien choisir les positions des angles d'orientation de l'azimut et d'inclinaison de ces panneaux. Des valeurs approximatives de ces angles sont souvent données par le constructeur, ou déterminées empiriquement par des modèles mathématiques ou par des logiciels de simulation. Mais les valeurs trouvées restent souvent imprécis par rapport à la réalité, ce qui nous posse à chercher des valeurs expérimentales nous-même relatives à la position de notre installation.

5.1.1 L'ANGLE AZIMUT

Pour déterminer cet angle expérimentalement, nous avons fixé la position du panneau dans un angle référentiel (0°E), et nous avons mesuré le courant I(A) et la tension U(V) aux bornes du panneau PV en faisant varier l'angle ψ de 0° à 90° [13]. Sur la figure suivante, nous représentons la puissance électrique délivrée par le panneau PV en fonction de cet angle (P=f(ψ)).

L'angle azimut qui correspond à une puissance maximale est ψ=15°. Au-delà de cette valeur, la puissance fournie par le panneau PV diminue presque linéairement. Cette valeur est relativement différente à celle donnée par le constructeur.

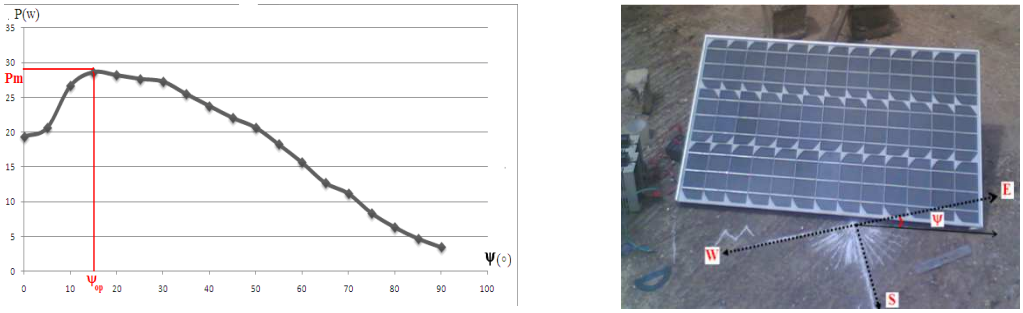


Fig. 9. Détermination de l'angle azimut optimal du panneau PV.

5.1.2 L'ANGLE DE L'INCLINAISON

Afin de déterminer l'angle (α) de l'inclinaison du panneau, nous avons procédé de la même manière que pour l'angle azimut. En effet, nous avons mesuré la puissance électrique délivrée en faisant varier cet angle α entre 0° et 90°, et nous avons mesuré les valeurs de U et I correspondantes [13]. La courbe de la figure suivante représente la caractéristique expérimentale P=f(α).

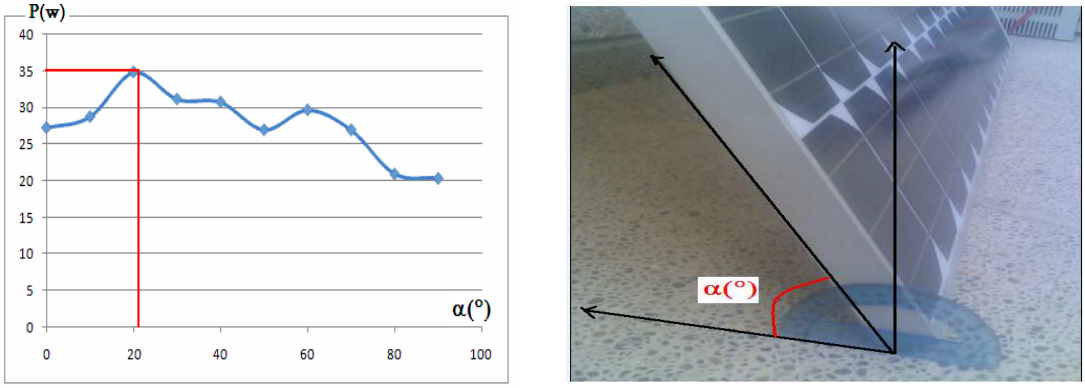


Fig. 10. Caractéristique expérimentale P=f(α) et réglage de l'angle d'inclinaison

Cette courbe nous permet de déterminer expérimentalement l'angle d'inclinaison optimale (correspond à une puissance maximale) qui est de l'ordre de 21° (20,63°). Par contre, la valeur théorique de l'angle d'inclinaison est de l'ordre de 31,81°.

L'orientation du panneau PV selon ces deux angles trouvés expérimentalement assure le positionnement optimal de cette installation fixe afin que toute comparaison avec le système mobile développé soit fiable.

5.2 L'EFFET DE LA TEMPERATURE SUR LE PANNEAU PV

Un autre facteur qui influence sur les caractéristiques électriques d'une cellule Photovoltaïque et par conséquence sur son rendement énergétique, est la température souvent ignorée par les installateurs. Afin de déterminer le comportement électrique réel du panneau PV en fonction de cette grandeur (condition hors laboratoire), nous avons réalisé un dispositif expérimental qui mesure la puissance électrique du panneau PV produite pour des différentes températures, en fixant des thermomètres sur différentes endroits de la face arrière du panneau PV [14].

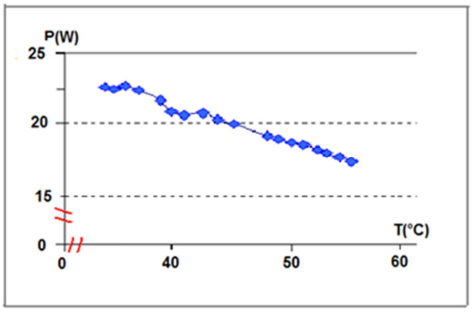


Fig. 11. Caractéristique expérimentale P = f(T) du panneau PV

Il est remarqué à partir de cette courbe que la puissance fournie décroit d'une manière approximativement linéaire lorsque la température augmente, et par conséquence les performances du panneau diminuent. En effet, pour une augmentation de température de 30°C, la puissance électrique chute d'environ de 5W ce qui est équivalent à une dégradation de puissance de 20%. Pour remédier à ce problème, on peut faire appel à un système de refroidissement à air ou la recommandation de choisir un endroit d'installation protégé contre l'échauffement. Il est donc, nécessaire pour toute comparaison avec un système PV fixe de tenir compte de la température en effectuant les mesures dans les mêmes conditions.

5.3 MESURES EFFECTUEES PAR LES DEUX SYSTEMES DE POSITIONNEMENT

D'autres mesures électriques ont été effectuées à l'aide d'un autre panneau PV, en utilisant le système automatique développé, et les résultats sont comparés avec ceux trouvés avec un système fixe. En effet, nous avons prélevé des courants et des tensions en assurant le point maximal de la puissance fournie par le choix de la résistance convenable de la charge électrique branchée au module PV. Pendant les mesures effectuées sur l'installation fixe, nous avons adopté les paramètres angulaires trouvés précédemment afin de rendre cette installation optimale. Les courbes suivantes montrent les variations de ces grandeurs électriques (Icc et Vco) en fonction du temps au cours d'une journée.

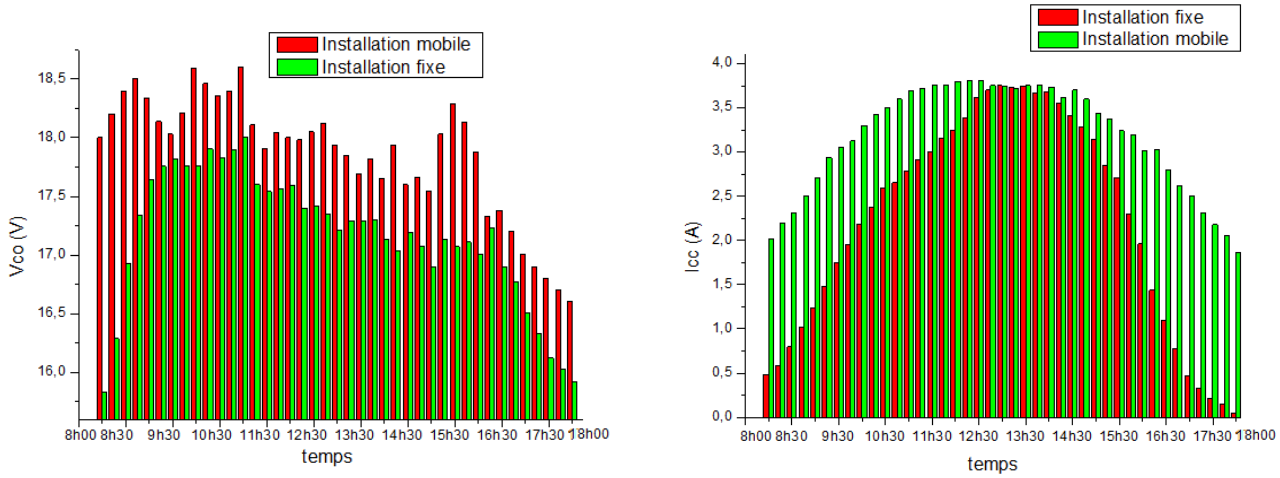


Fig. 12. Grandeurs électriques mesurées avec les deux types d'installation PV.

On se basant sur ces mesures, plusieurs informations peuvent être extraites à savoir l'ordre des courants et des tensions délivrés par les deux types d'installation PV, la marge de puissance produite, la manière de sa variation, …etc. Ces informations nous aident également à effectuer un bon dimensionnement d'une telle installation qui utilise les panneaux PV sans stockage, comme dans le cas de l'irrigation ou le choix des pompes convenables nécessitent la connaissance avec précision les seuils des courants et des tensions d'alimentation. Ces données nous permettent aussi de prévoir le nombre et le mode de branchement des modules PV pour l'installation (parallèle, série ou combinaison), et par conséquence l'estimation correcte des coûts relatifs et l'assurance d'une installation optimale. Ces mesures peuvent être considérées comme une base de données photovoltaïque relative à la région de travail (Tadla-Azilal) et les régions qui ont des caractéristiques similaires [13].

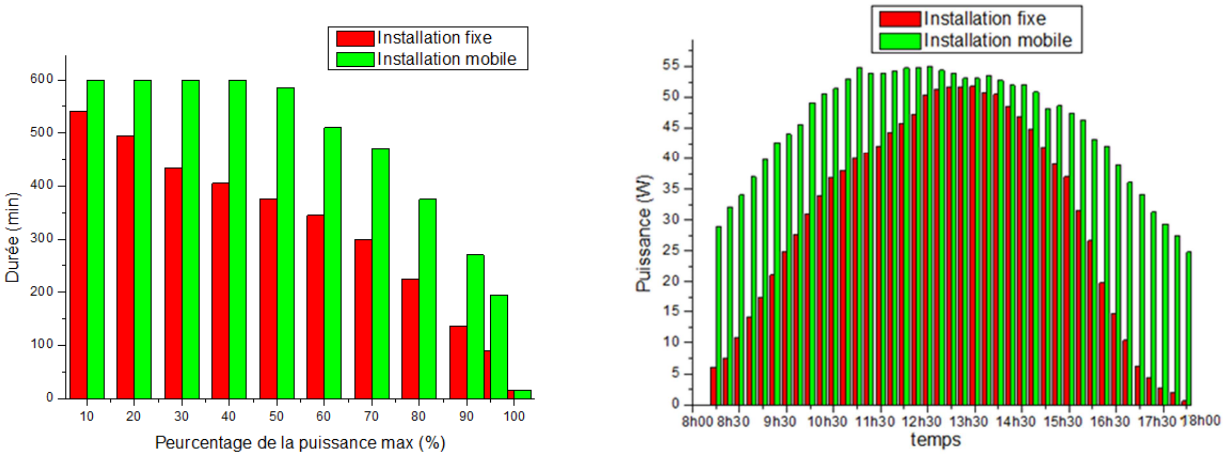


Fig. 13. Histogrammes de la puissance électrique fournie par les 2 systèmes.

Afin de mieux détecter l'apport de l'installation automatique mobile que nous avons développé et réaliser, nous présentons une comparaison des puissances électriques fournies avec le mécanisme fixe durant toute une journée en prélevant des mesures chaque 15min. Les résultats de cette comparaison sont présentés dans les diagrammes de la figure 13. Ces diagrammes présentent plusieurs informations statistiques qui peuvent être modélisées par la loi de Gauss.

$$y = y_o + Ae^{-2.(\frac{x-\mu}{\sigma})^2}$$

Avec μ est l'espérance, σ est l'écart type, yo est la moyenne et A est le maximum de l'amplitude.

Le tableau suivant résume les principaux résultats de cette comparaison ainsi que l'apport du système automatique réalisé par rapport au système PV fixe.

Table. 3. Comparaison des paramètres du modèle des deux mécanismes.

Paramètres du modèle	Installation PV fixe	Installation PV mobile	Variation relative %
Pmax (W)	51,83	55,05	6,21
μ (min)	289.10	280.82	2,94
σ (min)	302	646	60
Energie électrique produite (Wh) (de 8h00 à 18h00)	316	460	45,5

Il est clair que le système automatique réalisé apporte des gains sur plusieurs niveaux. En effet, un gain de l'énergie électrique fournie par le PV mobile est de l'ordre de 144Wh de 08h00 au 18h00 ce qui est équivalent à un gain de 45,5% et la puissance maximale produite est augmentée de 6,21%. En revanche, le système développé permet de déterminer avec précision le moment exact dans la journée où cette puissance sera maximale, c'est à 12h41min au lieu de 14h49min, et cela fait une différence de 8 minutes ; qui correspond à une erreur d'un pas de mesure avec le sous-programme 2 indiqué dans la table 2. Cette erreur provoque un décalage de tout le spectre électrique mesuré durant la journée, ce qui produit une diminution de la l'énergie électrique d'environ 5%.

Ce système apporte aussi un autre gain indiqué par l'écart-type du modèle de Gauss, qui nous informe sur l'intervalle du temps à partir duquel la puissance électrique fournie devienne significative (Pσ). Cette marge de temps est améliorée de 5h à 8h dans une journée, c-à-d d'une augmentation de 60%, et cela nous garantit une puissance électrique supérieure à (Pσ) durant l'intervalle (σ). De même, par le système réalisé nous avons assuré une durée de 585 min avec une puissance électrique supérieure à 50% de la puissance maximale, ce qui représente un gain de 210min. Aussi, nous avons obtenu des gains respectivement de 170 min et 150 min avec des puissances électriques supérieures à 70% et 80% de la puissance maximale, comme le montre le diagramme gauche de la figure 15. Ces améliorations sont très importantes dans plusieurs applications industrielles telle que l'irrigation avec le photovoltaïque qui fonctionnent uniquement dans la journée. Ces applications utilisent des pompes électriques qui nécessitent certaines seuils des courants, des tensions et des puissances pour le démarrage et le fonctionnement. Ces gains sont trop bénéfiques au niveau du coût, la facilité de montage, et l'augmentation du rendement énergétique, surtout pour les grandes installations qui utilisent plusieurs modules PV et travaillent avec des puissances électriques très élevées.

6 CONCLUSION

Dans ce travail, nous avons ciblé l'optimisation de l'énergie électrique générée par des panneaux PV au niveau de ses positionnements. Bien sûr, il existe d'autres niveaux d'optimisation qui ne sont pas traités dans ce travail et qu'il existe dans le marché d'autres systèmes qui automatisent le positionnement des PV en suivant le soleil, mais notre système réalisé présente 3 points essentiels :

- Son coût est relativement très faible, et il utilise des éléments disponibles dans le marché.
- La simplicité de ce système qui le rende réalisé localement par les chercheurs, les industriels et les agricultures intéressés.
- C'est un système bi-axial qui utilise 2 actionneurs qui permettent de varier deux angles à la fois, ce mécanisme le rend utilisable à n'importe qu'il endroit en évitant les difficultés souvent rencontrées pendant le montage, comme dans le cas des installations fixes qui exigent la détermination avec précision des paramètres géographiques de l'endroit de l'installation.

En conclusion, le système réalisé apporte plusieurs gains ; en particulier, il améliore l'énergie électrique générée par un module PV de plus de 45%, et il assure des durées élevées de fonctionnement qui dépassent les 8 heures dans une journée, ce qui représente une amélioration de 60%. Il permet aussi de gagner 5% de l'énergie électrique grâce à la détection automatique du pic de la puissance mesuré. Il faut noter, que ces valeurs sont relatives à un seul panneau PV, ces gains vont augmenter sûrement si les installations utilisent plusieurs modules photovoltaïques, telles que les grandes fermes agricoles irriguées et les usines industriels, etc.

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Comparative Appraisal of some Specification Error Test

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ABSTRACT: This research work compared the power of some specification error test using bootstrapping experiment to generate the data for each of the models at different sample sizes (n) 20, 30, 50, and 80 respectively, each with 100 replications(r). The models in this research consist of three omitted variables. For the models considered, the experiment reveals that the Ramsey Regression Equation Specification Error Test (RESET test) is more efficient than that of Q test in detecting the error of omitted variable in specification error.

KEYWORDS: Bootstrap, Error, Simulation, Specification, RESET, Q test.

1 INTRODUCTION

Specification is a process of developing a regression model. It involved the procedure of an appropriate functional form for the model and choosing which variable to include. Specification error occurs when an independent variable is correlated with the error term i.e. when a wrong model has been estimated. It implies that at least one of the key features or assumptions of the model is incorrect. And in consequence, estimation of the model may yield results that are incorrect or misleading.

The models considered in this work satisfy the assumptions of linear regression model (LRM) but some very important questions that arise when there is specification error are: what would happen if we use the LRM when the assumptions are not met, i.e. when it is not appropriate? What are the properties of the OLS estimators under a specification error? According to Kelvin A. Clarke (2006), when a model is mis-specified due to omitted variable, there is always the fear of omitted variable bias. He said a key underlying assumption is that the danger posed by omitted variable can be ameliorated by the inclusion of control variables. Also small amount of nonlinearity in control variables can also have a deleterious effect on the models considered (Achen 2005, Welch 1975).

Olubusoye O. E. et el (2004) compared the power of RESET, White Test and Q- test in detecting specification errors arising from omitted variables, functional misspecification and contemporaneous correlation residuals. He concluded that RESET is the most powerful test for detecting incorrect functional form and the test is robust to autocorrelation and heteroscedastic disturbance. Research also suggest that RESET tests for GLMs have reasonable power properties in medium to large samples for testing functional and omitted variable in linear regression (Sapra 2005).

Bootstrap is a particular resampling scheme with replacement. In statistics and econometrics, bootstrapping has come to mean to resample repeatedly and randomly form an original initial sample using each bootstrapped sample to compute a statistic. The resulting empirical distribution of the statistic is then examined and interpreted as an approximation to the true sampling distribution.

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It is one of the several econometric methods that have grown in popularity as a consequence of the great advances in computing technology.

This research article is aimed at comparing the performance of the Ramsey's RESET test and the Q test in detecting the error when variables are omitted in a regression model. We make use of the bootstrap simulation approach. In the next section, we explain how the data used was generated, followed by the procedure of the RESET test, procedure of the Q test. This is followed by the discussion of our results, the conclusion and the references.

2 METHODOLOGY

Consider the standard linear regression model given as

$$Y = X\beta + U$$

Where: Y is an n x 1 vector of dependent variables

X is an n x k matrix of regressors

β is a k x 1 vector of parameter

U is an n x 1 vector of disturbance and is normally distributed with covariance matrix proportional to the identity matrix.

A three model of the form

Model	Specification	Problem
1.	True: $y_t = 1.0 - 0.4x_{3t} + x_{4t} + 0.1x_{2t} + u_t$	
	Null: $y_t = \beta_0 + \beta_1 x_{4t} + \beta_2 x_{3t} u_t$	Omitted Variable
2.	True: $y_t = 1.0 - 0.4x_{3t} + x_{4t} + x_{2t} + u_t$	
	Null: $y_t = \beta_0 + \beta_1 x_{4t} + \beta_2 x_{3t} u_t$	Omitted Variable
3.	True: $y_t = 1.0 - 0.4x_{3t} + x_{4t} + 2.0x_{2t} + u_t$	
	Null: $y_t = \beta_0 + \beta_1 x_{4t} + \beta_2 x_{3t} u_t$	Omitted Variable

The true model is the model that has been specified correctly without any specification error and the null model is the model that contained the problem of omitted variable i.e x_{2t} is been omitted for all the three models. Observations on the dependent variables are generated according to one of the specification labeled true.

The criteria for evaluating the performance of the estimators in this research are the

- Mean, $\hat{\beta} = \frac{\sum_{i=1}^{r} \beta}{r}$, where r = number of replications.
- Bias$(\hat{\beta}) = \hat{\beta} - \beta$
- Variance$(\hat{\beta}) = \frac{1}{r}\sum_{i=1}^{r}(\hat{\beta} - \beta)^2$
- MSE$(\hat{\beta}) = \frac{1}{n}E(\hat{\beta} - \beta)^2$
- RMSE$(\hat{\beta}) = \sqrt{}$ MSE$(\hat{\beta})$

Which are used to check if the models satisfy the assumptions of linear regression model (LRM) and also check the effect of omitted variable variables in the models before proceeding to test for specification error.

2.1 DATA GENERATION

For the bootstrap experiment, the study considers the specification labeled 'true model' from the above models. Firstly, we considered the first model;, $y_t = 1.0 - 0.4x_{3t} + x_{4t} + 0.1x_{2t} + u_t$ we assigned numerical values to all the parameters in $(\beta_0 = 1, \beta_2 = 0.1, \beta_3 = -0.4, \beta_4 = 1)$ ned a numerical value on the basis of assumed σ^2, then the disturbance term U is generated. The U generated was standardized. A random sample of size (n) of X was then selected from a pool of

random numbers and numerical values for $y_t = 1.0 - 0.4x_{3t} + x_{4t} + 0.1x_{2t} + u_t$was computed for each of the sample sizes

using Microsoft Excel software. The x'sand y's generated were copied from Microsoft Excel into STATA and then bootstrapped and replicated 100 times using a STATA command, each replication produces a bootstrap sample which gives distinct values of y that leads to different estimates of β's for each bootstrap sample regression of y on fixedx. The procedure above is then repeated for different sample sizes and was also performed on each of the three models.

2.2 PROCEDURE FOR RESET (REGRESSION SPECIFICATION ERROR TEST)

Using the equation;

$$Y_t = \beta_0 + \beta_1 X_{1t} + \cdots + \beta_k X_{kt} + U_t \quad (2)$$

Also consider the model;

$$\hat{Y} = E\left[\frac{Y}{x}\right] = \beta X \quad (3)$$

Introducing $\hat{y}$ as a form of additional regressor(s);

We introduce$\hat{Y}^2, \ldots, \hat{Y}^k$. The Ramsey's RESET test then tests whether $(\beta_1 X)^2, (\beta_1 X)^3, \ldots, (\beta_1 X)^k$ has any power to explain Y. This is executed by estimating the following linear regression equation;

$$Y = \beta + \beta_1 \hat{Y}^2 + \cdots + \beta_k \hat{Y}^k \quad (4)$$

Further test by a means of F- test whether β_1 through β_{k-1} are zero. If the null hypothesis states that all regression coefficients of the nonlinear terms are zero is rejected, then the model suffers from misspecification. That is,

$H_o: U \sim N(0, \sigma^2)$

Vs

$H_o: U \sim N(0, \sigma^2)$ where $U \neq 0$

The test is based on the argument regression

$$Y = \beta_0 + X\beta + U$$

The F-test procedure follows;

$$F = \frac{R^2_{new} - R^2_{old} / number\ of\ parameters}{1 - R^2_{new} / n - number\ of\ parameters\ in\ the\ new\ model} \quad (5)$$

Let R^2obtained from (5) be R^2_{new} and that obtained from (2) be R^2_{old}.

If the computed F-value is significant at the chosen level of significance(α), we therefore accept the hypothesis that the model (2) is mis-specified.

Using STATA package, we subject the result of the bootstrap to analysis of the test RESET using the command ovtest which computes the RAMSEY RESET test.

2.3 PROCEDURE Q TEST

From the assumed model, we obtained the OLS residual, we ordered the residuals in step in an increasing values of X and compute the Q- statistic from the residuals given as,

$$Q_n = \frac{\sum_{n=1}^{n} \sum_{n=1}^{n-1} (\bar{u}_t - \bar{u})(\bar{u}_{t-1} - \bar{u})}{\sum_{n=1}^{n} (\bar{u}_t - \bar{u})^2}$$

This follows a null chi square distribution at appropriate level of significance, using STATA package, the residual will be ordered using command tsset var (name) and subsequently compute the Q statistic using the command wntestq (variable name).

3 RESULT AND DISCUSSION

In this section, we make a critical comparison between the performance of RESET and Q tests in detecting error when a variable is omitted in a regression model.

The summary of the test of hypothesis of this research is given below;

H_o: There is no specification error

Vs

H_1: H_o is false

Take $\alpha = 0.05$

Percentage Rejection Region of the Hypothesis

Table 1: Result for Model 1

N	RESET	Q TEST
20	51.72	16.79
30	33.38	16.14
50	27.64	48.18
80	67.05	16.85

In model 1, the performance of RESET produced the best result at $n = 80$, except at $n = 50$ when the performance of Q test has substantial power.

Table 2: Result for Model 2

N	RESET	Q test
20	92.58	21.42
30	85.89	24.47
50	31.74	76.88
80	95.51	26.94

In model 2, RESET has the highest percentage based on the performance. It produced the best result at $n = 80$. The performance of Q test increased above seventy percent of the rejection region at $n = 50$

Table 3: Result for Model 3

N	RESET	Q test
20	62.00	47.50
30	28.96	15.77
50	35.79	93.30
80	78.72	54.47

For model 3, the performance of RESET produced the best result at $n = 80$ while the performance of Q test increased more than ninety three percent.

Comparing the percentage of rejection as a whole, for $n = 20$, the performance of RESET are quite good in all part but we obtained the best result when $n = 80$. This simply implies that as sample size increases, the percentage of rejection of RESET gets better than the Q test.

Comparing the percentage of rejection based on the same sample size, at $n = 20$, the performance of RESET is the best, when $n = 30$, for RESET, model 2 perform better than other models but the effect tends to decrease as the sample size increases. At $n = 50$, the RESET does not perform well with all the result less than 50% compared to the Q test which has a higher percentage but the RESET still has a better result than the Q test as a whole and at $n = 80$, the result of RESET once again gets better especially in model 2 as compared to the Q test.

4 CONCLUSION

We have examined the performances of two powerful tests; the RESET and Q test in detecting specification error in the presence of omitted variables in a regression model. The bootstrap simulation experiment indicates that the RESET test is more powerful and robust as compared to the Q test.

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Une insolite tumeur de collision de l'ovaire : à propos d'un cas et revue de la littérature

[An unusual tumour of collision of the ovary: a case report and review of the literature]

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ABSTRACT: Collision tumor means the coexistence of two adjacent tumors, but histologically distinct without mixture into the fabric. These tumors involving the ovaries are rare. Benign cystic teratomas are often present at the same time as other abnormalities of the ovary. The most common histological combination in the ovary is the coexistence of cystic mature teratoma with mucinous tumors, its association with serous tumors is rare and the incidence is unknown. Ovarian mature cystic teratomas are benign often diagnosed in young girls.
We present a rare case of a triple coexistence of a large tumor collision (consisting of a serous cystadenoma, mucinous cystadenoma and a mature cystic teratoma Benin) in the same ovary in a girl of 16 years.

KEYWORDS: collision tumour, mature teratoma, mucinous cystadenoma, serous cystadenoma.

RESUME: La tumeur de Collision signifie la coexistence de deux tumeurs adjacentes, mais histologiquement distinctes sans mélange histologique dans le même tissu. Ces tumeurs impliquant les ovaires sont rares. Les tératomes kystiques bénins sont présents souvent au même moment que d'autres anomalies de l'ovaire. La Combinaison histologique la plus fréquente dans l'ovaire est la coexistence de tératome kystique mature avec les tumeurs mucineuses, son association avec les tumeurs séreuses est rare et l'incidence est inconnue.
Les Tératomes kystiques ovariens bénins matures sont souvent diagnostiqués chez les jeunes filles.
Nous présentons un cas rare d'une triple coexistence d'une grosse tumeur de collision (constituée d'un cystadénome séreux, cystadenome mucineux et d'un tératome kystique mature bénin) dans le même ovaire chez une jeune fille de 16 ans.

MOTS-CLEFS: tumeur de collision, tératome mature, cystadenome mucineux, cystadenome séreux.

1 INTRODUCTION

Le tératome kystique mature représente 20% de toutes les tumeurs ovariennes [2],[5] se voit surtout chez les jeunes filles et de ce fait, il est le plus souvent bénin. Le Cystadénome mucineux représente 41% de toutes les tumeurs épithéliales ovariennes bénignes, et 76% des tumeurs mucineuses de l'ovaire, et 17% de l'ensemble des tumeurs l'ovaire [2] L'association de tératome kystique mature et cystadenome mucineux de l'ovaire est rare [2],[4] leur association avec un

cystadenome séreux est encore exceptionnelle. A notre connaissance, la présence synchrone dans le même ovaire de ces trois entités, n'a jamais été décrite dans la littérature. Nous rapportons un cas de la présence simultanée dans le même ovaire d'un tératome kystique mature, cystadénome mucineux et cystadénome séreux chez une jeune fille de 16ans, nous passerons une brève revue de la littérature sur l'association des trois entités.

2 PATIENT ET OBSERVATION

Nous rapportons le cas d'une jeune fille âgée de 16 ans, qui accusait des douleurs abdominopelviennes avec augmentation du volume abdominal et sensation de pesanteur, sans signes urinaires ni digestifs.

A l'examen, l'abdomen est augmenté de volume avec présence d'une énorme mase abdomino pelvienne de consistance ferme, fixe et indolore, mesurant 27cm X27cm de grand axe.

L'examen gynécologique n'a pas été fait car la patiente était vierge.

La patiente a bénéficié uniquement d'une échographie abdominopelvienne qui a objectivé une masse solido kystique comportant plusieurs petits kystes à contenu finement echogène, avec un épanchement abdominopelvien de moyenne abondance.

Un dosage sérique des marqueurs tumoraux a été fait et qui a conclu une augmentation des trois marqueurs suivants : CA125, CA19.9 et ACE. L'alpha protéine ainsi que BHCG n'étaient pas augmentés.

La patiente a bénéficié d'une extraction de la masse tumorale avec l'annexe.

Au laboratoire d'anatomie pathologique l'examen macroscopique trouvait une énorme masse d'allure kystique mesurant 27cm X27cm avec des foyers à contenu pilo-sébacé.

Il existait cependant des zones charnues, solides cérébroïdes, des foyers chondroides des foyers kystisés comportant un matériel mucoide, filant et enfin d'autres foyers kystiques contenant un liquide serohématique avec des végétations endokystiques. (Figure 1)

Une série de coupes a été réalisé dans différents secteurs de la masse.

A l'examen microscopique : On a pu identifier plusieurs secteurs de morphologie variables : un revêtement malpighien kératinisé sous-tendu par du collagène et contenant des annexes pilosébacées, du tissu adipeux, du cartilage des travées osseuses, des faisceaux musculaires lisses et du tissu glial et cérébelleux (figure 2). Tous ces tissus sont matures, sans atypies cytonucléaires. Dans d'autres foyers de cette tumeur on a mi en évidence une paroi kystique bordée par un revêtement séreux cubique uni stratifié cilié, dépourvu d'atypies cytonucleaires, par endroit on notait des papilles et un certain degré de stratification nucléaire (figure 3). Il n'a pas été vu de mitose. En d'autres endroits on a objectivé la présence de cavités bordées par un revêtement cylindrique, unistratifié, régulier mucosecrétant de type intestinal (figure4).



Fig. 1. Enorme masse multi kystique et hétérogène.

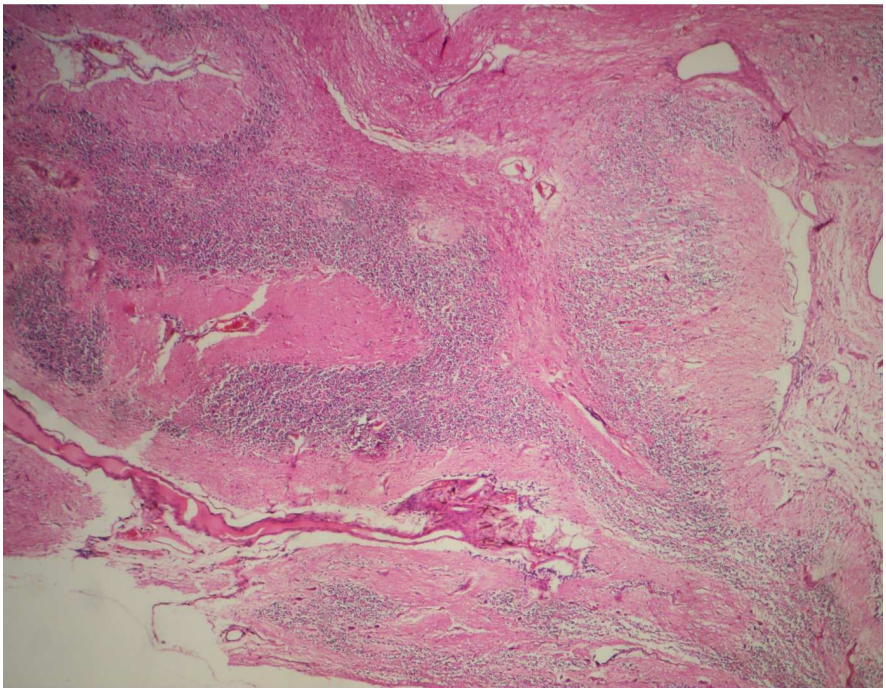


Fig. 2. Hematoxyline Eosine, GX100 : mise en évidence du tissu cérébelleux.

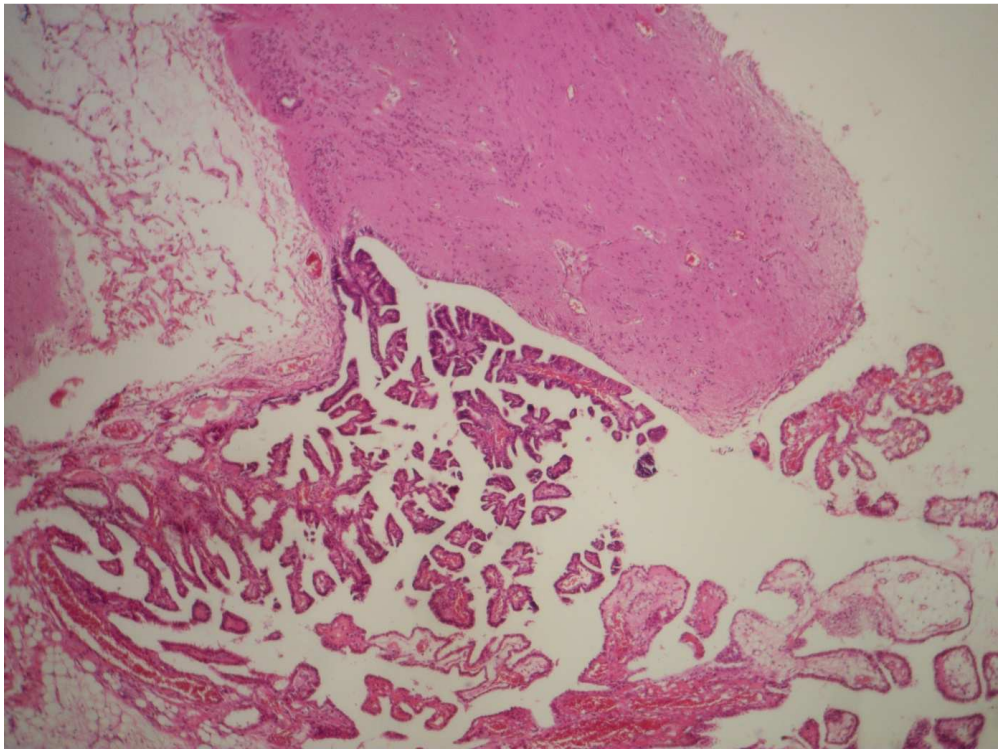


Fig. 3. Hematoxyline Eosine, GX100 : composante papillaire séreuse.

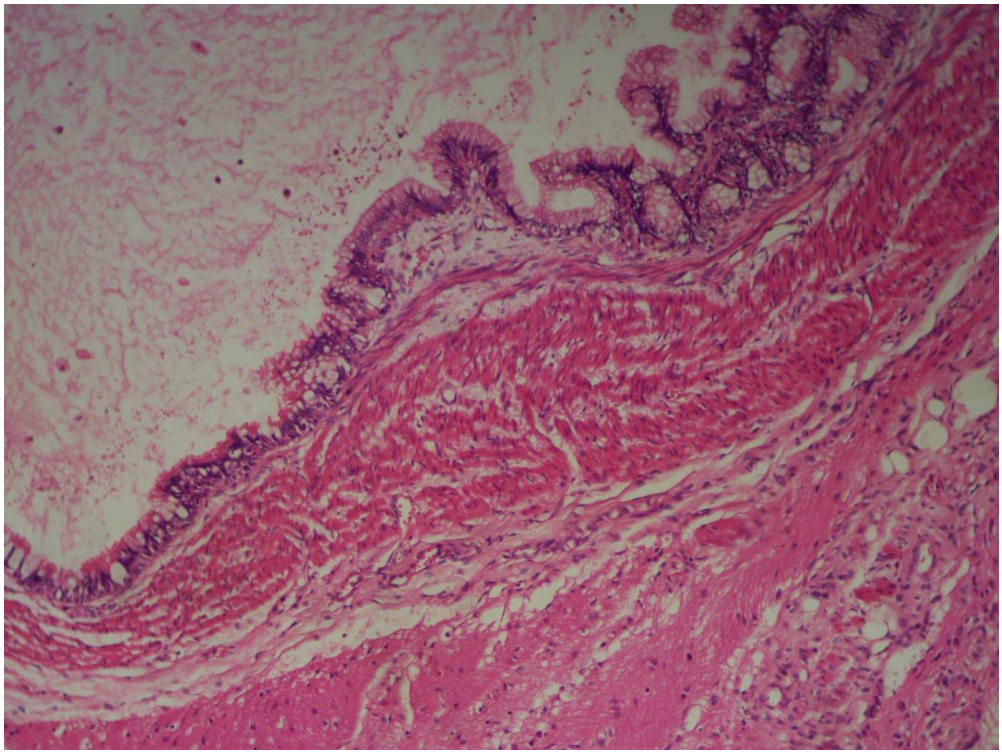


Fig. 4. Hematoxyline Eosine, GX250 : composante mucineuse de type intestinal.

3 DISCUSSION

Les tumeurs de collision ont été décrites dans divers organes autres que l'ovaire, y compris l'œsophage, l'estomac, le foie, les os, les reins, le cerveau et les poumons, la plupart d'entre elles ont été signalées dans des rubriques de cas pour diagnostic [1].

Les tumeurs de collision impliquant les ovaires sont rares et seuls quelques cas ont été décrits. La combinaison histologique la plus fréquente des tumeurs de collision de l'ovaire est composé de tératome et tumeurs mucineuses cystadénomes ou cystadénocarcinome

Dans notre cas, nous présentons la triple coexistence rare d'une tumeur de collision de l'ovaire, avec un tératome mature kystique de l'ovaire, un cystadenome séreux et cystadenome mucineux.

Les divers combinaisons qui ont été rapportées, comprennent un ensemble de cystadénocarcinome sereux et kyste dermoïde, tératome et cystadénocarcinome mucineux, carcinosarcome et kyste dermoïde, choriocarcinome et cystadénome, sarcome et tumeur mucineuse, sarcome et le carcinome séreux, cystadénome séreux et tumeur à cellules de Sertoli-Leydig[1],[2],[3]

Le tératome semble être la composante la plus courante dans les combinaisons rapportées de tumeurs de collision de l'ovaire [1],[2],[3],[5],[7].

La collision de tératome mature et cystadenomes séreux et mucineux décrite ici n'a pas été déclarée auparavant à notre connaissance [1],[2]

Ces tumeurs ovariennes de collision cystadenomes, tératomes sont souvent unilatérales, varient de 2 à 200 cm en taille et se produisent dans le groupe des 17 à 66 ans d'âge [6]. Notre patiente avait 16 ans et a présenté une tumeur unilatérale mesurant 27cmX27cm de grand axe.

Autrefois, on croyait que le cystadenome mucineux provenait de l'épithélium gastro-intestinal du tératome pluritissulaire mature (surtout le sous type intestinal) [6],[8], Une autre possibilité a été évoqué serait que le tératome pluritissulaire résulte de la parthénogenèse de l'ovule et les kystes mucineux et séreux seraient secondaires à une métaplasie de l'épithélium de la muqueuse folliculaire. Cependant la pathogénie exacte de la relation entre ces trois entités reste mystérieuse [1],[6].

Les tumeurs de collision sont diagnostiquées en post opératoire, car il n'y a pas de caractéristiques spécifiques qui évoquent leurs diagnostics préopératoires. Certains auteurs ont analysé rétrospectivement les résultats radiologiques des tumeurs de collision confirmées par l'examen anatomopathologique associées aux tératomes, et ont identifié les caractéristiques qui pourraient les diagnostiqué avant l'intervention [3]. Ils ont constaté que le diagnostic d'une tumeur de collision n'est révélé qu'en postopératoire par l'examen histologique. Il est donc crucial de bien échantillonner les différentes zones pour diagnostiquer ces tumeurs de collision [3].

Le traitement des tumeurs de collision peut être difficile, en particulier si les différents composants sont de type histologique diverse, influençant le pronostic.

Les facteurs qui doivent être pris en compte dans la décision thérapeutique sont les contingents les plus agressives de la tumeur ainsi que le stade qui déterminera par la suite le pronostic.

Dans notre cas, la patiente a bénéficié d'une kystéctomie avec annexectomie du même coté, les suites opératoires étaient simple et la patiente bénéficiera d'un contrôle régulier ultérieur.

4 CONCLUSION

Les tumeurs de collision de l'ovaire sont rares, mais encore plus rare est la coexistence avec d'autres tumeurs ovariennes bénignes, comme dans notre cas. La suspicion préopératoire de l'existence de ces tumeurs sera utile, d'une part, d'augmenter le niveau de surveillance du chirurgien lors de l'opération et d'autre part, va forcer le pathologiste à effectuer un échantillonnage correcte de la masse excisée, de manière à éviter les erreurs de diagnostic d'un second ou même un troisième type de tumeur (en général une tumeur mucineuse), ce qui pourrait se révéler particulièrement important dans le traitement ultérieur et le pronostic de la patiente.

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Fibromatose desmoïde Uterine : À propos d'un cas

[Desmoid tumor of the Uterus : a case report]

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ABSTRACT: The fibromes desmoïdes are benign tumours, extremely rare especially in pelvic localization. We report the case of a 47 years old patient presenting a fibrome desmoïde uterine localization. The treatment consists of a surgical excision of the lesion by a hysterectomy seems not to allow a repetition of the lesion.

KEYWORDS: Fibroma desmoid, Tumor uterus.

RESUME: Les fibromes desmoïdes sont des tumeurs bénignes, extrêmement rares surtout en localisation pelvienne. Nous rapportons le cas d'une patiente âgée de 47 ans présentant un fibrome desmoïde de localisation utérine. Le traitement consiste en une excision chirurgicale de la lésion enmonobloc par une hystérectomie semble ne pas permettre une récidive de la lésion.

MOTS-CLEFS: Fibrome desmoïde, Tumeur utérine.

1 INTRODUCTION

Les tumeurs Desmoides sont les tumeurs rares, bénignes mais fréquemment agressives d'origine mésenchymateuse, formant un groupe d'entités pathologiques hétérogène résultant de la prolifération des fibroblastes bien-différenciés. MacFarlane. En 1832 a premièrement décrit ce qui a été appelé plus tard tumeur desmoide. Le terme « desmoid » a été attribué à ces tumeurs par Muller en 1838 pour indiquer leur aspect macroscopique caractéristique et pour le donner une consistance rugueuse. En 1923, Nichols et al a montré l'association du polypose familial avec les tumeurs desmoides. Aujourd'hui, il est bien connu que la plupart des tumeurs desmoid se produisent sporadiquement, et chez ces patients ils sont trouvés généralement dans la cavité abdominale ou la paroi abdominale. D'autres emplacements possibles des tumeurs desmoides sont le tronc ou les extrémités [1]. Dans notre cas, la tumeur est de localisation utérine. La gestion clinique des patients avec les tumeurs desmoides est difficile et controversée. Beaucoup de questions demeurent sans réponse concernant le dépistage précoce, le rôle de la chirurgie (indication, rôle, synchronisation et ampleur), et la place du traitement conservateur [1].

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2 CAS CLINIQUE

Une patiente de 47 ans multipare avec toujours un cycle menstruel régulier jusqu'il y a 3 mois, ayant accouchée deux fois par césarienne et sans antécédents pathologique notable, s'est présentée en consultation pour des méno-métrorragies depuis 3 mois d'aggravation progressive. L'examen clinique a révélé une masse bombant dans le douglas légèrement douloureuse se mobilisant en bloc avec l'utérus le reste de l'examen gynécologique est sans particularités le tout évoluant dans un contexte de conservation de l'état général mais avec des signes digestifs à type de constipation.

L'échographie pelvienne monte une masse échogène accolée à l'utérus au niveau isthmique de 9cm / 7cm faisant évoquer un fibrome utérin. Les annexes sont normaux, sans épanchement dans le douglas. Une hystérectomie a été proposer à la patiente puis réalisée permettant d'enlevé la masse en sa totalité en monobloc avec l'utérus quoi que la dissection était relativement un peu difficile.

L'aspect macroscopique de la tumeur était comparable à celui d'une tumeur à un fibrome utérin (Fig. 1,2).

L'histologie a posé le diagnostic de fibromatose (ou tumeur) desmoïde (Fig. 3).

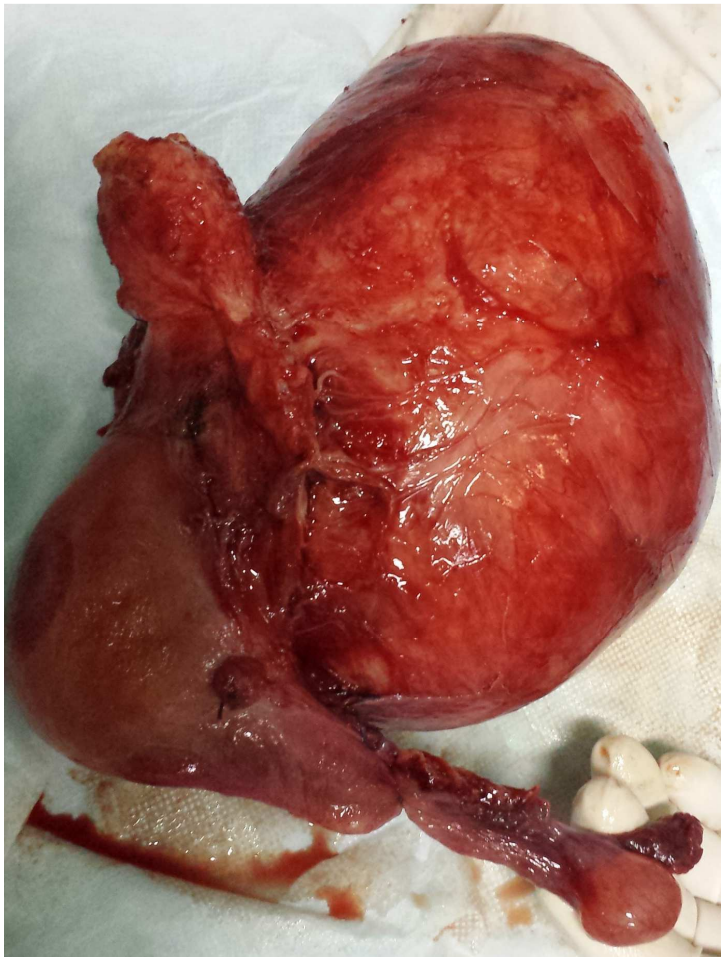


Fig. 1. Vue de profil sur la pièce d'hystérectomie avec la tumeur extirpée en monobloc



Fig. 2. Vue de Face sur la pièce d'hystérectomie avec la tumeur extirpée en monobloc

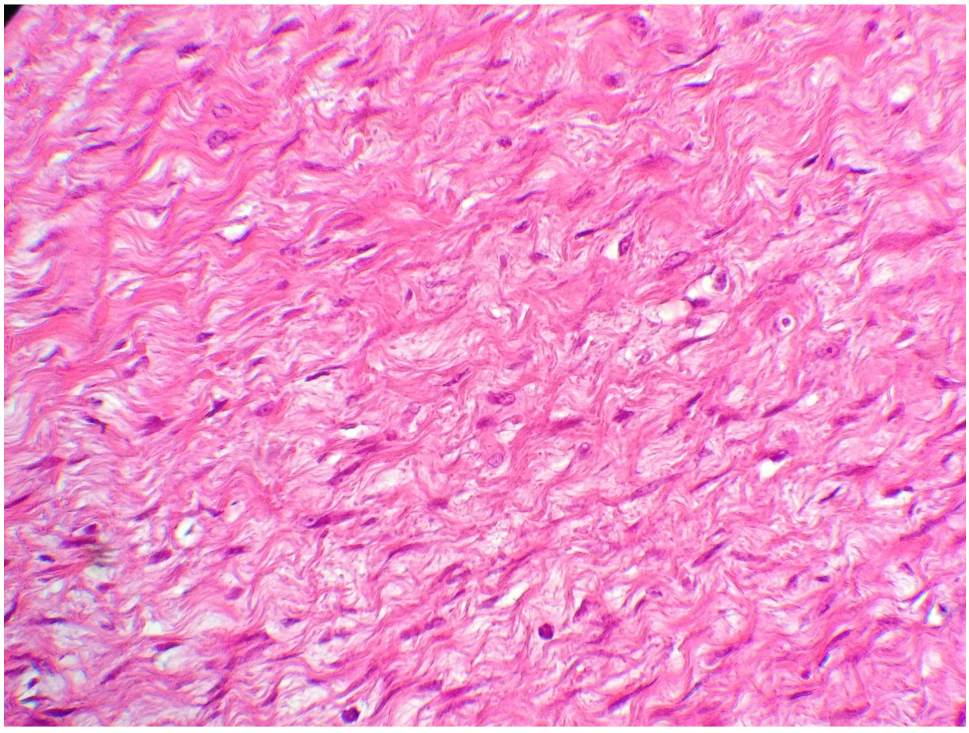


Fig. 3. Hemateine Eosine: Grandissement 50 fois: Proliferation de cellule fusiformes regulieres, disposes en faisceaux, et entourées de nombreuses fibres de collagène

3 DISCUSSION

Les fibromes desmoïdes sont un groupe de tumeurs fibreuses profondes, cliniquement hétérogènes, regroupées sous le vocable des « fibromatoses desmoïdes ». Elles sont classées selon leur comportement biologique en trois groups : sporadique, associé à une polypose adénomateuse familiale, et la forme familiale ou multicentrique [2]. La forme infantile est parfois décrite comme un quatrième groupe.

Parallèlement, ces tumeurs ont également été classifiées selon leur localisation anatomique en extra-abdominales, pariétales abdominales ou intra-abdominales. Le pic d'incidence est situé entre 20 et 40 ans. Ces tumeurs surviennent deux fois plus souvent chez la femme. Si leur étiologie reste actuellement largement inconnue, plusieurs hypothèses ont été proposées. Le rôle de l'imprégnation hormonale a été évoqué par plusieurs auteurs suggérant que les tumeurs desmoïdes soient estrogéno–dépendantes.

Le rôle d'un traumatisme, y compris celui causé par une chirurgie antérieure, a également été évoqué [4]. Néanmoins, leur existence en tant que lésions réactionnelles semble remise en cause actuellement, étant donné le rôle prépondérant que semble jouer le facteur génétique [2].

En raison de l'absence de potentiel métastatique et de leurs caractéristiques microscopiques dépourvues d'atypies nucléaires, ces tumeurs sont considérées comme bénignes [2],[5]. Cependant, elles furent encore classées récemment parmi les fibrosarcomes de bas grade en raison de leurs capacités d'invasion locale et de récidive. En effet, s'il n'existe pas actuellement de série clinique suffisamment large permettant de quantifier le risque avec précision, les taux de récidives varient entre 25 et 50 % [5],[7]. La symptomatologie des fibromes desmoïdes n'est pas très spécifique. Leur localisation utérine est rare. Nous n'avons retrouvé aucun cas décrits au niveau uterin dans la littérature.

Le diagnostic est histologique. Les tumeurs desmoides partagent presque toutes les mêmes caractéristiques histologiques [2]. Les tumeurs Desmoides sont des proliférations des cellules mésenchymateuses qui peuvent surgir en n'importe quelle structure musculo-aponévrotique. La nature précise de la cellule impliquée est peu claire, mais les cellules montrent la morphologie de fibroblaste et peuvent être d'origine de myofibroblaste. Au microscope, des tumeurs desmoides sont mal entourées, infiltrant le tissu environnant, et manquant d'une vraie capsule. Elles se composent de collagène abondant entourant les paquets mal entourés de cellules ovales, minces, fusiformes d'aspect uniforme [1].

Le traitement de choix est la chirurgie. Ces tumeurs doivent être excisées « en bloc » avec une marge suffisante [3]. Cependant, la réalisation de marges de sécurité, ne permet souvent pas d'éviter une récidive, et reste donc très controversée [7].

Des contrôles cliniques fréquents sont à recommander afin de détecter précocement toute récidive, bien qu'aucun consensus thérapeutique ne soit défini dans ces cas. Une résection chirurgicale n'étant pas toujours réalisable, les traitements médicaux s'imposent alors comme ultime recours [8].

Par ailleurs, le rôle des traitements complémentaires à la chirurgie première reste controversé. La majorité des données fournies par la littérature se réfèrent à des études rétrospectives ou à des cas anecdotiques. La radiothérapie a ainsi été utilisée comme traitement néo-adjuvant, adjuvant, et parfois en remplacement de la chirurgie. L'effet de diverses combinaisons d'agents chimio thérapeutiques, dont l'association Vinblastine/Méthotrexate fût une des plus utilisées, n'a jamais été démontré sur un grand nombre de patients.

Enfin, le traitement hormonal par Tamoxifène a montré des effets favorables, sans doute par son interaction avec les récepteurs aux estrogènes qui seraient exprimés en grand nombre par les cellules des tumeurs desmoïdes. Ces données restent elles aussi limitées à un nombre restreint de patients [7],[8]. Dans notre observation la patiente n'a reçu aucun traitement adjuvent juste une surveillance rapprochée par des IRM à deux reprise depuis un an ne montrant aucun signe de récidive locale.

4 CONCLUSION

Les fibromes desmoïdes de la main et des doigts de l'adulte jeune représentent une localisation rare au sein d'une entité clinique connue pour son caractère localement invasif. Ceci rend le traitement chirurgical définitif de ces lésions difficile et le taux de récidive est élevé.

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Place du screening toxicologique par chromatographie liquid haute performance couplée à un détecteur à barrette de diodes (HPLC-DAD) dans le diagnostic des intoxications médicamenteuses

[Role of toxicological screening by high performance liquid chromatography with diode array detection (HPLC-DAD) in diagnosis of drug intoxication]

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ABSTRACT: The study's objective was to assess the role of toxicological screening by high performance liquid chromatography with diode array detection (HPLC-DAD) in diagnosis of drug intoxication to compare those results with results obtained by immunoassay and colorimetric tests.

This prospective study was carried out over a period of one year (2012) at the Laboratory of Moroccan Poison Control and Pharmacovigilance Center. Toxicological screening was performed by using HPLC-DAD, immunoassay and colorimetric tests using plasma and urine of 107 patients. The plasma sample was submitted to a liquid-liquid extraction. The residue was subjected to HPLC-DAD using prazepam as the internal standard. The separation was carried out on an ODS-Hypersil column with phosphate buffer /acetonitrile as the mobile phase. The screening immunoassay and colorimetric tests have been applied to urine samples.

The most common drugs present were benzodiazepines (39, 44%) and antidepressants (23, 94%). The results showed a good agreement (67.29 %) between the results of screening by HPLC-DAD and results obtained by immunoassay and colorimetric tests. The discordance was occurred in 32.71%.

In our study, the causes of discordance were technical limits. It was the absence of the molecule suspected at the spectral library or the similarity of the UV-spectra. In other cases the toxicokinetic of the suspected substance influence the results; the compound is metabolized or even eliminated or the identified drug is administered to the patient as symptomatic treatment.

Data analysis shows that toxicological screening by HPLC -DAD allows the identification of unrecognized drugs by immunoassay and colorimetric tests. This method can simultaneously identify several molecules belonging to different classes of drugs.

KEYWORDS: Screening, HPLC-DAD, Intoxication, Drugs, Colorimetric, Immunoassay.

RESUME: L'objectif de cette étude était d'évaluer la place du screening toxicologique de médicaments par chromatographie liquide haute performance couplée à un détecteur à barrette de diodes (HPLC-DAD) dans le diagnostic des intoxications médicamenteuses et de comparer les résultats obtenus par apport aux résultats des méthodes colorimétriques et immunologiques.

Il s'agit d'une étude prospective, basée sur l'analyse de 107 prélèvements sanguins et urinaires reçus au laboratoire du Centre anti poison et de pharmacovigilance du Maroc pendant une période de 12 mois. Pour le screening par HPLC-DAD, les

plasmas ont subi une extraction liquide-liquide (prazépam comme standard interne). La séparation s'est effectuée sur colonne HYPERSIL ODS à l'aide d'un gradient acétonitrile/tampon phosphate. Les urines des malades ont été analysées par des méthodes colorimétriques et immunologiques. Les médicaments recherchés étaient des benzodiazépines (39, 44%) suivis des antidépresseurs (23,94%). Il y'avait une bonne concordance (67,29 %) entre les résultats du screening par HPLC/DAD et ceux obtenus par les méthodes colorimétriques et immunologiques et une discordance dans 32,71% des cas.
Les causes de discordance étaient d'une part des causes techniques, absence de la molécule suspectée au niveau de la spectrothèque soit la ressemblance des spectres UV pour les molécules pharmaco-chimiquement proches). D'autre part, la toxicocinétique de la substance incriminée peut influencer le résultat, la molécule mère est déjà métabolisée voire éliminée. Dans d'autres cas le médicament identifié est administré au patient comme traitement.
Le screening toxicologique par HPLC-DAD permet l'identification des médicaments non reconnus par les tests colorimétriques et immunologiques. Il permet également l'identification simultanée de plusieurs molécules appartenant à des classes médicamenteuses différentes.

MOTS-CLEFS: Screening, HPLC-DAD, Intoxication, Médicament, Colorimétrique, immunologique.

1 INTRODUCTION

La prise en charge d'une intoxication est essentiellement symptomatique et repose avant tout sur l'approche clinique, regroupant l'anamnèse, l'examen clinique complet, l'électrocardiogramme et les bilans biologiques [1]. L'analyse toxicologique est un complément dans cette prise en charge. Celle-ci permet d'identifier et/ou de doser la substance toxique consommée afin de confirmer ou de réfuter l'hypothèse d'intoxication, d'évaluer sa gravité et de surveiller le traitement [2], [3], [4], [5].

Les analyses toxicologiques utilisent principalement deux grands groupes de méthodes différentes qui sont les méthodes colorimétriques, photométriques, enzymatiques et immunologiques d'une part et les méthodes séparatives d'autre part. Le premier groupe permet de donner une orientation rapide sur l'origine de l'intoxication, il est simple et ne nécessite pas de traitement pré-analytique, mais ce groupe a une sensibilité variable, il est moins spécifique et peut donner lieu à des interférences où à des réactions croisées. Afin de confirmer les résultats des échantillons obtenus par ces méthodes, on a recours à des méthodes plus sophistiquées et précises telles que la chromatographie liquide haute performance couplée à un détecteur à barrette de diodes (HPLC-DAD). Ces méthodes permettent d'identifier et/ou de doser après extraction appropriée de nombreuses xénobiotiques avec une grande sensibilité et spécificité et avec un coût d''investissement considérablement réduit [1], [5], [6].

Selon les données épidémiologiques du Centre Anti-Poisons du Maroc (CAPM), le médicament reste le toxique le plus incriminé dans les intoxications [7]. Pour répondre aux demandes toxicologiques des patients, le laboratoire du CAPM a développé une technique de screening médicamenteux par HPLC-DAD. L'objectif de cette étude était d'évaluer la place du screening toxicologique de médicaments par HPLC-DAD dans le diagnostic des intoxications médicamenteuses et de comparer les résultats obtenus par apport aux résultats des méthodes colorimétriques et immunologiques.

2 MATERIELS ET METHODES

Il s'agit d'une étude prospective étalée sur une année (01 Janvier 2012 à 31 Décembre 2012). L'étude a été menée au laboratoire de toxicologie et de pharmacologie du CAPM. Le laboratoire couvre les examens de toxicologie médicale ainsi que les dosages des médicaments pour le suivi thérapeutique des patients.

Les patients inclus étaient des patients hospitalisés ou consultant en ambulatoire pour une suspicion d'intoxication médicamenteuse aigue et chez qui au même temps des prélèvements sanguins et urinaires ont été réalisés. Tous les prélèvements non-conformes (Echantillons de sang coagulé, Echantillons sans identité, identité illisible ou incomplète) ont été exclus. Un tableau clinique a été fourni pour chaque patient renfermant toutes les informations utiles.

Le sang est prélevé dans des tubes contenant des anticoagulants (EDTA ou héparine) puis centrifugé à 3000 tr/min pendant 10 minutes et enfin conservé à 4˚C. La réalisation de l'extraction nécessite l'utilisation de 1 ml de plasma. Les urines sont conservées à + 4°C. Les plasmas sanguins sont utilisés pour le screening toxicologique par HPLC-DAD et les urines ont servi pour les analyses colorimétriques et immunologiques.

L'analyse du screening toxicologique médicamenteux a été effectuée sur une chaine HPLC (Type Agilent série 1100) équipée d'un détecteur à barrette de diodes et d'une colonne HYPERSIL ODS 100×2,1 mm, 5 µm précédée d'une précolonne 20 x 2 mm, pilotée par le logiciel HP Chemstation for LC, version B02 possédant la bibliothèque Toxicol. La température de l'enceinte thermostatée est de 40° C. La phase mobile est un mélange d'acétonitrile et de tampon phosphate 20 mM dont les proportions varient selon un gradient (tableau 1). Les longueurs d'onde d'acquisition utilisées sont 210, 230, 254 nm.

Après extraction liquide-liquide utilisant le prazépam comme standard interne, 10 µl d'échantillon sont injectés dans la colonne et l'analyse chromatographique dure 20 minutes.

L'interprétation des résultats est effectuée par Le logiciel « Chemstation » qui permet la détermination de la concordance du spectre élué à son homologue en bibliothèque qui est évalué par le match factor et la concordance entre les molécules est acceptée à une valeur supérieure ou égale à 990/1000.

Tableau 1. Condition chromatographiques du screening par HPLC/DAD

Temps (min)	Débit (ml/min)	% Tampon	% Acétonitrile
6,50	0,4	55	45
13,00	0,4	25	75
15,00	0,4	20	80
19,00	0,4	85	15

Les méthodes effectuées au niveau des urines comprenaient la recherche des salicylés par la réaction de Trinder, des phénothiazines par la réaction de Forrest, des imipramines par la réaction au nitrite de sodium et du paracétamol par la réaction à l'O-crésol [8]. Les benzodiazépines, opiacées, morphiniques, cocaïniques et cannabinoïdes sont recherchées par les tests d'immuno-chromatographie (cassettes fournis par RAPID DRUG SCREEN –Individual TM).

3 RESULTATS

Pendant la période d'étude on a reçus, des échantillons sanguins et urinaires de 107 patients. L'âge moyen est de 18,43± 1,9 ans. Le sexe ration est de 1,16 en faveur des individus de sexe féminin. Pour tous les cas analysés par HPLC-DAD, la répartition des intoxications médicamenteuses selon les classes pharmaceutiques des médicaments a montré que les benzodiazépines viennent au premier rang avec 39,44% du total, suivis par les antidépresseurs 23,94%, les antiépileptiques 12,68%, les neuroleptiques 11,27%, les antalgiques non opiacés 7,04% et 5,63 pour les autres classes de médicaments (figure 1).

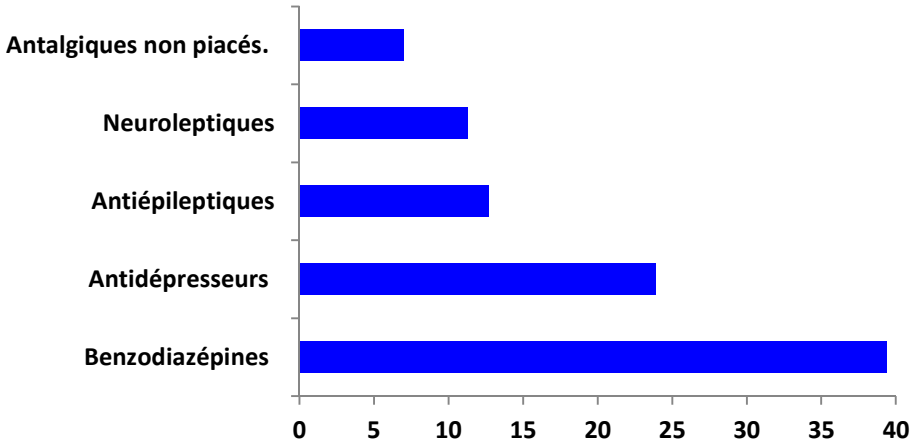


Fig. 1. Répartition des médicaments détectés par HPLC-DAD selon la classe thérapeutique de médicament.

Les résultats obtenus par les méthodes colorimétriques et immunologiques ont montré que les benzodiazépines (60,38%) occupent la première place suivies par les antidépresseurs tricycliques (13,21%), les neuroleptiques (7,55%), et un pourcentage de 9,43% pour les antiépileptiques et les antalgiques non opiacés.

La comparaison des résultats obtenus a montré une bonne concordance (67,29 %) entre les résultats du screening par HPLC-DAD et ceux obtenus par les méthodes colorimétriques et immunologiques (Tableau 2) et une discordance dans 35 cas soit 32,71% (Tableau 3). Cette discordance était en rapport avec des résultats négatifs par HPLC-DAD et positifs par les méthodes colorimétriques et immunologique et vis versa, ou la détermination de deux médicaments différents par chaque méthode.

Tableau 2. Comparaison des résultats du screening pour les intoxications médicamenteuses par HPLC-DAD, méthodes colorimétriques et immunologiques : cas des concordances.

Méthode immunologiques et colorimétriques	**Screening par HPLC-DAD**	**Effectifs**	**Pourcentage**
Négatif	Négatif	37	51,39
Benzodiazépines= P SPI=N	Bromazépam	5	6,94
Benzodiazépines= P SPI=N	Midazolam	4	5,55
Benzodiazépines= P SPI=N	Diazépam	3	4,17
Benzodiazépines= P SPI=N	Témazépam	2	2,78
Benzodiazépines= P SPI=N, Coc=N, Morph=N, THC=N	Diazépam Bromazépam	1	1,39
Benzodiazépines= P SPI=N, Coc=N, Morph=N, THC=N	Témazépam Diazépam	1	1,39
Benzodiazépines= P SPI=N, Coc=N, Morph=N, OP=N	Témazépam Carbamazépine	1	1,39
Benzodiazépines= P SPI=N, Coc=N, Amph=N, Morph=N THC=N, OP=N	Oméprazole Alprazolam Zolpidem	1	1,39
Benzodiazépines= P SPI=N, Coc=N, Amph=N, THC=N	Lévomépromazine, Zolpidem, Alprazolam	1	1,39
Imipraminiques= P SP=N, BDZ=N	Amitriptyline	4	5,55
Imipraminiques= P SP=N, BDZ=N, Coc=N, Morph=N, OP=N	Nortriptyline	1	1,39
Paracétamol= P SPI=N, BDZ=N	Paracétamol	2	2,78
Phénothiazines=P SI=N, BDZ=N	Chloropromazine	2	2,78
Phénobarbital=P SPI=N, BDZ=N	Phénobarbital	4	5,55
Salicylés=P PI=N, BDZ=N, Amph=N, Morph=N	acide acétylsalicylique	1	1,39
Phénothiazines=P, Benzodiazépines=P SI=N, Coc=N, Morph=N, Amph=N	Périciazine, Diazépam	1	1,39
Phénothiazines=P SI=N, BDZ=N, Morph=N, THC=N, OP=N	Lévomépromazine	1	1,39
Total		**72**	**100**

N= négatif, P= positif S = salicylés, P= phénothiazines, I= imipramines, BZD= benzodiazépines, OP= opiacées, Morp= Morphiniques, Amph= amphétamines, Coc= cocaïniques, THC= cannabinoïdes.

L'analyse chromatographique par HPLC-DAD nous a permis de confirmer le résultat négatif obtenu par les méthodes colorimétrique et immunologiques pour la recherche de salicylés, phénothiazines, imipramines, benzodiazépines, Amphétamines, opiacées, cocaïniques et cannabinoïdes.

Tableau3. Comparaison des résultats du screening pour les intoxications médicamenteuses par HPLC-DAD, méthodes colorimétriques et immunologiques : cas des discordances.

Nombre de cas ayant le même résultat	*Méthodes colorimétriques et immunologiques*	*Molécules identifiées par HPLC-DAD*
7	Benzodiazépines	Négatif
2	Salicylés	Négatif
1	Morphiniques	Négatif
1	Négatif	Amitriptyline
1	Négatif	Thiopental
1	Négatif	Métabolite d'amisulpride, chlorpromazine
1	Négatif	Carbamazépine
2	Négatif	Phénobarbital
1	Négatif	Miansérine
1	Négatif	Levomopromazine
1	Négatif	Bromazépam, Amitriptyline
3	Négatif	Bromazépam
1	Négatif	Tianéptine
1	Négatif	Miansérine
1	Négatif	Désipramine
2	Négatif	Diazépam
1	Négatif	Midazolam
1	Négatif	Dibenzépine
1	Négatif	Estazolam, Acide valproique
1	Benzodiazépines	Miansérine
1	Benzodiazépines	Lévomépromazine, Tianéptine
1	Benzodiazépines	Paracétamol, Hydroxyzine
1	Benzodiazépines	Noramidopyrine, Lévomépromazine
1	Benzodiazépines	Tianéptine

La confrontation des médicaments suspectés cliniquement avec les résultats de l'HPLC-DAD a montré une parfaite concordance (74,42%). La discordance a été notée pour 11 cas soit 25,58% (Tableau 4).

Tableau 4. Cas de discordances entre les analyses par HPLC-DAD et les tableaux cliniques

Tableaux cliniques	**Analyses par HPLC-DAD**
Niaprazine	Négatif
Hydroxyzine	Négatif
Maprotiline	Négatif
Paracétamol	Négatif
Bromazépam, Alprazolam	Négatif
Lévodopa	Négatif
Trihexyphenidyle Chlorhydrate	Négatif
Prazépam	Diazépam
Amitriptyline	Imipramine
Valproate de sodium	Carbamazépine
- Clomipramine	Thiopental

4 DISCUSSION

Sur les 107 analyses effectuées par HPLC-DAD, la répartition des intoxications médicamenteuses selon les classes pharmaceutiques des médicaments a montré que les familles médicamenteuses les plus incriminées, sont les psychotropes ce qui concorde avec les résultats de l'étude réalisé par le CAPM. Le bromazépam étant le principe actif le plus rencontré, l'abondance de cette molécule peut être expliquée par sa vente illégale dans le marché parallèle au Maroc. [8]

Dans notre études, pour tous les cas où on a noté une parfaite concordance entre les résultats des méthodes colorimétriques, immunologiques et les résultats du screening par HPLC-DAD, il s'avère que les dépistages colorimétriques et immunologiques permettent uniquement le diagnostic de certains médicaments ou certaines classes de médicaments (paracétamol, benzodiazépines, barbituriques, salicylés, antidépresseurs tricycliques) ou de stupéfiants (amphétamines, dérivés opiacés) sans préciser la nature exacte du produit en cause de l'intoxication, de plus la liste des molécules développées pour ces tests est limitée et de nombreuses classes médicamenteuses sont ignorées [3, 9].

L'HPLC-DAD permet l'identification de plusieurs molécules appartenant à des classes médicamenteuses très variées (bromazépam, phénobarbital, lévomépromazine, dibenzépine...).

Pour les cas de non concordance entre les deux méthodes dans cette étude. Les analyses toxicologiques par HPLC-DAD se sont révélées négatifs pour 10 cas alors que les méthodes colorimétriques et immunologiques ont identifié pour ces même cas 7 benzodiazépines, 2 salicylés et un morphinique. Ce résultat peut être expliqué d'une part par le temps post intoxication qui pourrait être suffisant pour l'élimination du médicament par l'organisme d'autre part la toxicocinétique de la molécule incriminé peut influencer le résultat, la molécule mère peut être déjà métabolisé voir éliminée.

Cependant, pour 5 autres cas, identifiés comme benzodiazépines positifs par les méthodes colorimétriques et immunologiques, l'HPLC-DAD, quant à elle, a identifié trois antidépresseurs, deux antalgiques non opiacés, deux neuroleptiques et un anxiolytique.

Cette dernière discordance peut être expliquée par les interférences connues pour les méthodes colorimétriques et les réactions croisées des méthodes immunologiques qui peuvent conduire à des faux 'positifs' [1, 10].

Par ailleurs, 20 cas ont été déclarés négatifs par les méthodes colorimétriques et immunologiques alors que l'HPLC-DAD a permis d'identifier le midazolam, l'amitriptyline, l'amisulpride, la chlorpromazine, la lévomepromazine, le bromazépam, la désipramine, le diazépam, la dibenzépine, l'estazolam, la tianéptine et le phénobarbital. Le résultat positif de recherche de ces molécules par HPLC-DAD confirme la grande sensibilité et la grande spécificité de la méthode vis-à-vis de ces molécules.

Les résultats négatifs par les méthodes immunologiques pourraient être expliqués par la différence d'affinité des molécules d'une même classe vis-à-vis d'un même anticorps ce qui peut donner lieu à des faux négatifs [6].

La concentration de la molécule incriminée dans l'intoxication (La concentration circulante est inférieure au taux de positivité du test) peut donner des faux négatifs par les méthodes immunologiques [6].

Pour l'acide valproïque, la miansérine, le thiopental et la carbamazépine, ce résultat pourrait être expliqué pour la miansérine par le fait que les antidépresseurs tétracycliques ne sont pas détectables par les trousses immunologiques utilisées pour le dépistage des antidépresseurs imipraminiques tricycliques [10].

Pour les autres molécules (l'acide valproïque, le thiopental, la pholcodine), on ne dispose pas à l'échelle de notre laboratoire de méthodes spécifiques pour la détection de ces molécules.

Concernant les patients ayant suivis un traitement médical avant l'analyse, la confrontation des résultats obtenus par HPLC-DAD en relation avec les médicaments suspectés par le clinicien a montré une concordance dans 32 cas et une discordance dans 11 cas.

Parmi les 11 cas de discordance, 7 analyses par HPLC-DAD se sont révélés négatives malgré la prise préalable par les patients de certains médicaments. Les médicaments utilisés diffèrent selon les cas et concernent les produits suivants : niaprazine, hydroxyzine, maprotiline, alprazolam, bromazépam, paracétamol, lévodopa et trihexyphenidyle chlorhydrate.

Ce résultat négatif obtenu pourrait être expliqué, en partie, par le délai relativement important entre la prise du médicament et le moment de la réalisation de l'analyse toxicologique. Cette donnée ne peut pas être confirmée puisque on ne dispose pas dans les informations fournis au laboratoire du délai d'intoxication constituant une limite de notre étude.

Le résultat pour 2 cas (lévodopa et trihexyphenidyle chlorhydrate) était négatif en raison d'absence dans notre spectrothèque Toxicol des spectres homologues pour ces deux médicaments.

Pour 4 autres cas le clinicien avait suspecté la prise de certains médicaments (prazépam, amitriptyline, valproate de sodium, clomipramine) alors que l'HPLC-DAD en avait identifiée d'autres (diazépam, imipramine, carbamazépine, thiopental). Ce constat pourrait être expliqué soit par la ressemblance des spectres UV pour les molécules pharmaco-chimiquement proches soit que le médicament identifié est administré au patient comme traitement de base ou traitement symptomatique.

Les résultats de cette étude laissent entendre que l'HPLC-DAD est une méthode capable de détecter plusieurs molécules appartenant à des classes médicamenteuses très variées ainsi que leurs métabolites incluant même les intoxications polymédicamenteuses [9]. Cependant, cette technique nécessite un temps d'analyse et d'interprétation assez longs, un personnel qualifié en HPLC et la constitution d'une base très large de spectres de médicaments (spectrothèque).

5 CONCLUSIONS

Les résultats de cette étude montrent que le screening toxicologique par HPLC-DAD pourrait constituer un outil de diagnostic efficace, car il permet l'identification de molécules appartenant à des classes médicamenteuses très variées ainsi que leurs métabolites; de plus ce type de screening permet de préciser la nature exacte de la molécule incriminée dans l'intoxication et de confirmer les tests colorimétriques et immunologiques qui ne permettent que l'identification de la classe médicamenteuse. Par ailleurs, l'HPLC-DAD permet l'identification formelle des composés non décelables par les tests colorimétriques et immunochimiques.

Le dialogue entre le clinicien et l'analyste est indispensable, cette collaboration clinico-biologique doit être instaurée afin d'éviter les pièges analytiques.

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Linear stability analysis of Taylor-Couette flow in a viscoelastic fluid under out-of phase modulation

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ABSTRACT: In this work, the linear stability analysis of a pulsed Taylor-Couette flow is investigated in the case of a linear Maxwell fluid when both cylinders are subjected to an out-of phase modulation with equal modulation amplitude and equal modulation frequency. The linear problem is solved using the Floquet theory and a technique of converting a boundary value problem to an initial value problem. Attention is focused on the influence of elasticity on the critical parameters corresponding to the onset of instability. The numerical results show that the Deborah number has a destabilizing effect in the high frequency limit and the critical parameters are independent on the frequency number. However, in the low frequency limit the Maxwell fluid behaves as a Newtonian one and no effect of Deborah number is observed.

KEYWORDS: Linear stability; Pulsed Taylor-Couette flow; Maxwell fluid; Floquet theory.

1 INTRODUCTION

Several studies devoted to the modulation of the Taylor-Couette flow have been conducted both experimentally and theoretically in different configurations in which the angular velocities of the inner and outer cylinders are respectively, $\Omega_1 + \varepsilon_1 \cos(\omega\, t^*)$ and $\Omega_2 + \varepsilon_2 \cos(\omega\, t^*)$. The effect of the modulation on the threshold of instability compared to the unmodulated case was discussed in [1-2-3-4-5-6-7-8-9]. Otherwise, two configurations corresponding to a zero mean modulation, $\Omega_1 = \Omega_1 = 0$, in phase $\varepsilon_1 = \varepsilon_2 = 1$ or out of phase $\varepsilon_1 = -\varepsilon_2$ have been revisited theoretically in the narrow gap approximation in [10-11-12] and the first experimental evidence of these configurations was achieved in these investigations. The experimental results, corresponding to the modulation in phase, have been in good agreement with the linear stability analysis and both experimental and theoretical results have showed that the flow is less unstable in the limit of low and high frequency while destabilization is maximum for an intermediate frequency. For modulation in out of phase, the numerical results in [12] compared well with the experimental observations at high and moderate frequencies but showed a disagreement at low frequencies.

In contrast to these works which have examined the case of a Newtonian fluid, we perform in this paper a linear stability analysis of the pulsed Taylor-Couette flow in a viscoelastic fluid which is modeled by a linear Maxwell model. Considering the narrow gap approximation, we investigate in the case of an out-of phase zero mean modulation, the effect of frequency modulation and elasticity characterized by Deborah number on the threshold of instability.

2 MATHEMATICAL FORMULATION

Consider the time periodic flow in an incompressible viscoelastic fluid filling the annulus space between two infinitely long cylinders of radii R_1 and $R_2 = R_1 + d$ with d being the gap width, Fig. 1. The angular velocity of the inner and the outer

cylinders are respectively $\Omega_1 = \Omega_0 \cos(\omega\, t^*)$ and $\Omega_2 = -\Omega_0 \cos(\omega\, t^*)$. The quantities Ω_0 and ω denote respectively the amplitude and the adimensional frequency of the modulated rotation.

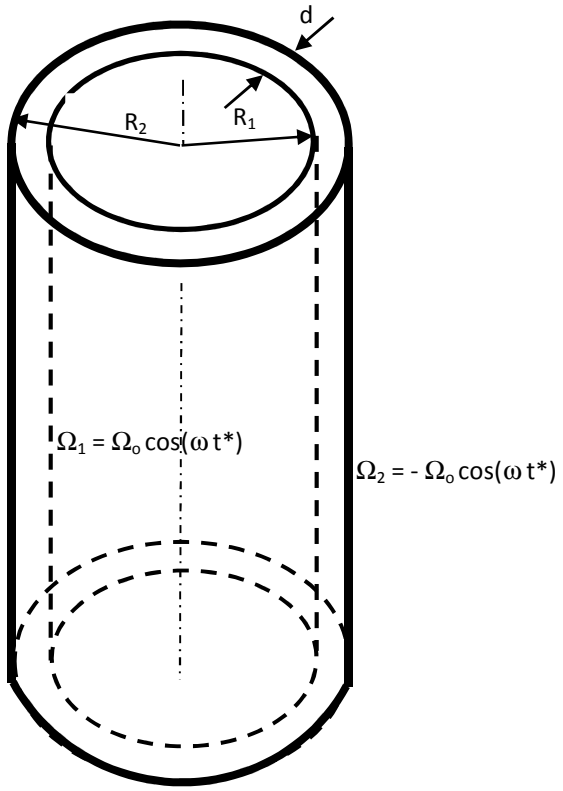


Fig 1. Viscoelastic fluid confined in a Taylor-Couette system with rotation modulation of the inner and outer cylinders

The governing equations are the momentum and mass equations which are given by

$$\frac{\partial \boldsymbol{V}^*}{\partial t^*} + \boldsymbol{V}^*.\nabla \boldsymbol{V}^* = -\frac{1}{\rho}\ \nabla P^* + \nu\, \nabla.\boldsymbol{\tau} \tag{1}$$

$$\nabla.\boldsymbol{V}^* = 0 \tag{2}$$

where $\boldsymbol{V}^*$ is the velocity vector, $\boldsymbol{\tau}$ is the extra stress tensor, P^* is the pressure and ν is the kinematic viscosity. The fluid is assumed to obey a linear Maxwell model and can be represented by a purely viscous damper and a purely elastic spring connected in series

$$\boldsymbol{\tau} + \lambda\, \frac{\partial}{\partial t^*}\boldsymbol{\tau} = \mu\, \boldsymbol{ID} \tag{3}$$

We denote by $\boldsymbol{ID}$ the rate of strain tensor defined by $\boldsymbol{ID} = \nabla \boldsymbol{V}^* + \nabla^t \boldsymbol{V}^*$ and we designate by ρ the density, μ the dynamic viscosity and λ the relaxation time.

2.1 BASE FLOW

In dimensional cylindrical-polar coordinates (r^*, θ, z^*), the velocity components are denoted respectively, in the radial, azimuthal and axial direction, by (U^*, V^*, W^*). Hereafter, we assume that the base flow is azimuthal and axisymetric and then it is written as $\mathbf{V}^* = (0,\, V^*, 0)$ with P^* and V^* are θ independents. Under these assumptions, a combination of the equations (1 – 2 – 3) leads to the following system

$$\rho\left(1 + \lambda\frac{\partial}{\partial t^*}\right)\left(-\frac{V^{*2}}{r^*}\right) = -\left(1 + \lambda\frac{\partial}{\partial t^*}\right)\left(\frac{\partial P^*}{\partial r^*}\right) \tag{4}$$

$$\rho\left(1 + \lambda\frac{\partial}{\partial t^*}\right)\frac{\partial V^*}{\partial t^*} = \mu\left(\frac{\partial^2 V^*}{\partial r^{*2}} + \frac{\partial}{\partial r^*}\left(\frac{V^*}{r^*}\right)\right) \tag{5}$$

$$0 = -\left(1 + \lambda\frac{\partial}{\partial t^*}\right)\left(\frac{\partial P^*}{\partial z^*}\right) \tag{6}$$

We introduce the following dimensionless variables

$$r^* = R_1 + d\,x, \qquad t = \frac{\mathrm{t}^*}{\frac{\mathrm{d}^2}{\nu}}\ , \qquad V_B = \frac{V^*}{R_1\Omega_0}\ , \qquad P_B = \frac{P^*}{\rho\ R_1 \mathrm{d}\ {\Omega_0}^2}$$

Equation (6) shows that the pressure is independent of z^*. Assuming that the gap width d is small compared to the radius R_1 of the inner cylinder and using the small-gap approximation in which all terms of order d/R_1 are neglected, the dimensionless azimuthal velocity of the basic state satisfies equation (5) which is now in the form

$$\Gamma\frac{\partial^2 \mathrm{V}_B}{\partial t^2} + \frac{\partial \mathrm{V}_B}{\partial \mathrm{t}} = \frac{\partial^2 \mathrm{V}_B}{\partial \mathrm{x}^2} \tag{7}$$

with the boundary conditions

$$V_B(x=0,t) = \cos(\sigma t), \qquad V_B(x=1,t) = -\cos(\sigma t) \tag{8}$$

The parameters $\sigma = \omega\, d^2/\nu$ and $\Gamma = \lambda\,\nu/d^2$ are respectively the frequency number and Deborah number. The parameter σ is the ratio of the viscous diffusive time and the period of modulation whereas Γ is the ratio of the relaxation time and viscous diffusive time. The pressure of the base flow, P_B , is obtained from equation (4) which is written as

$$\rho\left(1+\Gamma\frac{\partial}{\partial \mathrm{t}^*}\right)V_B = -\left(1+\Gamma\frac{\partial}{\partial \mathrm{t}^*}\right)\left(\frac{\partial P_B}{\partial x}\right)$$

The solution of Equations (7) and (8) is of the form

$$V_B(x,t) = V_1(x)\cos(\sigma t) + V_2(x,t)\sin(\sigma t) \tag{9}$$

The functions V_1 and V_2 are given by

$$V_1(x) = \frac{\cos(\gamma\,\beta\,x)\cosh\big(\gamma\,\xi\,(1-x)\big) - \cos(\gamma\,\beta\,(1-x))\cosh(\gamma\,\xi\,x)}{cosh(\gamma\,\xi) - \cos(\gamma\,\beta)}$$

$$V_2(x) = \frac{\sin(\gamma\,\beta\,x)\sinh\big(\gamma\,\xi\,(1-x)\big) - \sin(\gamma\,\beta\,(1-x))\sinh(\gamma\,\xi\,x)}{cosh(\gamma\,\xi) - \cos(\gamma\,\beta)}$$

where $\gamma = \sqrt{\frac{\sigma}{2}}$, $\beta = \sqrt{\sigma\Gamma + \sqrt{1+\Gamma^2\sigma^2}}$, $\xi = \sqrt{\sigma\Gamma - \sqrt{1+\Gamma^2\sigma^2}}$. The parameter γ expresses the ratio of two lengths $\gamma = \mathrm{d}/\delta_N$ where $\delta_N = \sqrt{2\nu/\omega}$ is the thickness of the Stokes layer for a Newtonian fluid. The parameters β and ξ express also the ratio of two lengths, indeed $\beta = \xi^{-1} = \delta_M/\delta_N$ where $\delta_M = d\,(\sigma/2)^{-1/2}\big(\sigma\Gamma + \sqrt{1+\sigma^2\Gamma^2}\big)^{-1/2}$ is the thickness of the Stokes layer for a linear Maxwell fluid defined in [13].

2.2 LINEAR STABILITY AND NUMERICAL APPROACH

The linear stability of the base flow respecting axisymmetric disturbances is considered. The velocity and the pressure fields in the perturbed state are written as the sum of the base flow variables and small perturbations

$$\mathbf{u} = (0, \mathrm{V_B}, 0) + \big(\mathrm{u(x,z,t)}, \mathrm{v(x,z,t)}, \mathrm{w(x,z,t)}\big) \tag{10}$$

$$\mathrm{P} = \mathrm{P_B} + \mathrm{p(x,z,t)} \tag{11}$$

Substituting expressions (10) and (11) into equations (4)-(5) and linearizing yields

$$\left(M - \frac{\partial}{\partial \mathrm{t}} - \Gamma\frac{\partial^2}{\partial \mathrm{t}^2}\right)u\ + 2\,T_a^2\,\mathrm{V_B}\,v = \left(1+\Gamma\frac{\partial}{\partial \mathrm{t}}\right)\left(\frac{\partial P}{\partial x}\right) \tag{12}$$

$$\left(M - \frac{\partial}{\partial \mathrm{t}} - \Gamma\frac{\partial^2}{\partial \mathrm{t}^2}\right)v\ = \left(1+\Gamma\frac{\partial}{\partial \mathrm{t}}\right)\left(\frac{\partial V_B}{\partial x}\right)u \tag{13}$$

$$\left(M - \frac{\partial}{\partial \mathrm{t}} - \Gamma\frac{\partial^2}{\partial \mathrm{t}^2}\right)w\ = \left(1+\Gamma\frac{\partial}{\partial \mathrm{t}}\right)\left(\frac{\partial P}{\partial z}\right) \tag{14}$$

$$\frac{\partial u}{\partial \mathrm{x}} + \frac{\partial w}{\partial \mathrm{x}} = 0 \tag{15}$$

The boundary conditions for perturbations are

$$u = v = w \ = 0 \ \text{ at } \ x = 0{,}1 \tag{16}$$

where $M = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial z^2}$ and T_a is the Taylor number defined as Ta= ($R_1\Omega_0 d/\upsilon)\sqrt{d/R_1}$. Hereafter, we seek the solution of the system of equations (12--15) in terms of normal modes as

$$(u, v, w, p) = \left(\tilde{u}(\mathrm{x}, \mathrm{t}), \tilde{v}(x, t), \tilde{w}(x, t), \tilde{p}(x, t)\right) \exp(iqz) \tag{17}$$

where q is the axial wave number and i verifies $i^2 = -1$. Eliminating the pressure and the third component of velocity, the linearized equations governing the behavior of the eigenfunctions $\tilde{u}(\mathrm{x}, \mathrm{t})$ and $\tilde{v}(x, t)$ become

$$\left(\Delta - \frac{\partial}{\partial \mathrm{t}} - \Gamma \frac{\partial^2}{\partial \mathrm{t}^2}\right) \Delta \tilde{u} = 2q^2 \, T_a^2 \, \left(1 + \Gamma \frac{\partial}{\partial \mathrm{t}}\right) \mathrm{V_B} \, \tilde{v} \tag{18}$$

$$\left(\Delta - \frac{\partial}{\partial \mathrm{t}} - \Gamma \frac{\partial^2}{\partial \mathrm{t}^2}\right) \tilde{v} \ = \left(1 + \Gamma \frac{\partial}{\partial \mathrm{t}}\right) \left(\frac{\partial V_B}{\partial x}\right) \, \tilde{u} \tag{19}$$

where $\Delta = \frac{\partial^2}{\partial x^2} - q^2$. The boundary conditions of the system (18) – (19) are

$$\tilde{u} = \tilde{v} = \frac{\partial \tilde{u}}{\partial x} = 0 \quad \text{at} \ \ \mathrm{x} = 0{,}1 \tag{20}$$

The numerical approach used in this work was employed in the studies related to the instability of modulated flows [10-11-12-14]. The system of equations (18) and (19) is solved using the Floquet theory and then, the perturbed quantities are expanded in the form

$$(\tilde{u}, \tilde{v}) = \exp(\mu t) \sum_{n=-\infty}^{n=+\infty} \left(U_p(x), V_p(x)\right) \exp(in\sigma t) \tag{21}$$

The Floquet exponent $\mu = \mu_0 + i\mu_1$ is a complex number. Here, we aim to determine the marginal stability corresponding to harmonic solutions *i.e.* $\mu_0 = \mu_1 = 0$. Hereafter, the base flow is rewritten as

$$V_B = F(x) \exp(i\sigma t) + F^*(x) \exp(-i\sigma t) \tag{22}$$

where $\mathrm{F(x)} = \frac{1}{2}\left(\mathrm{V_1(x)} - \mathrm{iV_2(x)}\right)$ and the starred quantity means the complex conjugate. Introducing expressions (21) and (22) into the system (18)-(19), we obtain an infinite set of equations

$$(D^2 - q^2 - in\sigma + \Gamma n^2\sigma^2)(D^2 - q^2)U_n = 2q^2 {T^2}_a (1 + i\Gamma n\sigma)(FV_{n-1} + F^*V_{n+1}) \tag{23}$$

$$(D^2 - q^2 - in\sigma + \Gamma n^2\sigma^2)V_n = (1 + i\Gamma n\sigma)\left(\frac{dF}{dx}U_{n-1} + \frac{dF^*}{dx}U_{n+1}\right) \tag{24}$$

where $D = \frac{\mathrm{d}}{\mathrm{dx}}$ and the associated boundary conditions are

$$u_n = v_n = Du_n = 0 \quad \text{at} \ \ x = 0{,}1 \tag{25}$$

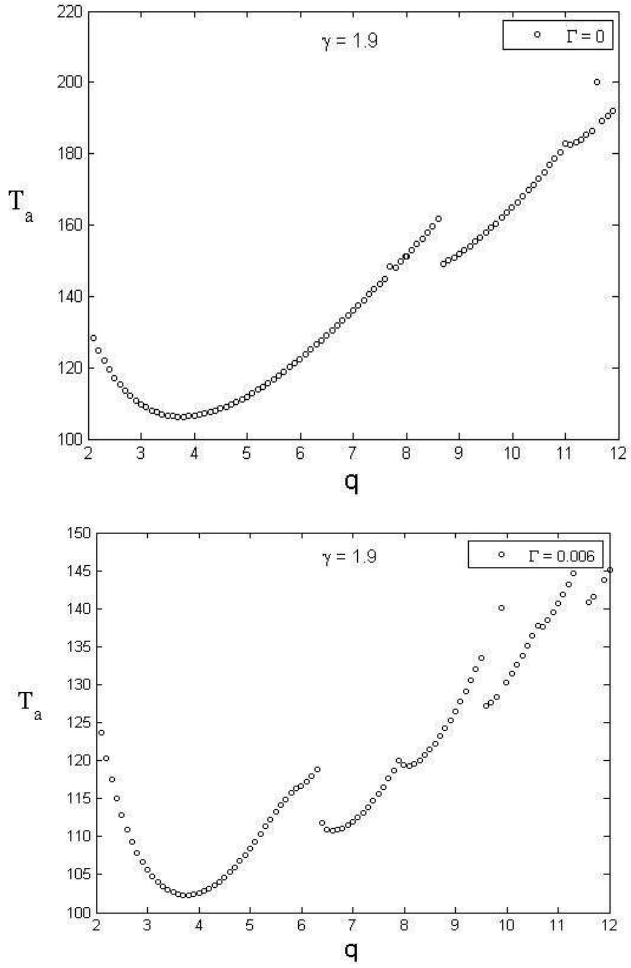
The system (23)-(24) is transformed into a set of first-order ordinary differential equations for the quantities, $\mathrm{U_n}$, $\mathrm{DU_n}$, $(\mathrm{D^2 - q^2})\mathrm{U_n}$, $\mathrm{D}(\mathrm{D^2 - q^2})\mathrm{U_n}$, $\mathrm{V_n}$ and $\mathrm{DV_n}$. A set of $3 + 6N$ independent solutions satisfying the boundary conditions (25) at $x = 0$ is constructed by a Runge-Kutta numerical scheme [14]. A linear combination of these solutions satisfying the boundary conditions (25) at the other extreme $x = 1$ leads to a homogeneous algebraic system for the coefficients of the combination. A necessary condition for the existence of nontrivial solution is the vanishing of the determinant which can be formally written as

$$F\left(\sigma, q, T_{a,}, \Gamma\right) = 0$$

For assigned values of the frequency number, σ, and Deborah number, Γ, the neutral curves $T_a(q)$ are obtained and then the critical Taylor and wave numbers, T_{ac} and q_c, are determined. The convergence of the numerical solutions depends greatly on the order N of the truncated Fourier series where $-N \leq n \leq N$. The number of modes N retained in the system (23)-(24) depends strongly on the frequency value. For instance, $N = 3$ and $N = 11$ are the orders of the Fourier series for high and low frequency respectively.

3 NUMERICAL RESULTS AND DISCUSSION

We investigate the effect of Deborah number on the onset of instability in a linear Maxwell fluid confined between two out-of-phase oscillating cylinders with the same amplitudes and frequency. Thereafter, this effect is analyzed by determining the critical parameters, Taylor and wave numbers, versus the parameter $\gamma = \sqrt{\frac{\sigma}{2}}$ in which σ is the dimensionless frequency of modulation. For instance, we show in Fig.2 the marginal stability curves when $\gamma = 1.9$ for different values of Deborah number. As one can see, the shape of these curves is affected by Deborah number and the number of minimums increases with this number. Also, one can note that the smaller value of these minimums corresponding to the critical Taylor number decreases when Deborah number weakly increases. This first observation confirms the destabilizing effect of Deborah number.



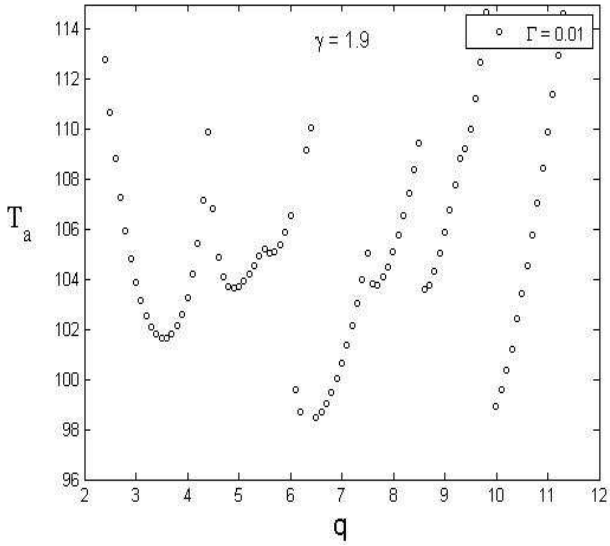


Fig. 2. ***Marginal stability curves for*** $\gamma = \sqrt{\frac{\sigma}{2}} = 1.9$ ***and for different values of Deborah number*** Γ.

The critical Taylor number versus the parameter γ is reported in Fig. 3 for different values of Deborah number. The numerical results in the case of a Newtonian fluid, $\Gamma = 0$, are compared to the numerical and experimental ones obtained in [5] and [11] and show an excellent agreement. As observed in Fig. 3, a change in the shape of the curves is revealed in the high frequency limit. Indeed, in contrast to the Newtonian fluid case, $\Gamma = 0$, where the critical Taylor number increases with the frequency number γ, we note that at $\Gamma = 0.001$, $\Gamma = 0.006$ and $\Gamma = 0.008$, the critical Taylor number varies independently on the frequency number and tends respectively to the values : $T_{ac} = 863.32$, $T_{ac} = 223.03$ and $T_{ac} = 198.25$. Furthermore, in the high frequency limit, the increase of Deborah number leads to a destabilization of the base flow. This destabilizing effect is observed for $\gamma > 1$ and becomes more pronounced as the frequency number increases. However, when the frequency number tends to zero, *i.e*. long period of modulation, the critical Taylor number reproduces quite well the classical Taylor-Couette solution corresponding to the steady rotation of the cylinders for a Newtonian fluid, $T_{ac} = 68.91$. In this frequency limit, the Deborah number has no effect on the critical Taylor number.

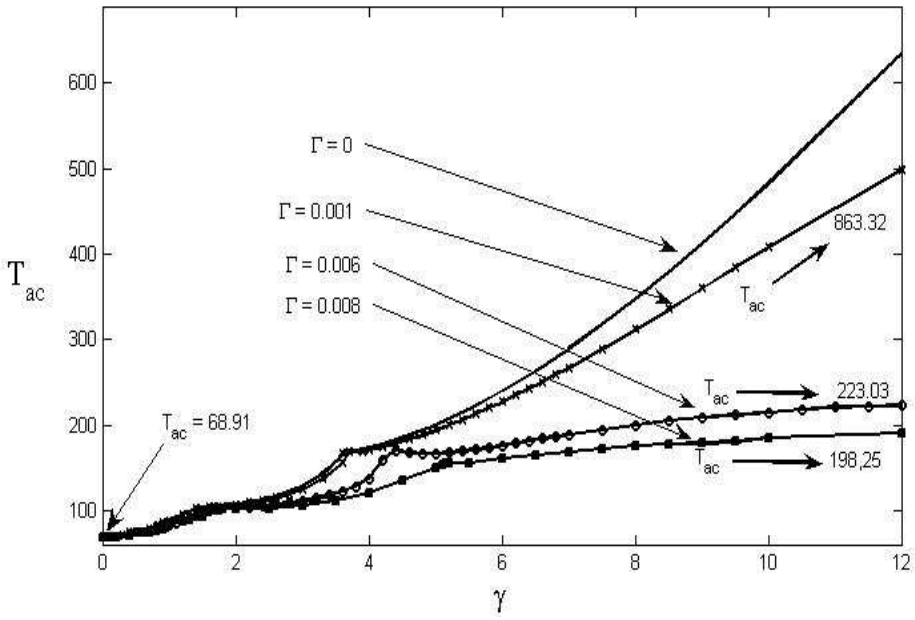


Fig. 3. ***Critical Taylor number versus the frequency number for different values of Deborah number*** Γ

The critical wave number versus γ is reported in Fig.3 for different values of Deborah number. The variation of q_c presents some discontinuities which occur at certain values of the parameter . The values of the parameter at which there are discontinuities, tend to shift toward to somewhat larger values.

In the low frequency limit, the critical wave number remains constant $q_c = 4$. This value corresponds to that of the classical Taylor-couette solution of a Newtonien fluid.

In the range of high frequency, the same behavior as that of the critical Taylor number occurs. For Γ = 0, the critical wave number increases versus the frequency number γ. However, we note that for $\Gamma = 0.001$ $\Gamma = 0.006$ and $\Gamma = 0.008$, the critical wave number becomes almost constant and takes respectevely the values depending only on $q_c = 16.2$, $q_c = 7$ and $q_c = 6.5$. Finally, one can notice that the critical wave number decreases with increasing the Deborah number.

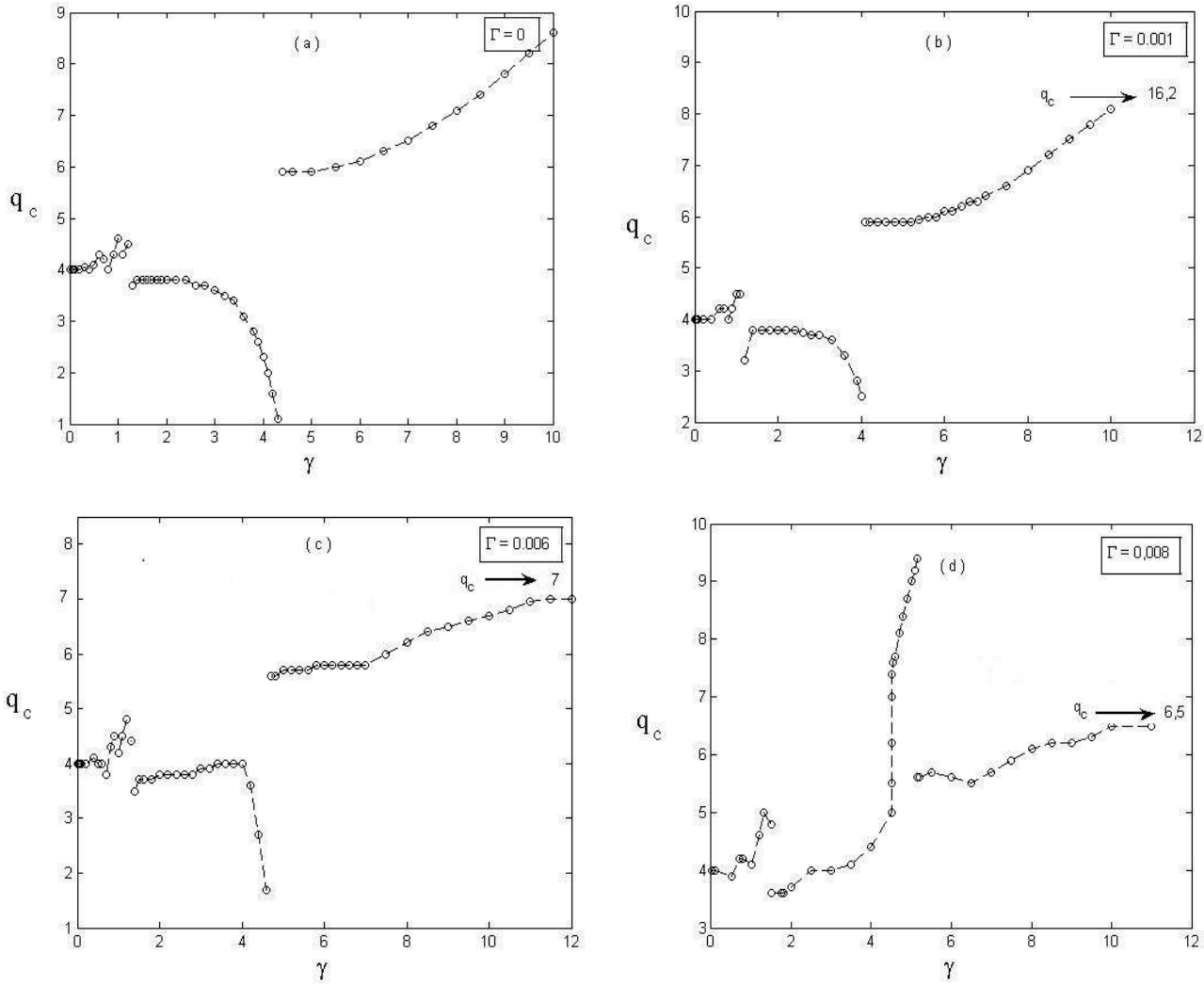


Fig. 4. Critical wave number versus the frequency number for different values of Deborah number Γ (a) : $\Gamma = 0$, (b) : $\Gamma = 0.001$, (c) : $\Gamma = 0.006$ (d) : $\Gamma = 0.008$

4 CONCLUSION

We have examined the linear stability of a pulsed flow of a viscoelastic fluid in the Taylor-Couette geometry when the outer and the inner cylinders are oscillating in out-of-phase with the same amplitude and frequency. We have focused on the effect of elasticity and frequency on the critical parameters, Taylor and wave numbers.

From a linear stability analysis, the numerical results have shown that at high frequencies, and in contrast to a Newtonian fluid, the critical Taylor and wave numbers are independent on the frequency number when Deborah number increases and the critical parameters tends to asymptotic values depending only on Deborah number. Furthermore, we have shown that

elasticity has a strong destabilizing effect. In this case only the spring will contribute to the total behavior in this frequency range. Decreasing the frequency number to intermediate frequency, the overall trend of the pulsed flow is toward more destabilization and the effect of elasticity is always destabilizing.

In the low frequency limit, the Maxwell fluid behaves as a Newtonian one and the critical Taylor number is given by $\boldsymbol{T_{ac} = 68.91}$ which correspond to the unmodulated case. In this situation, the spring connected in series with a dashpot could be removed from the rheological model and only the dashpot will contribute to the total behavior.

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The application of Plackett and Burman design in screening the parameters acting on the hydrodistillation process of Moroccan rosemary (*Rosmarinus officinalis* L.)

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ABSTRACT: Rosemary, *Rosmarinus officinalis* L., is an herb widely used throughout the world. It is, without doubt, one of the most popular plants in Morocco. For the purpose of examining the factors affecting the extraction of the essential oil of this plant by hydrodistillation, a screening study by Hadamard matrix type Plackett and Burman was conducted. After an appropriate choice of seven variables, sixteen experiments lead to a mathematical model of first degree connecting the response function (yield) to factors. Later than the realization of the experiments and data analysis, we concluded that six factors have a significant effect on the hydrodistillation process, namely: the extracting time, the individuality effect, the harvest period, the mass plant/water ratio, the drying of plant material and the temperature of heating. As for the cutting of plants, it presents a statistically negligible effect. Our study proved the great efficiency to applying the experiments design methodology for characterizing the operational parameters that affect the hydrodistillation. It is about a relevant and economical way which allows to obtain the maximum of information in a short time and, especially, with a minimum of experiments.

KEYWORDS: *Rosmarinus officinalis* L., hydrodistillation, screening, Plackett and Burman design, yield.

1 INTRODUCTION

The aromatic and medicinal plants represent a considerable value to the Moroccan economy [1]. Among these plants, *Rosmarinus officinalis* L. which represents all alone an annual production in essential oil estimated by seventy tonnes [2] It is one of the most widespread plants of the *Labiatae* family which contains a great quantity of essential oil (up to 1%) [3]. The oil has tonic stimulant properties; it is used as a pulmonary antiseptic, a choleretic and a colagoguic, it has also stomachic, antidiarrhoic, antirheumatic properties [4] and it is a strong antioxidant [5]. Thus, it is essential to understand the factors' effects which act on the process of hydrodistillation, and see their close link with the improvement of essential oil yield. To achieve this objective, we preceded by the application of the statistical techniques such as the experimental designs to make this improvement increasingly accessible. These methods, which allow the experimentation in a minimum number of experiments [6], give the opportunity to screen the factors from the most to the least influential, and also optimize the operating conditions to achieve the best possible result.

The use of experiments designs in the analysis and the optimization of the extraction of essential oil process was evoked by several authors. Some have used other types of designs such as complete factorial design [7], [8], [9], and others have passed directly to the optimization by using response surface methodology [10], [11].

In this article, we have made a screening of the factors acting on the operation of hydrodistillation of *Rosmarinus officinalis* L.. We have used the screening designs which are best known for factors with 2 levels: the Hadamard matrices or Plackett and Burman design [12]. The experimentation highlights the effects of some factors on the studied response [8]. The choice of screening design for our study instead of the complete factorial design is based on the number of the studied factors which is seven. This number, which is higher compared to the number of factors of the studies that have used a complete factorial design, will cause an increase in the number of experiments (2^7 = 128 experiments for seven factors). As for the response surface designs, they are generally used for the optimization. In our case, a screening design of Plackett and Burman type is more advocated. The objective of this study of screening is to determine the most important factors acting on hydrodistillation process of studied plant with a view to a more detailed study of parameters optimization. The optimization study will come into perspective and it will be concerned only with factors which are considered influential on the hydrodistillation process.

2 MATÉRIALS AND MÉTHODS

2.1 VEGETABLE MATERIALS

Rosmarinus officinalis L. plants were collected from the National Institute of Medicinal and Aromatic Plants garden in Taounat.

2.2 EXTRACTION MATERIALS

The apparatus used for the hydrodistillation is of the type Clevenger [13] according to the method recommended by the French Pharmacopoeia [14]. The process operates at the atmospheric pressure and is equipped with a recycling system, permitting the mass plant/water ratio to be maintained at its initial level. During every experiment, plant material and water were placed, in determined proportions, in a one liter capacity glass ball. The mixture was heated to boiling temperature and the liberated steams crossed up the column and passed out of the condenser in a liquid state. At the end of the distillation, two phases were observed, an aqueous phase (aromatic water) and an organic phase (essential oil), less dense than water. The obtained essential oil was dried over anhydrous sodium sulphate and was stored in the refrigerator at 4°C in dark glass bottles until use.

2.3 PLACKETT AND BURMAN DESIGN

Based on a process or phenomenon, the first problems which the experiments design can provide information about, are those of screening parameters. A screening study may be defined as a step for identifying rapidly, in a large number, those factors that are actually influential on a process in a fixed experimental field.

The most known matrices screening experiments are the matrices of Hadamard [15] or matrices of Plackett and Burman, for which the number of experiments is close to the numbers of the studied factors [16]. These designs are matrices with orthogonal columns composed only of values +1 or -1 [17]. These deigns are generally saturated and the mathematical model is a model without interactions [18].

The Plackett and Burman design is a fractional factorial design and the main effect (the contrast coefficient) of such a design may be simply calculated as the difference between the average of measurements made at the high level (+1) of the factor and the average of measurements made at the low level (-1). Contrast coefficients allow the determination of the effect of each factor. A large contrast coefficient either positive or negative indicates that a factor has a large impact on response; while a coefficient close to zero means that a factor has little or no effect [19].

2.4 EXPERIMENTAL DOMAIN OF FACTORS AND RESPONSES

The levels of factors were selected by taking into account the operating experimental limits, the literature data on hydrodistillation conditions [20], and the previous studies [7], [9], [10], [11], [21].

The factors that could affect the essential oil yield can be divided into two categories:

Continuous or quantitative factors:

- The extracting time varies between 150 and 210 minutes.
- The ratio between the vegetable material and water in the distillation flack: this factor varies between 1/12 and 1/4 (x 100g/100ml).
- The heating temperature of the flask which is directly related to the steam flow leaving the heated flask and hence in the flow of condensation. To test this parameter, two heating temperatures are used: 250 °C and 350 °C.

Qualitative factors:

- The harvest period of plant material which takes two modalities: the beginning of January and the end of June.
- The drying of the studied plants with both modalities: fresh plant and dried plant. The drying of the plant is done in the shade during eight days in a room in which the temperature is fixed at 25 °C.
- The effect of the change of the treated individual: we have studied two separate plants, so we have the modalities "Individual 1" and "Individual 2".
- The cutting of plants in small pieces before the hydrodistillation, which has the both modalities: entire plant and cut plant.

The table 1 shows the seven factors which were simultaneously studied to quantify the effect of each one on the hydrodistillation operation.

The studied response is an essential oil yield of *Rosmarinus officinalis* L. which results in the expression:

$$Y = Y_{HE}(\%) = \frac{M_{HE}}{M_s} \times 100$$

Where M_{HE} = essential oil mass (g), M_s = dry vegetal matter mass (g) and Y_{HE} = essential oil yield (%).

2.5 EXPERIMENTAL MATRIX

Since we have seven factors, the experimental design will be a matrix of eight experiments. For more precision, we have duplicated the chosen design, which thus leads to a matrix of sixteen essays. Three repetitions were carried out for each of the experiments.

2.6 MATHEMATICAL MODEL AND STATISTICAL ANALYSIS

The resulting mathematical model is a polynomial of order one as:

$$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + \varepsilon$$

With:

$Y = Y_{HE}$ (%) : yield of essential oil (response).

b_0 represents the average theoretical value of the response.

b_1, b_2, b_3, b_4, b_5, b_6 and b_7: Principal effects of coded factors X_1, X_2, X3, X_4, X_5, X_6 and X_7 respectively.

ε is an error term.

The statistical significance was checked by an F-test (analysis of variance) at the 95% significance level. The mean squares (MS) are obtained as follows:

$$MS = {}^{SS}/_{DF}$$

Where SS is the sum of squares of each variation source and DF is the respective degree of freedom.

The ratio between the mean square regression (MS_R) and the mean square residual (MS_r), $F_{ratio(R/r)}$, was used in order to establish whether the model was statistically significant [7]. The greater F value from unity adequately explains the variation of the data around its mean, in addition the estimated factor effects are real [22], [23].

The quality of fitting the first-order polynomial was also expressed by the coefficient of regression, R^2. The R^2 measures the proportion of total variation about the mean response explained by the regression, in fact it is the correlation between observed and predicted response and it is often expressed as a percentage by multiplying by 100 [25].

The model coefficients were considered significant for values of p <0.05. The statistical significance of the model coefficients was determined by using the t-test (only significant coefficients with p-value < 0.05 are included). During this study, we have used the conception and the treatment software of experiments design Nemrodw [25].

3 RESULTS

The observed response values with different combinations of seven studied variables are listed in Table 2.

3.1 STATISTICAL VALIDATION OF THE USED MODEL

According to the table of the analysis of variance (Table 3), we can conclude that the regression explains the studied phenomenon well since the significance of the risk (p_{value}< 0.0001) is lower than 0.05. Obviously, the calculation of $F_{Ratio(R/r)}$ which is equal to 89.96, has shown that it is 25 times higher than the value of $F_{(0.05;7,8)}$ at the 95% confidence level which is equal to 3,5. As a practical rule, a model has a statistical significance if the calculated F value is at least three to five times greater than the theoretical value [26].

The correlation coefficient R^2=98.7% is very sufficient. The value gives a good agreement between the experimental and predicted values of the adapted model.

These results are clearer on the graph (Figure 1) which shows that the curve of the observed values in term of the predicted values has perfectly the shape of a line.

3.2 STUDY OF THE FACTORS EFFECTS

The main effects of the seven studied variables are shown in table 4. Each coefficient is associated with the values of t and p value. The values of t are employed to determine the significance of the regression coefficients of each of the parameters and the values of p are defined as the lowest level of importance leading to the rejection of the null hypothesis [7]. In general, the more the magnitude of t is larger, the more the value of p is smaller, and the more the corresponding coefficient term is significant [27]. The value of the constant b_0 is equal to 1.75. This value does not depend on any factor.

The results show also that only the factor b_7, which is related to the cutting of plants, doesn't have any influence on the hydrodistillation operation, since the other six factors have a risk's signification inferior than 0.05. These results are clearer on the two graphs of the factors' effects (Figure 2).

3.3 FITTED MODEL

The statistical mathematical model that represents the response in terms of the most influential variables is:

$$Y = 1.75 + 0.028\,X_1 + 0.015\,X_2 + 0.06\,X_3 - 0.032\,X_4 - 0.038\,X_5 - 0.012\,X_6 + \varepsilon$$

The experimental error (ε) represents the residual standard deviation of the response. It can be calculated from the replications of the experiments and it has been found that it has the value of 0.014.

4 DISCUSSIONS

4.1 STATISTICALLY NEGLIGIBLE PARAMETERS

4.1.1 CUTTING OF PLANTS

For the cutting, we estimated that this factor have a large influence on the yield because it permits important surface contact to occur between the plant material and water, therefore facilitating the essential oil extraction process. Figure 3 shows that there is a small increase in yield in passing from the entire to cut leaves, However, the results obtained (table 4) revealed a weak effect of cutting and shows that this factor doesn't have any influence on the hydrodistillation operation, since the risk signification (0.3) is more than 0.05.

4.2 STATISTICALLY SIGNIFICANT PARAMETERS

4.2.1 EXTRACTING TIME

Both graphs show that the time (factor b_3) is the most influential factor on the hydrodistillation operation with a coefficient of 0.06. It contributed all alone by 48.78% in the variability of the studied response. Obviously, the time influences directly the hydrodistillation operation and its impact on such operation has been demonstrated by several authors [7], [9], [10], [11], [21].

4.2.2 INDIVIDUALITY EFFECT

The individuality effect is the second factor that affects the hydrodistillation operation with a negative coefficient of -0,038 and 20.35% of contribution in the variability of yield. The negative sign shows that the passage from the individual 1 to individual 2 in the realization of the experiments generates a decrease in the essential oil yield. This change from one individual to another can be explained by the stage of development of the plant organ (leaf, flower and fruit ontogeny) [28] or due to factors such as the plant age [29], [30], or even to genetic factors [30], [31].

4.2.3 VEGETABLE MATERIAL / WATER RATIO

The third factor that showed a significant influence on the yield is evidently the ratio between vegetable material and water in the distillation flask. This factor has a coefficient of -0.032 and a contribution of 14.31%. The minus sign indicates that the passage of the min level (the ratio 1/ 12) to the max level (the ratio 1/4) causes a fall in the essential oil yield. Several studies have shown that the increase in the ratio of vegetable material and water generates a decrease in yield [7], [8], [10]. This decrease can be explained by the fact that a high amount of plant material in the water prevents the water vapor formed in the bottom of the flask to be mounted in the tube of condensation which causes a reduction in yield [32].

4.2.4 HARVEST PERIOD

The harvest period comes in the fourth position with a coefficient of 0.028 and a contribution of 11.2%. This result indicates that the yield becomes more important at the end of June compared to the beginning of January. These results are in accordance with Moretti's ones [33] that indicated that summer is the best period for better exploiting the rosemary essences, and also those reported by other authors [34], [35] which show that the best essential oil yields of *Rosmarinus officinalis* L. are found in June.

4.2.5 DRYING

The fifth factor that had a significant effect on the studied response is the drying of plant with a coefficient of 0.015, a contribution of only 3.05%. Indeed, the study showed that the drying of the plant for a week causes an increase in the yield, which coordinates with the results found on rosemary [36], [37] which say that the drying in the shade induces a significant improvement in the obtained yield. This increase in the essential oil yield can be explained by an important physiological activity. The biosynthesis of essential oils continues and accelerates after the harvest of vegetable material in response to water stress [37], [38], [39].

4.2.6 HEATING TEMPERATURE

The last factor having a significant effect on the yield is the heating temperature, with a coefficient and a contribution of -0.012 and 2.12% respectively. Its growth leads to an increase in the flow of condensation. This increase has a negative effect on yield. Indeed, a big increase in the flow of condensation leads to a decrease of the residence time of the condensate in the decanter, and it does not leave time for essential oils to be separated from the liquid [40]. These results accord with those found by other authors [7], [8], [32].

5 TABLES AND FIGURES

Table 1. Parameter levels and coded values used in the experimental design

Factors	levels	Units	Coded variables	Coded levels
Harvest period	Biginning of January		X1	-1
	End of June			1
Drying	Fresh plant		X7	-1
	Dried plant			1
Extracting time	150	Min	X5	-1
	210			1
Mass plant/water ratio	1/12	x 100g/100ml	X4	-1
	1/4			1
Individuality effect	Individual 1		X2	-1
	Individual 2			1
Heating temperature	250°	°C	X6	-1
	350°			1
cutting of plants	Cut plants		X3	-1
	Entire plants			1

Table2. Experimental design of the hydrodistillation process of Rosmarinus Officinalis L. with the answers recorded for each experiment

N° of Experiment	Harvest period	Drying	Extracting time	Mass plant/water ratio	Individuality effect	Heating temperature	Cutting of plan	Y_{HE} (%)
1	1	1	1	-1	1	-1	-1	1,85
2	1	1	1	-1	1	-1	-1	1,87
3	-1	1	1	1	-1	1	-1	1,78
4	-1	1	1	1	-1	1	-1	1,8
5	-1	-1	1	1	1	-1	1	1,73
6	-1	-1	1	1	1	-1	1	1,7
7	1	-1	-1	1	1	1	-1	1,61
8	1	-1	-1	1	1	1	-1	1,63
9	-1	1	-1	-1	1	1	1	1,66
10	-1	1	-1	-1	1	1	1	1,67
11	1	-1	1	-1	-1	1	1	1,89
12	1	-1	1	-1	-1	1	1	1,89
13	1	1	-1	1	-1	-1	1	1,75
14	1	1	-1	1	-1	-1	1	1,77
15	-1	-1	-1	-1	-1	-1	-1	1,74
16	-1	-1	-1	-1	-1	-1	-1	1,72

Table 3. Analysis of variance for the fitted model

Source of variance	DF	Sum of squares	Mean square	F Ratio	p-value
R	7	0,118075	0,016868	89,96	<0,0001*
r	8	0,0015	0,000188		
Total	15	0,119575			
R^2	98,70%				

R: regression; r: residual; DF: degrees of freedom

Table 4. Estimated regression coefficients for the Plackett and Burman design

Name of parameter	Coefficient	Effect	Standard error	Ratio t	Prob
Constant	b0	1,75375	0,003423	512,3	<0,0001*
Harvest period	b1	0,02875	0,003423	8,4	<0,0001*
Drying	b2	0,015	0,003423	4,38	0,0023*
Extracting time	b3	0,06	0,003423	17,53	<0,0001*
Mass plant/water ratio	b4	-0,0325	0,003423	-9,49	<0,0001*
Individuality effect	b5	-0,03875	0,003423	-11,32	<0,0001*
Heating temperature	b6	-0,0125	0,003423	-3,65	0,0065*
Cutting of plan	b7	0,00375	0,003423	1,1	0,3

** Statistically significant for a level of confidence of 95%.*

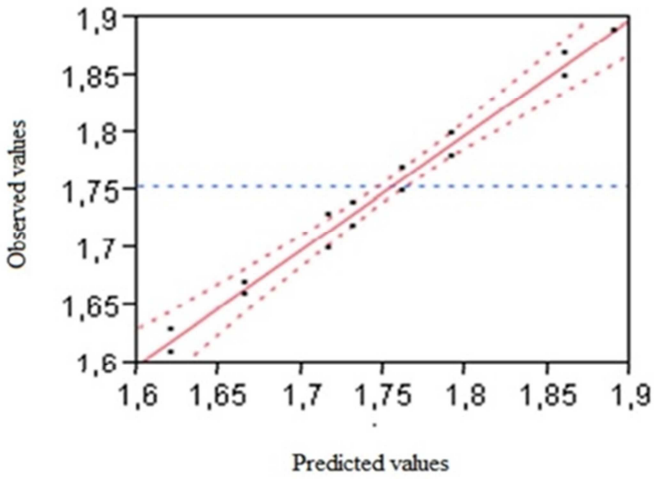


Fig. 1. Curve of the observed values in terms of the predicted values

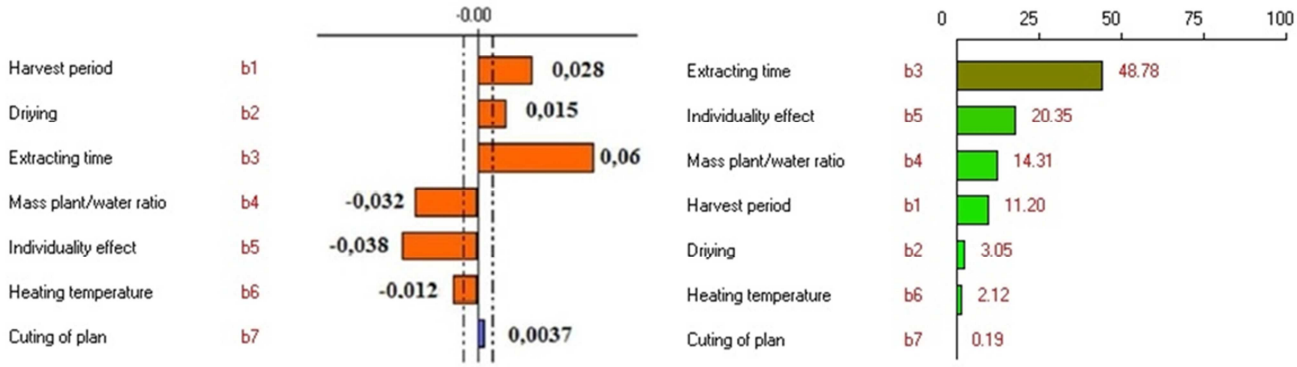


Fig. 2. On the Left graph of the factors effects, on the right graph which shows the percentage of contribution of each factor in the variation of the studied response

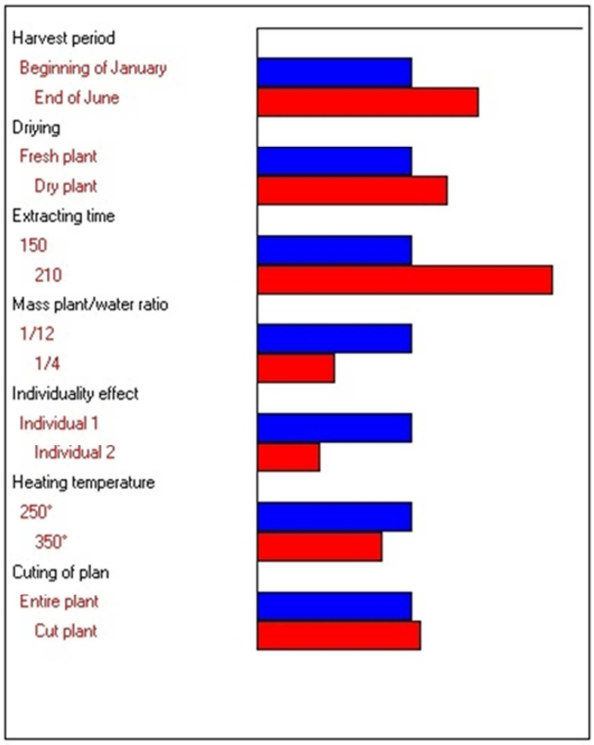


Fig. 3. Variation of the response (Y_{HE} (%)) in terms of the variation of each parameter

6 CONCLUSION

In this study, we were able to evaluate the effect of operating conditions on the essential oil yield of *Rosmarinus officinalis* L., by using as a strategy the experiments design methodology to get the maximum results with a minimum of experiments. The results show clearly that the experimental conception is an appropriate method for screening the factors affecting the hydrodistillation operation of the studied plant. The design of Plackett and Burman which was applied led to a first-order model whose statistically significant coefficients are related to the most influential factors on the response.

After the statistical validation of the obtained model, we passed to the analysis of effects. Thus, this model allowed, on one hand, to show that the Extracting time, the individuality effect, the ratio of vegetable material and water, the harvest period, the drying, and the heating temperature are all the factors which influence the hydrodistillation, having all a significant effect on yield (0.06, -0.038, 0.032, 0.028, 0.015, -0.012 respectively). On the other hand, it showed that although the cutting of the plants increases the exchange surface between water and the matter, this factor presents a negligible effect (approximately 0.003) and is not statistically significant on the essential oil yield.

To complete this study, an optimization study must be brought into play. It will seek the optimal operating conditions to have a better yield through using another type of experiments design developed for this type of study; namely, the response surface methodology by acting only on the continuous operating factors such as time processing, mass plant/water ratio, heating temperature, and the drying time.

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Density functional theory study on pressure induced structural transformation, elastic properties and electronic structure of gallium arsenide (GaAs)

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ABSTRACT: The structural phase transformation under induced pressure of the GaAs- zinc blende (ZB) phase to rock salt (RS) phase, elastic properties and electronic structure of the stable (ZB) phase are studied under the framework of the density functional theory (DFT). When pressure is increased up to 10.7 GPa, transition from the GaAs-ZB to GaAs-RS structure occurs and the dependence of volume decrease of ZB to RS structure at the transition pressure is 14.11%. The elastic parameters such as elastic constants C_{11}, C_{12}, C_{33}, Zener anisotropic factor (A), Kleinmann parameter (ζ), Poisson's ratio (υ), Youngs modulus (Y) and energy band gap of GaAs-ZB structure shows a systematic variation with increase in pressure upto transition pressure. The results are found to be in consistent with other experimental and theoretical results.

KEYWORDS: Density Functional Theory (DFT); Energy band structure; Elastic properties; Phase transition.

1 INTRODUCTION

Gallium arsenide (GaAs) is a group III-V binary compound semiconductor utilized in the electronics and telecommunications industries and in the military science [1, 2]. Gallium arsenide chips are found in products such as night vision telescopes, discrete microwave circuitry, and room temperature lasers. It is superior semiconductors to silicon for optoelectronic devices due to its ability to handle signals at higher frequencies, at the same time generate lower noise [3, 4]. It is the most technologically important compound semiconductor material which has been intensively investigated in recent years. The study of electronic and structural properties helps us to understand, characterize and predict the mechanical properties of materials in the surroundings under extreme conditions. This study plays an important role in physical condensed matter [5]. With technological development, study of structural properties, phase diagram and high pressure phases of GaAs has aroused considerable scientific interest in the past decades. Froyen and Cohen [6] first reported the structural phase of GaAs in 1983. The structural transformation in GaAs was also investigated by Besson *et al* [7] and Weir *et al* [8] using the single-crystal x-ray absorption spectroscopy and elastic neutron scattering. Studies on electronic structures, high-pressure properties have been reported by various groups [9-12]. In literature, works on the phase transformation, band structure, density of states (DOS) and elastic properties with variation of pressure is still rare. To the best of our knowledge none of the papers in open literature has considered the variation of energy band gap and elastic properties from the induced pressure perspective and investigated the behavior of the same with the available experimental data. The present paper is mainly focused on study of the phase transition from the zinc-blende to rocksalt structure, band structure

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and elastic properties of GaAs with increasing pressure using WEIN2K code based on DFT. This paper is organised as follows: Section 2 describes the theoretical and computational method used in this study. The results are discussed in section 3 and conclusions are given in section 4.

2 THEORETICAL AND COMPUTATIONAL METHOD

The calculation of GaAs has been performed with modified Becke-Johnson (mBJ) [13] exchange potential using full-potential linearised augmented plane wave (FP-LAPW) method [14] within the framework of density functional theory (DFT) [15, 16, 17] with Perdew-Bruke-Ernzerhof-Generalized Gradient Approximation (PBE-GGA) for the exchange correlation potential [18] as implemented in the WIEN2K code [19]. Within DFT formalism, the total energy can be expressed as a functional of density of electron system, ρ and can be written by the following functional,

$$E[\rho] = T_o[\rho] + V_H[\rho] + V_{xc}[\rho] + V_{ext}[\rho] \quad (1)$$

where, $T_o[\rho]$ is the kinetic energy of a non-interacting electron system, $V_H[\rho]$ and $V_{XC}[\rho]$ are the Hartree and exchange-correlation contributions to the energy and V_{ext} [ρ] is the energy due to the external potential of the system. Thus the corresponding Hamiltonian called the Kohn-Sham Hamiltonian is

$$\begin{aligned}\hat{H}_{KS} &= \hat{T}_o + \hat{V}_H + \hat{V}_{XC} + \hat{V}_{ext} \\ &= -\frac{\hbar^2}{2m_e}\vec{\nabla}^2{}_i + \frac{e^2}{4\pi\varepsilon_o}\int\frac{\rho(\vec{r}^{\,/})}{|\vec{r}-\vec{r}^{\,/}|}d\vec{r}^{\,/} + V_{XC} + V_{ext}\end{aligned} \quad (2)$$

The exact density of N electron system can be expressed in ground state by:

$$\rho(\vec{r}) = \sum_{i=1}^{N} \phi_i(\vec{r}) * \phi_i(\vec{r})$$

where the single particle wave functions $\phi_i(r)$ are the N lowest energy solutions of the Kohn Sham equation: $\hat{H}_{ks}\phi_i = \phi_i\phi_i$ of the N electron system.

These equations can be solved self consistently in an iterative process. In this method, the lattice is divided into non-overlapping spheres (called atomic or muffin tin sphere) surrounding each atomic sites and an interstitial region [20]. Inside the muffin tin (MT) region, the potential is a product of radial function and spherical harmonics and expanded up to order l = 10. For the interstitial regions that are outside the muffin tin spheres, the potentials are expanded in plane waves. 8000 k-points are used for the integration procedure as we find that above 8000 k-points the energy remains same and this 8000 k-points reduces to 256 irreducible k-points inside the Brillion zone including five high symmetry points W, L, Γ, X and K. Convergence is obtained at $R_{MT}K_{max}$ = 9.0 where R_{MT} is the atomic sphere radii and K_{max} gives the plane wave cut-off. The calculations are performed with the equilibrium lattice constants which are determined from the plot of the total energy against the unit cell volume by fitting to the Birch-Murnaghan equation of states [21].

3 RESULTS AND DISCUSSION

3.1 STRUCTURAL PROPERTIES

The total energy curve as a function of unit cell volume for GaAs in zinc-blende and rocksalt structure is shown in figure 1. It is clearly seen that ZB structure of GaAs is more stable than the RS structure which is in good agreement with previous results [22, 23, 24]. The obtained zero pressure equilibrium lattice constant (a_0) for GaAs-ZB structure is found as 5.74 A^o. This lattice constant corresponding to the optimized structure is slightly larger than experimental values as given in table 1. It has an error of about 1.8% which is quite acceptable under the 2% error and is used for further calculation. Thus the agreement between our result and other available theoretical and experimental data [25, 26, 27, 28, 29, 30] is well good indicating that our calculation can proceed for further study.

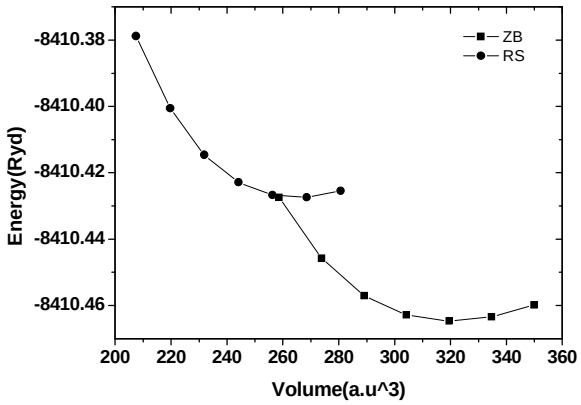


Fig.1. Energy versus volume for ZB and RS structure of GaAs.

Table 1. Lattice Constants, Bulk Modulus And Pressure Derivative Of Bulk Modulus Of ZB And RS Structure Of Gaas At Zero Pressure.

Structure		A_0 [A^0]	B_0 [Gpa]	B_0'
ZB	Present Work	5.74	61.08	4.86
	References	5.65[a], 5.64[b],5.59[c]	60.4[d],74.7[a]	4.8[e],4.71[c],4.56[f]
RS	Present Work	5.39	71.10	4.90
	References	5.32[g],5.31[h],5.28[i]	73.54[c],69.95[i]	4.05[c],4.77[g],4.87[i]

Ref[a] [22], Ref[25][B], Ref[26][C], Ref[27][D], Ref[28][E], Ref[29][F], Ref[23][G], Ref[24][H], Ref[30][I],

3.2 PHASE TRANSITION AND ELASTIC PROPERTIES

The zero temperature pressure induced phase transition between the GaAs-ZB structure and GaAs-RS structure has been determined using the usual condition of equal enthalpies i.e. H = E + PV. The enthalpy as a function of energy is shown in figure 2. The phase transition from ZB to RS structure is found to occur at a pressure of 10.7 GPa which is close to the experimental values [31, 32] and other theoretical results as shown in table 2.

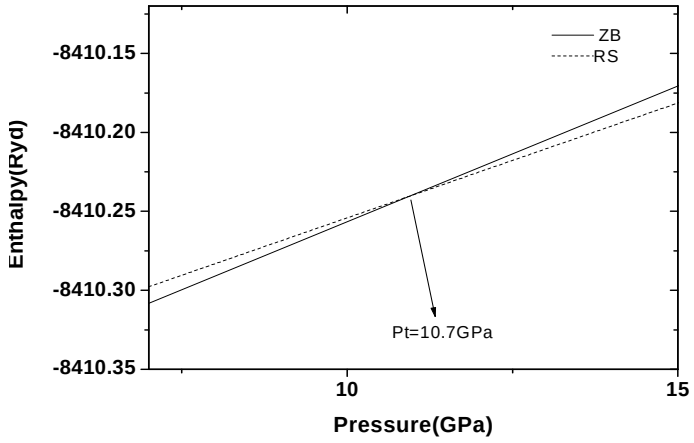


Fig.2. Enthalpy as a function of pressure.

Table 2. Transition pressure from ZB to RS in GaAs.

ZB-RS	Pressure [GPa]
Present work	10.7
Ref [7]	12±1.5
Ref [30]	10.5
Ref [31]	11.8
Ref [32]	12.3

To understand the volume collapse at the transition, the unit cell volume at different pressures (V_P) are normalised by dividing with volume at zero pressure (V_O). The normalised volume (Vp/Vo) of ZB and RS structure of GaAs at different pressure is shown in figure 3. With increase in pressure the relative volume is found to decrease for the two structures. During phase transition, the normalised volume of ZB phase is found to be occurring at 0.876 and for RS phase at 0.734. It is clearly seen that volume collapse occurs at 14.2% indicating that the ZB phase is more compressible than the RS phase.

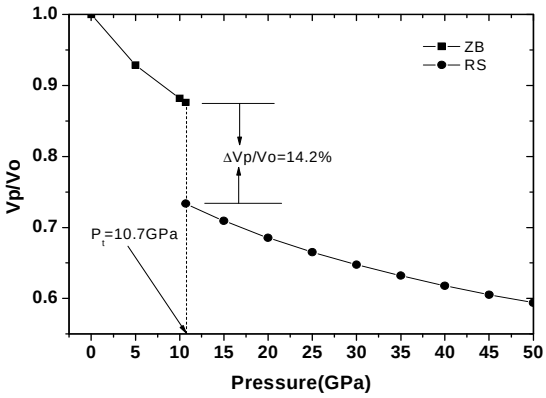


Fig. 3. Phase transition between ZB and RS structure of GaAs at 10.7 GPa pressure.

Since the transition pressure occurs at 10.7 GPa, the three independent observable elastic constants are obtained from 0 to 10 GPa pressure for ZB phase and 12 GPa to 25 GPa pressure for RS phase and is shown in figure 4. Figure 4 shows the linear increase in C_{11}, C_{12}, C_{44} value with increase in pressure for ZB phase. Also these values satisfy the mechanical stability conditions: $(C_{11}+2C_{12}) > 0$; $C_{11}C_{12} > 0$; $C_{44} > 0$; $C_{11} > 0$. In case of RS phase after transition pressure, even though there is a little variation in C_{44} value with linear increase in C_{11}, C_{12} values, and the stability conditions are found to be satisfied.

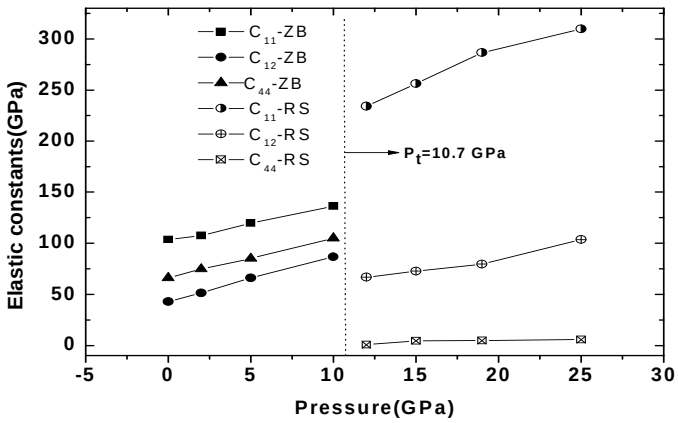


Fig. 4. Elastic constants (C_{11}, C_{12}, C_{44}) as a function of pressure for GaAs-ZB and GaAs-RS structure.

In this light of observations, we are confined our calculation for the elastic parameters on ZB structure up to a higher pressure of 10 GPa. The Zener anisotropic factor (A), Poisson's ratio (υ), Kleinmann parameter (ζ), Youngs modulus (Y), and Debye's temperature (θ_D) are important elastic parameters which determine the mechanical and thermal behaviour of a material.

The Zener anisotropic factor (A), Poisson's ratio (υ), Kleinmann parameter (ζ), Youngs modulus (Y) are calculated using the relation given by Mayer *et. al* [33]. The Zener anisotropy factor gives us an insight on the elastic isotropy of the material. For an elastically isotropic material, A = 1. If A > 1, it is stiffest along <111> plane body diagonals and when A < 1, it is stiffest along <100> cube axes. It is expressed as:

$$A = \frac{2C_{44}}{C_{11} - C_{12}} \tag{3}$$

Kleinmann parameter describes the relative position of the cation and anion sub-lattices and is given by the relation:

$$\zeta = \frac{C_{11} + 8C_{12}}{7C_{11} + 2C_{12}} \tag{4}$$

The Poisson's ratio gives us the stability of crystal against shear and provides a sharp criterion for differentiating the brittleness and ductility in solids and it is calculated using the relation,

$$\upsilon = \frac{1}{2}\left(\frac{B - (2/3)G}{B + (1/3)G}\right) \tag{5}$$

The Young's modulus is determined to measure the stiffness of the solid and is given by:

$$Y = \frac{9GB}{G + 3B} \tag{6}$$

where, $G = \frac{G_V + G_R}{2}$ is the isotropic shear modulus , G_v is the Voigt's shear modulus corresponding to the upper bound of G values, and G_R is the Reuss's shear modulus corresponding to the lower bound of G values. G_v and G_R can be expressed as

$$G_V = \frac{C_{11} - C_{12} + 3C_{44}}{5} \tag{7}$$

$$G_R = \frac{5(C_{11} - C_{12})C_{44}}{4C_{44} + 3(C_{11} - C_{12})} \tag{8}$$

Debye's temperature is an important parameter which determines the thermal characteristics of a material. Debye's temperature also gives us explicit information about lattice vibrations. It is calculated using the average sound velocity (υ_m) given by the common relation [34]

$$\theta_D = \frac{h}{k}\left[\frac{3n}{4\pi}\left(\frac{N_A\rho}{M}\right)\right]^{1/3}\upsilon_m \tag{9}$$

Where *h* is the Plank's constant, *k* is the Boltzmann constant, N_A is the Avogadro's number, *n* is the number of atoms per formula unit, *M* is the molecular mass per formula unit, *ρ* is the density and υ_m is given by [35]

$$\upsilon_m = \left[\frac{1}{3}\left(\frac{2}{\upsilon_t^3} + \frac{1}{\upsilon_l^3}\right)\right]^{-(1/3)} \tag{10}$$

where υ_t and υ_l are the transverse and longitudinal velocities respectively, which are obtained from Navier's equation [36] as

$$\upsilon_t = \sqrt{\frac{3B+4G}{3\rho}} \tag{11}$$

$$\upsilon_l = \sqrt{\frac{G}{\rho}} \tag{12}$$

The calculated elastic parameters for ZB phase with variation of pressure up to 10 GPa are shown in figure 5(a) and figure 5(b). A consistent pattern of linear increase in elastic parameters with increase in pressure can be observed from these figures.

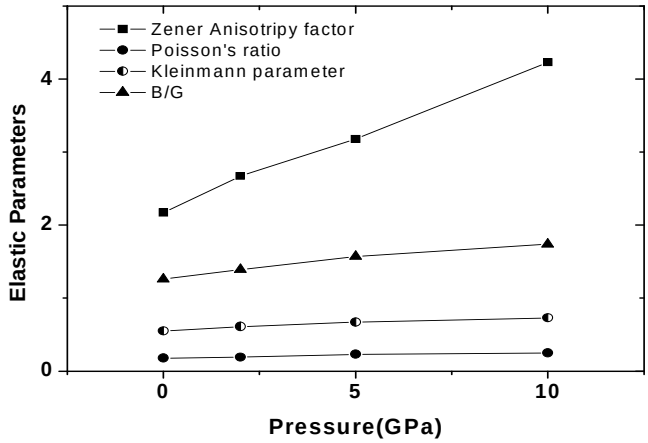


Fig. 5a. Elastic parameters (Zener anisotropic factor, Poisson's ratio, Kleinmann parameter and B/G ratio) as a function of pressure.

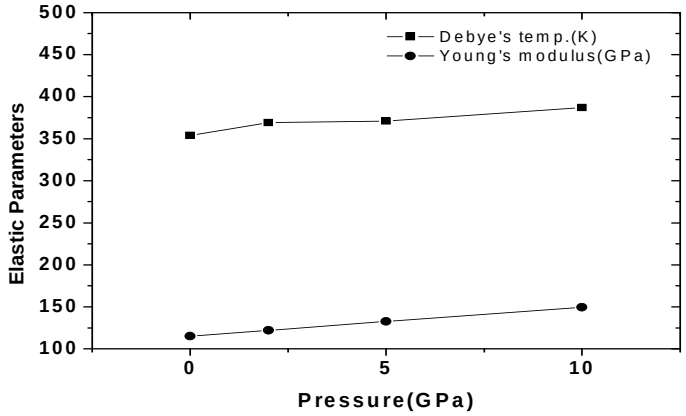


Fig. 5b. Debye's temperature and Young's modulus as a function of pressure.

The Kleimann parameter quantifies internal strain and thus indicates the relative ease of bond bending against the bond stretching. It also implies resistance against bond bending or bond angle distortion. In a system, minimizing bond bending leads to Kleinmann parameter, ζ = 0 and minimizing bond stretching leads to ζ =1. In the present study, the parameter ζ is found to be 0.55 to 0.73 with the variation of pressure, indicating the shrinkage in bond-stretching. Also the value of the Zener anisotropic factor varies from 2.17 to 4.23 with increase in pressure showing the degree of elastic anisotropy. The empirical malleability measure of a material is determined by the value of B/G [37]. A material is found to be brittle if B/G < 1.75 and ductile if B/G > 1.75. B/G value of the present studies varies from 1.26 to 1.74 with increase in pressure and hence it is found that GaAs-ZB structure is brittle and with increase in pressure it tends to become ductile. The larger the value of Young's modulus, the stiffer is the material and since the value of Y varies from 114.96 GPa to 149.456 GPa as pressure

increases, we find that GaAs-ZB pahse becomes more rigid. Poisson's ratio gives us the degree of directionality of the covalent bonds. For covalent materials, υ = 0.1, whereas for ionic materials, υ = 0.25 [38]. Our calculations show that with increase in pressure the value of υ varies from 0.18 to 0.25 showing that with increase in pressure the ionic contribution to inter atomic bonding becomes dominant. Fu *et al* [39] reported that for central force solids the lower and upper limits for υ are 0.25 and 0.5 respectively. Our values also indicates that as pressure increases, inter atomic forces tends to be more central. The value of Debye's temperature is also found to vary from 354K to 387K suggesting that with increasing pressure the Debye's temperature also increases indicating stiffer lattice and better thermal conductivity.

3.3 BAND STRUCTURE AND DENSITY OF STATES

The energy band diagram of GaAs-ZB structure and GaAs-RS structure at zero pressure and zero temperature is calculated using mBJ as it gives us more accurate results closer to the experimental values and the results are given in figure 6(a) and figure 6(b) respectively. From figure 6(a) we observed that the conduction band minimum as well as the valance band maximum is located at the middle of the Brillioun zone, Γ point. From these observations we can conclude that the band gap of GaAs-ZB structure is direct band gap with an energy band gap of 1.3eV while the experimental value is 1.4 eV. Again from figure 6(b) we find that the conduction band crosses the Fermi level and lies within the valance band making the GaAs-RS structure metallic in nature. The reason for the metallic nature in the RS structure is due to broadening of the band with increase in pressure and overlapping of the filled valance band and conduction band.

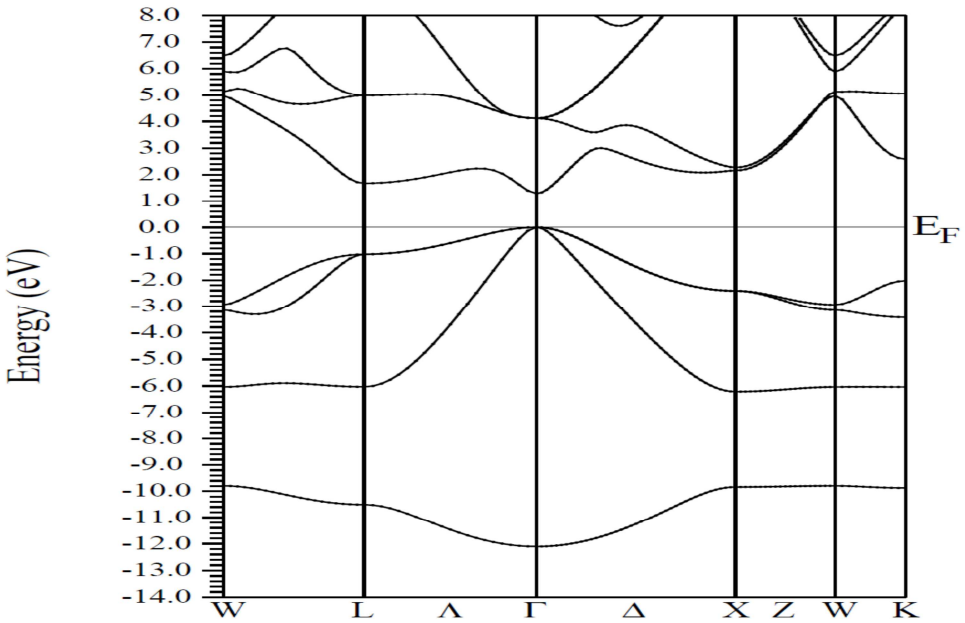


Fig. 6a. Band structure of GaAS-ZB structure.

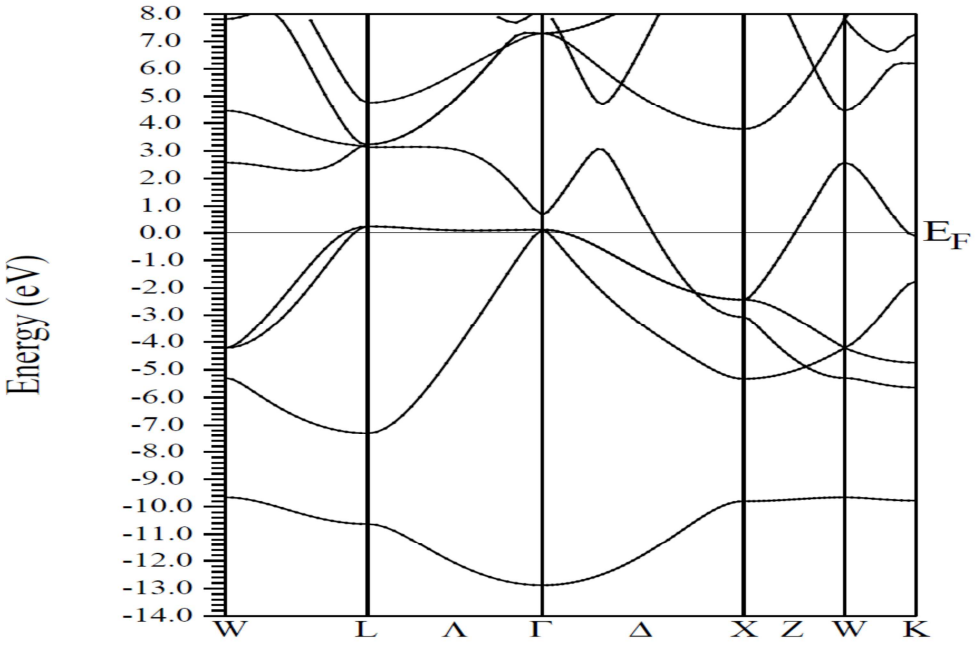


Fig. 6b. Band structure of GaAs-RS structure.

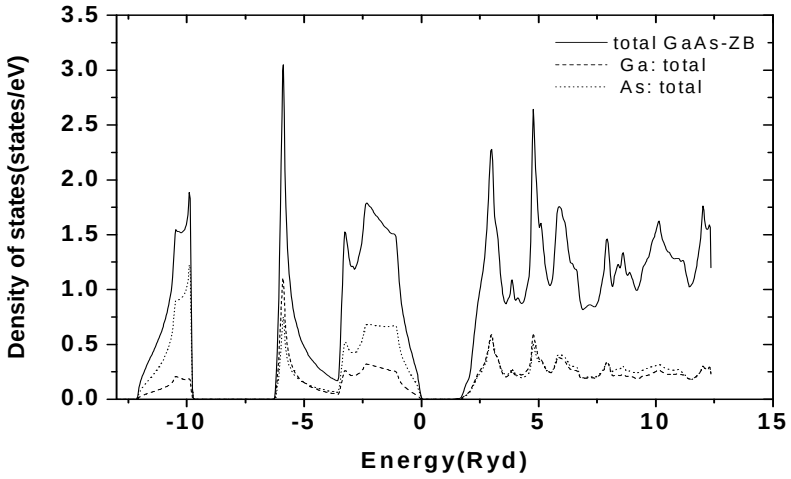


Fig. 7a. Total DOS of GaAs -ZB structure.

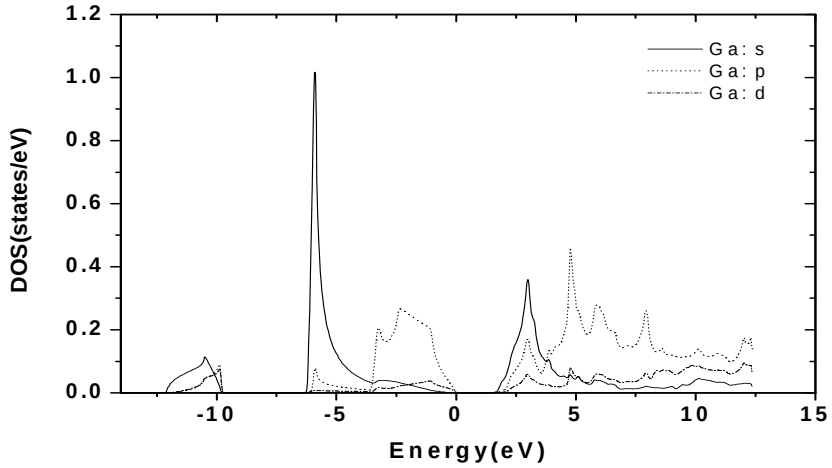


Fig. 7b. Partial DOS of Ga atom in GaAs-ZB structure.

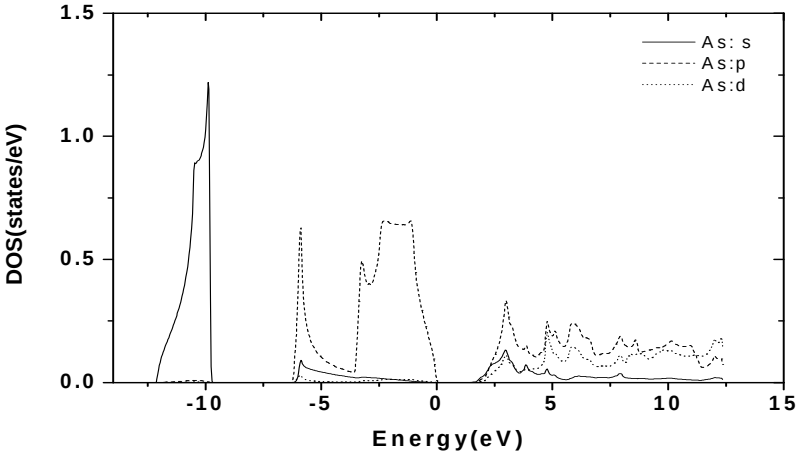


Fig. 7c . Partial density of As atom in GaAs-ZB structure.

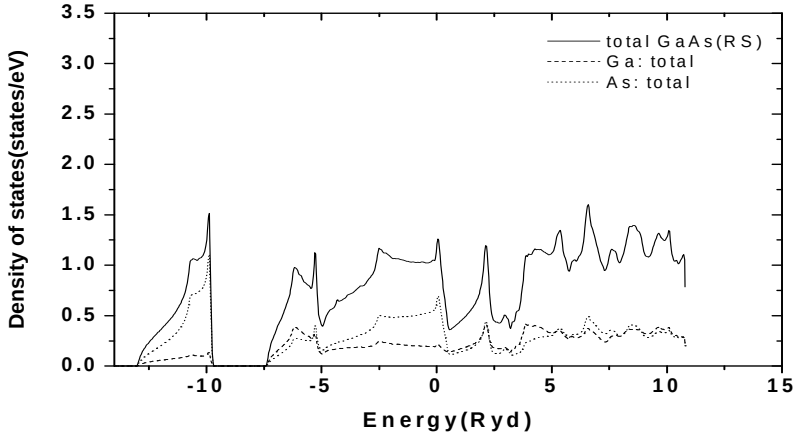


Fig. 8a. Total DOS of GaAs-RS structure.

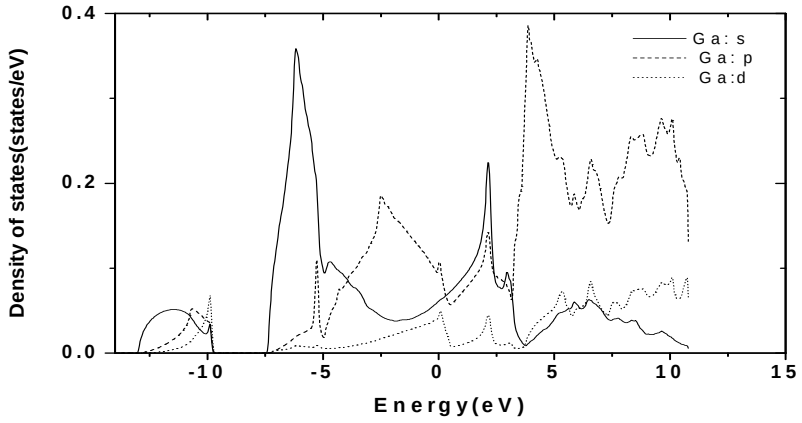


Fig. 8b. Partial DOS of Ga atom in GaAs-RS structure.

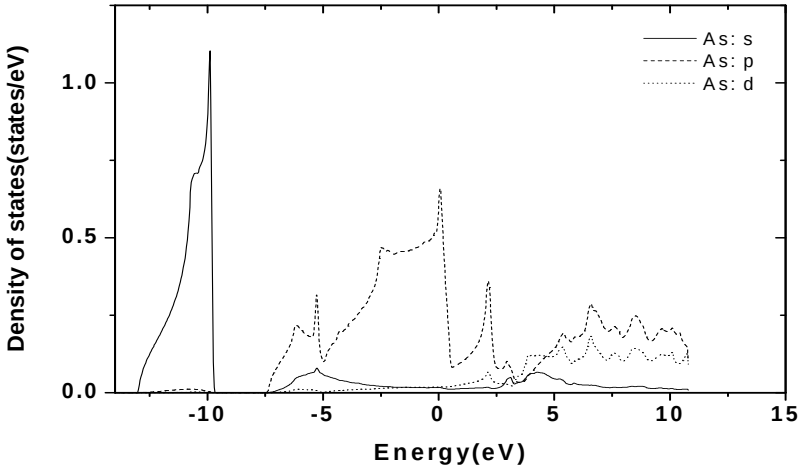


Fig. 8c. Partial DOS of As atom in GaAs-RS structure.

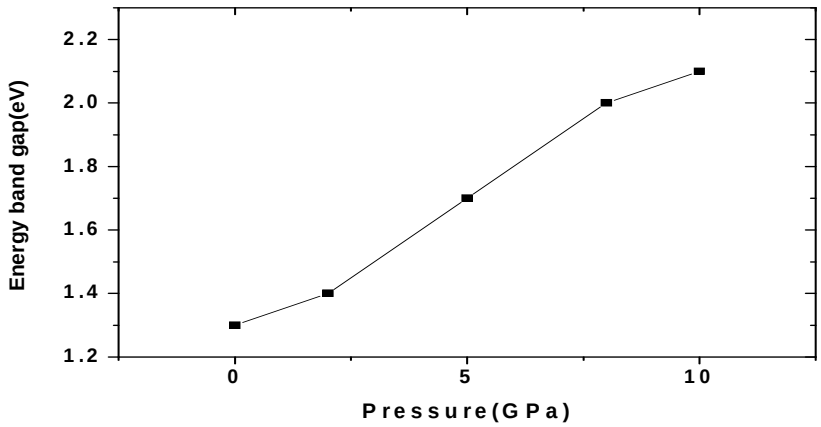


Fig. 9. Variation of energy band gap with pressure in GaAs ZB structure.

Figure 7(a,b,c) shows the total and partial DOS of GaAs in ZB phase and figure 8(a,b,c) shows the same in RS phase. From the partial DOS as shown in figure 7(b) and figure 7(c), one can observe that the lowest band appears in energy band diagram of ZB phase is mainly contributed from s-non metal (As atom) orbital and the valance band is mainly contributed by the s-metal (Ga atom) orbital and p-non metal (As atom) orbital with little contribution from the p-metal (Ga atom) orbital. The contribution of the s, p orbital of metal and non-metal in DOS in the lowest and valence band is found to decrease with increase in pressure. Similar behaviour is observed in partial DOS of GaAs-RS structure in figure 8(b) and figure 8(c) as the lowest band is mainly contributed by the s-non metal orbital while the valence band is mainly contributed by the p-non metal orbital and s- metal orbital with little contribution from the p-metal and d-metal orbital. An important observation in the energy band diagram of GaAs-RS structure is the crossing of the conduction band towards valence band and hence results in metalic nature. It is interesting to see the variation of band gap with pressure for the direct band gap in GaAs-ZB phase. These variations of the energy band gap with increase in pressure is shown in figure 9 and observe that with increase in pressure the band gap also increases. The resaon is that the energy eigenvalues corresponding to s, p, and d orbital's lies in the higher region with increasing pressure.

4 CONCLUSION

In this paper we present a detailed study of pressure induced structural transformation, elastic properties and electronic structure of GaAs. The phase transition from ZB to RS structure is obtained at 10.7 GPa and ZB structure is found to be more stable. During the phase transition, the relative volume of ZB structure occurs at 0.876 and the RS structure at 0.734 and volume collapses at 14.2% indicating that ZB structure of GaAs is more compressible as compared to RS structure. The calculated equilibrium lattice parameter, bulk modulus, pressure derivative of the bulk modulus and elastic constants are found to be in good agreement with the other experimental and theoretical studies. The elastic constants satisfy the mechanical stability condition from 0 to 10 GPa pressure for ZB structure and 12 GPa to 25 Gpa pressure for RS structure. The elastic parameters for the stable GaAs-ZB phase such as Zener anisotropic factor, Kleinmann parameter, Poisson's ratio and Youngs modulus show a systematic variation with increase in pressure up to 10 GPa pressure before transition. The GaAs-ZB structure is found to be direct band gap semiconductor of 1.3 eV and the band gap increases with increase in pressure.

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Biomagnetic Steady Flow through an Axisymmetric Stenosed Artery

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ABSTRACT: The steady slip flow assuming blood as the Casson fluid has been studied under the influence of transverse magnetic field. The results for the axial velocity, plug flow velocity, flow flux and the wall shear stress have been analyzed analytically and graphically taking suitable parameters. The analysis shows that the axial velocity, plug flow velocity and the flow flux increase along axial distance as the pressure gradient, magnetic field gradient and slip velocity increase but they decrease when the stenosis height increases. Also the wall shear stress showing fluctuations increase in z – direction when the pressure gradients, magnetic field gradient, slip velocity and the stenosis height increase. It also increases radially when magnetic field gradient increases but it decreases when the slip velocity increases.

KEYWORDS: Casson Fluid; Constricted Artery; Slip Boundary Condition; Yield Stress, Magnetic Flow.

1 INTRODUCTION

Many medical research works have so far proved this fact that the narrowing of the blood vessels is causing serious disorders in blood circulations which sometimes lead to the heart failures. It has been observed that the initial deposits of lipids at the sub-endothelial space and then extra addition of macrophages become fibrous in due course of time which creates the cardiovascular problems. So far a number of mathematical models taking different blood features have been proposed to study the rheology of blood. The magnetic aspect of blood has always been an interesting topic of research for the research workers. Since the hemoglobin present in the mature blood cells is a form of iron-oxides, therefore the blood behaves as a biomagnetic fluid. Some research workers have worked on the magnetic property of blood flow under stenotic conditions.

D.F. Young [1] studied the effect of an axially symmetric time-dependent stenotic growth into the lumen of a tube of constant cross-section over the steady flow by taking the blood as a Newtonian fluid. P.K. Suri et al. [2] presented a mathematical simulation of blood flow through branched arteries under transverse magnetic field and observed that the applied magnetic field reduces the strength of blockage at the apex of bifurcation. J.C. Mishra et al. [3] studied the flow through stenosed arteries. J.C. Mishra et al. [4] used the momentum integral method to study flow characteristic of blood through stenosed vessel. K. Haldar et al. [5] studied the effect of magnetic field on blood flow through indented tube in the presence of erythrocytes. V. P. Srivastava [6] dealt with the problem of stenotic blood flow taking blood as a particle-fluid suspension model and observed that the magnitudes of blood flow characteristics significantly increase with increase in red cell concentration. H.P. Mazumdar et al. [7] investigated some flow characteristics of a Newtonian fluid under effect of magnetic field through a circular tube.

Y. Haik et al. [8] studied the apparent additive viscosity of human blood because of a high static magnetic field and showed that the blood flow under gravity reduces by 30% when it is kept under high magnetic field of 10 T. J.C. Mishra et al. [9] gave a numerical model to study the effect of magnetic field on blood flow through an artery. S. Kenjeres [10] analyzed blood flow numerically in realistic arteries subjected to strong non-uniform magnetic fields. L. Parmar et al. [11] investigated the role of magnetic field intensity in Herschel – Bulkley blood flow through overlapping stenosed artery. Gaur and Gupta

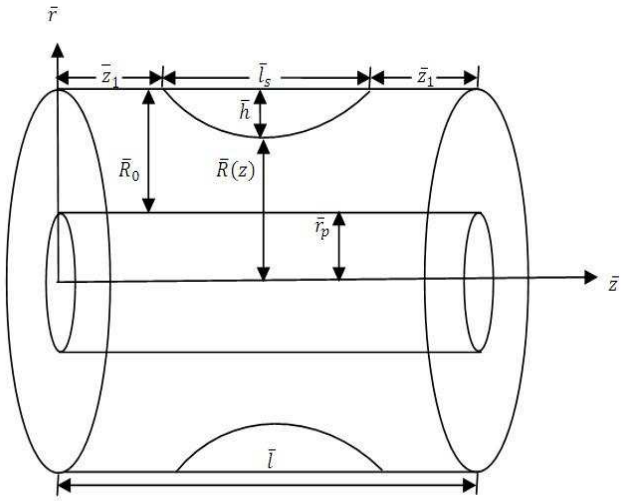
Corresponding Author: Manoj Kumar Gupta

[12] discussed a Casson fluid model to study the steady flow through a stenosed blood vessel in which the authors explained that the axial velocity, volumetric flow rate and pressure gradient increase with the increase in slip velocity and decrease with growth in yield stress. Gaur and Gupta [13] also studied the slip effects on steady flow through a stenosed blood artery and found that axial velocity, volumetric flow rate and pressure gradient decrease along the radial distance as the slip length increases but the wall shear stress increases with increase in slip length.

2 MATHEMATICAL FORMULATION

Let the blood flow be steady, laminar and incompressible through an axially symmetric stenosed cylindrical artery in z – direction.

The geometrical diagram of the stenosed artery is given below:



Let $\bar{R}_0$ be the radius of the normal tube and $\bar{R}(\bar{z})$ is the radius of the constricted area given by (Young, 1968):

$$\bar{R}(\bar{z}) = \begin{cases} \bar{R}_0 - \frac{\bar{h}}{2}\left[1 + \cos\frac{2\pi}{\bar{l}_s}\left(\bar{z}_1 + \bar{l}_s - \bar{z}\right)\right]; & \bar{z}_1 \le \bar{z} \le \bar{z}_1 + \bar{l}_s \\ \bar{R}_0 \quad ; \text{ otherwise} \end{cases} \tag{2.1}$$

Where $\bar{l}_s$ is the length of the stenosis in the artery of the length $\bar{l}$, $\bar{z}_1$ is the location of the stenosis of maximum height $\bar{h}$. Also, let $\bar{r}$ and $\bar{z}$ be radial and axial coordinates.

Here the blood is considered to behave as a Casson fluid under the effect of an externally applied uniform transverse magnetic field which generates a motion due to which the fluid particles are attracted towards the magnetic field.

Under the above considerations, the equations of motion in the dimensional form are:

$$-\frac{\partial \bar{p}}{\partial \bar{z}} + \frac{1}{\bar{r}}\frac{\partial}{\partial \bar{r}}(\bar{r}\bar{\tau}_c) + \epsilon_0 M\frac{\partial \bar{B}}{\partial \bar{z}} = 0 \tag{2.2}$$

$$\frac{\partial \bar{p}}{\partial \bar{r}} = 0 \tag{2.3}$$

Where $\bar{p}$ denotes pressure at any point, ϵ_0 magnetic permeability, M magnetization and $\bar{B}$ represents the magnetic field intensity. Also $\bar{\tau}_c$ denotes the shear stress of the fluid. Casson fluid has the following simplified constitutive equations:

$$F(\bar{\tau}_c) = -\frac{\partial \bar{v}_c}{\partial \bar{r}} = \frac{1}{\bar{k}_c}\left(\bar{\tau}_c^{1/2} - \bar{\tau}_0^{1/2}\right)^2 \text{ for } \bar{\tau}_c \ge \bar{\tau}_0 \tag{2.4}$$

$$\frac{\partial \bar{v}_c}{\partial \bar{r}} = 0 \qquad \text{for } \bar{\tau}_c \le \bar{\tau}_0 \tag{2.5}$$

where $\bar{v}_c$ is the axial velocity of the blood, $\bar{\tau}_0$ represents the yield stress and $\bar{k}_c$ is the fluid viscosity.

The equations (2.2) to (2.5) are subject to the following boundary conditions:

$$\left.\begin{aligned} \bar{v}_c &= \bar{v}_s \quad \text{at } \bar{r} = \bar{R}(\bar{z}) \\ \bar{\tau}_c &= \text{Finite value} \quad \text{at } \bar{r} = 0 \end{aligned}\right\} \tag{2.6}$$

where $\bar{v}_s$ denotes the slip velocity along z – axis.

Let us introduce the following non – dimensional variables as

$$R(z) = \frac{\bar{R}(\bar{z})}{\bar{R}_0},\ z = \frac{\bar{z}_1 + \bar{l}_s - \bar{z}}{\bar{l}_s},\ r = \frac{\bar{r}}{\bar{R}_0},\ \tau_c = \frac{\bar{\tau}_c}{\bar{p}_0 \bar{R}_0/2},\ \tau_0 = \frac{\bar{\tau}_0}{\bar{p}_0 \bar{R}_0/2},\ v_c = \frac{\bar{v}_c}{\bar{p}_0 \bar{R}_0^2/2\bar{k}_c},\ v_s = \frac{\bar{v}_s}{\bar{p}_0 \bar{R}_0^2/2\bar{k}_c},$$

$$H = \frac{\bar{h}}{\bar{R}_0},\ B = \frac{\bar{B}}{\bar{B}_0},\ \frac{\partial p}{\partial z} = \frac{\partial \bar{p}/\partial \bar{z}}{\bar{p}_0} \tag{2.7}$$

Here $\bar{p}_0$ is the steady – state amplitude and $\bar{B}_0$ represents the external transverse uniform constant magnetic field.

Under the above non – dimensional conditions, the radius of the stenotic area of the artery becomes

$$R(z) = \begin{cases} 1 - H\cos^2 \pi z\,; & 0 \le z \le 1 \\ 1 & ;\ \text{otherwise} \end{cases} \tag{2.8}$$

The dimensionless forms of equations (2.2) to (2.5) are

$$-2\frac{\partial p}{\partial z} + \frac{1}{r}\frac{\partial}{\partial r}(r\tau_c) - C\frac{\partial B}{\partial z} = 0 \tag{2.9}$$

$$\frac{\partial p}{\partial r} = 0 \tag{2.10}$$

$$-\frac{\partial v_c}{\partial r} = (\tau_c^{1/2} - \tau_0^{1/2})^2 \quad \text{for } \tau_c \ge \tau_0 \tag{2.11}$$

$$\frac{\partial v_c}{\partial r} = 0 \quad \text{for } \tau_c \le \tau_0 \tag{2.12}$$

$$\text{where } C = \frac{2\epsilon_0 M \bar{B}_0}{\bar{p}_0 \bar{l}_s} \tag{2.13}$$

The non – dimensional boundary conditions are

$$\left.\begin{aligned} v_c &= v_s \quad \text{at } r = R(z) \\ \tau_c &= \text{Finite value} \quad \text{at } r = 0 \end{aligned}\right\} \tag{2.14}$$

Using condition (2.14) in equation (2.9), the shear stress τ_c and wall shear stress τ_R can be written as

$$\tau_c = \frac{r}{2}\left(2\frac{\partial p}{\partial z} + C\frac{\partial B}{\partial z}\right) \tag{2.15}$$

$$\tau_R = \frac{R}{2}\left(2\frac{\partial p}{\partial z} + C\frac{\partial B}{\partial z}\right) \tag{2.16}$$

From equations (2.14) and (2.15),

$$\frac{\tau_c}{\tau_R} = \frac{r}{R} \tag{2.17}$$

3 METHOD OF SOLUTION

Thus velocity in the region $r_p \le r \le R(z)$ is obtained by integrating equation (2.11) using conditions (2.14) and (2.15) where $r_p = \frac{\bar{r}_p}{R_0}$ is the non – dimensional radius of the plug flow region, given as

$$v_c = v_s + \frac{1}{\left(2\frac{\partial p}{\partial z}+C\frac{\partial B}{\partial z}\right)}\left[\left(\tau_R^{1/2}-\tau_0^{1/2}\right)^4 + \frac{4}{3}\tau_0^{1/2}\left(\tau_R^{1/2}-\tau_0^{1/2}\right)^3 - \left(\tau_c^{1/2}-\tau_0^{1/2}\right)^4 - \frac{4}{3}\tau_0^{1/2}\left(\tau_c^{1/2}-\tau_0^{1/2}\right)^3\right] \quad (3.1)$$

Within plug flow region i.e. $0 \le r \le r_p$, $\tau_c = \tau_0$ at $r = r_p$, therefore the plug flow velocity is

$$v_c = v_s + \frac{1}{\left(2\frac{\partial p}{\partial z}+C\frac{\partial B}{\partial z}\right)}\left[\left(\tau_R^{1/2}-\tau_0^{1/2}\right)^4 + \frac{4}{3}\tau_0^{1/2}\left(\tau_R^{1/2}-\tau_0^{1/2}\right)^3\right] \quad (3.2)$$

Now the volumetric flow rate in the dimensionless form for the region $0 \le r \le R(z)$ can be obtained as

$$Q = 4\int_0^R rv(r)dr$$

$$= 4\int_0^{r_p} rv_p dr + 4\int_{r_p}^R rv_c dr$$

Hence

$$Q = 2R^2 v_s + \frac{R^2}{\left(2\frac{\partial p}{\partial z}+C\frac{\partial B}{\partial z}\right)}\left[2\left(\tau_R^{1/2}-\tau_0^{1/2}\right)^4 + \frac{4}{3}\tau_0^{1/2}\left(\tau_R^{1/2}-\tau_0^{1/2}\right)^3\right] + \frac{R^2}{\left(2\frac{\partial p}{\partial z}+C\frac{\partial B}{\partial z}\right)\tau_R^2}\left[\tau_R^4 - \frac{2}{3}\tau_R^2\tau_0^2 + \frac{8}{3}\tau_R^3\tau_0 - \frac{64}{21}\tau_R^{7/2}\tau_0^{1/2} + \frac{1}{21}\tau_0^4\right] \quad (3.3)$$

If $\tau_0 \ll \tau_R$ i.e. $\frac{\tau_0}{\tau_R} \ll 1$, then equation (3.3) reduces to the form

$$Q = 2R^2 v_s + \frac{R^2\tau_R}{\left(2\frac{\partial p}{\partial z}+C\frac{\partial B}{\partial z}\right)}\left(\tau_R - \frac{16}{7}\tau_0^{1/2}\tau_R^{1/2} + \frac{4}{3}\tau_0\right) \quad (3.4)$$

which also gives us the wall shear stress for the stenosed artery as

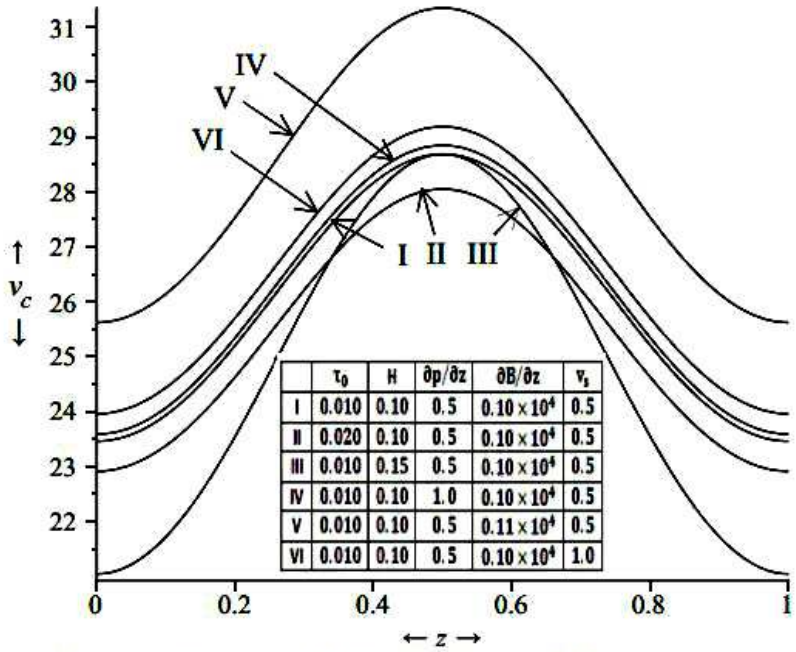
$$\tau_R = \left[\frac{8}{7}\tau_0^{1/2} + \left\{\frac{r\left(Q-2R^2 v_s\right)}{R^3\tau_c}\left(2\frac{\partial p}{\partial z} + C\frac{\partial B}{\partial z}\right) - \frac{4}{147}\tau_0\right\}^{1/2}\right]^2 \quad (3.5)$$

If there is no stenosis i.e. $R(z) = R_0$ then the wall shear stress for the non – constricted artery is given as

$$\tau_N = \left[\frac{8}{7}\tau_0^{1/2} + \left\{\frac{r\left(Q-2R_0^2 v_s\right)}{R_0^3\tau_c}\left(2\frac{\partial p}{\partial z} + C\frac{\partial B}{\partial z}\right) - \frac{4}{147}\tau_0\right\}^{1/2}\right]^2 \quad (3.6)$$

4 RESULTS AND DISCUSSION

The velocity profile for the axial velocity in the non – plug flow region has been obtained in equation (3.1) and the graphical discussions of the results are given in figures 1(a) and 1(b).



	τ_0	H	∂p/∂z	∂B/∂z	v_s
I	0.010	0.10	0.5	0.10×10^4	0.5
II	0.020	0.10	0.5	0.10×10^4	0.5
III	0.010	0.15	0.5	0.10×10^4	0.5
IV	0.010	0.10	1.0	0.10×10^4	0.5
V	0.010	0.10	0.5	0.11×10^4	0.5
VI	0.010	0.10	0.5	0.10×10^4	1.0

Figure 1 (a): Variation of Axial Velocity Along Axial Distance for Different Values of the Stenosis Height *H*, pressure gradient $\frac{\partial p}{\partial z}$, Magnetic Field Gradient $\frac{\partial B}{\partial z}$, Yield Stress τ_0 and Slip Velocity v_s.

Figure 1(a) gives the variations of the axial velocity versus axial distance for the different values of the stenosis height H, pressure gradient $\frac{\partial p}{\partial z}$, magnetic field gradient $\frac{\partial B}{\partial z}$, yield stress τ_0 and slip velocity v_s with some fixed value $\tau_c = 0.030$. It is observed that the axial velocity first increases achieving a maximum value at the peak of the stenosis and then starts decreasing along the axial distance. Also the axial velocity increases with an increase in slip velocity, pressure gradient and magnetic field gradient but it decreases when the yield stress increases.

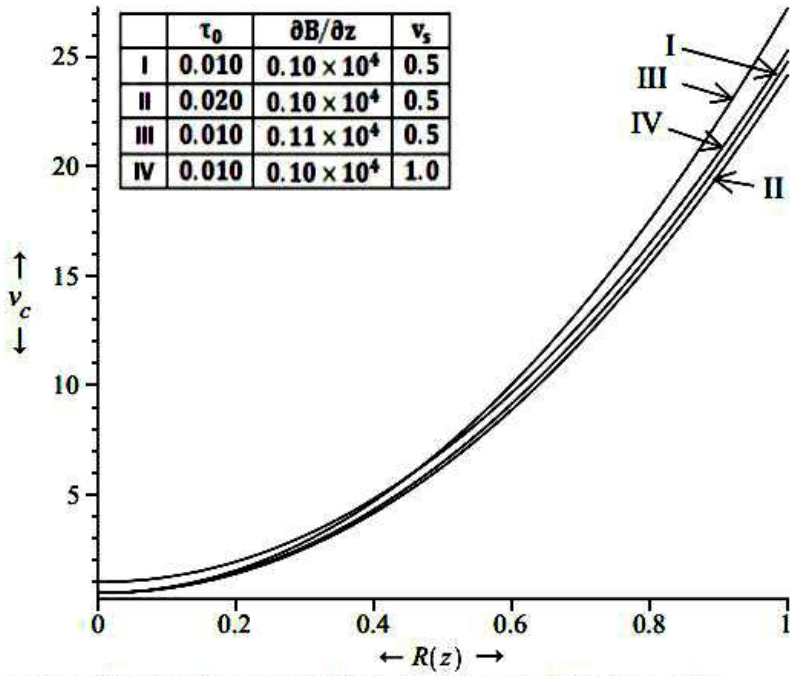
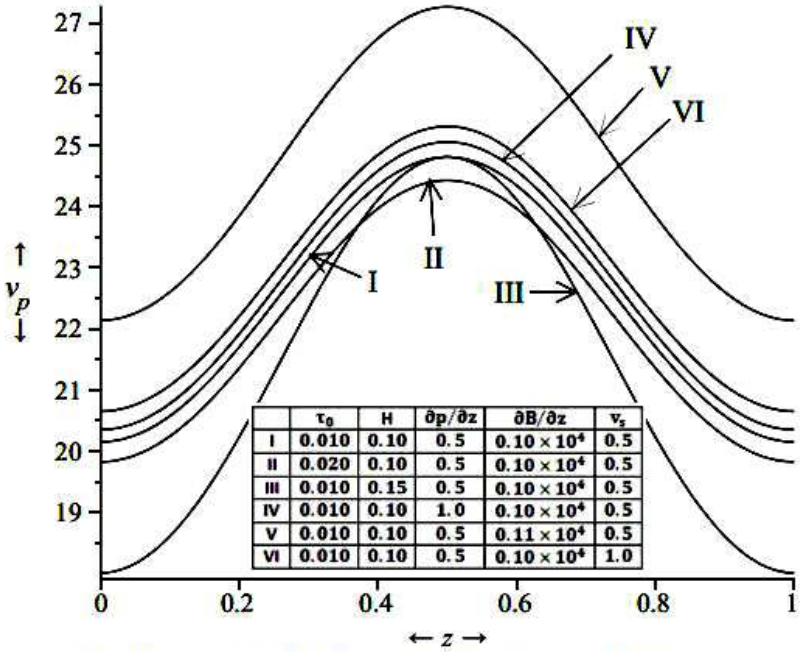


Figure 1 (b): Variation of Axial Velocity Along Radial Distance for Different Values of the Magnetic Field Gradient $\frac{\partial B}{\partial z}$, Yield Stress τ_0 and Slip Velocity v_s.

Figure 1(b) shows the variations of the axial velocity along radial distance for the various values of the magnetic field gradient $\frac{\partial B}{\partial z}$, yield stress τ_0 and slip velocity v_s with some fixed value $\tau_c = 0.030$. When the magnetic field increases, the axial velocity starts increasing slowly but it increases fast as the radial distance increases. As the slip velocity increases, the axial velocity increases a little fast but grows slowly when the radial distance increases. The axial velocity decreases slowly when the yield stress increases along the radial distance.

The graphical description of the axial velocity for the plug flow area obtained through equation (3.2) has been given in figures 2(a) and 2(b).



	τ_0	H	$\partial p/\partial z$	$\partial B/\partial z$	v_s
I	0.010	0.10	0.5	0.10×10^4	0.5
II	0.020	0.10	0.5	0.10×10^4	0.5
III	0.010	0.15	0.5	0.10×10^4	0.5
IV	0.010	0.10	1.0	0.10×10^4	0.5
V	0.010	0.10	0.5	0.11×10^4	0.5
VI	0.010	0.10	0.5	0.10×10^4	1.0

Figure 2(a): Variation of Plug Flow Velocity Along Axial Distance for Different Values of the Stenosis Height H, pressure gradient $\frac{\partial p}{\partial z}$, Magnetic Field Gradient $\frac{\partial B}{\partial z}$, Yield Stress τ_0 and Slip Velocity v_s.

Figure 2(a) describes the changes in plug flow velocity along axial distance for the different values of the stenosis height H, pressure gradient $\frac{\partial p}{\partial z}$, magnetic field gradient $\frac{\partial B}{\partial z}$, yield stress τ_0 and slip velocity v_s with a fixed value $\tau_c = 0.030$. The graph shows that the plug flow velocity first increases to get a maximum value at the peak of the stenosis along the axial distance and after a certain point it starts decreasing. The plug flow velocity increases greatly for smaller increments in magnetic field gradient along the axial distance. As the slip velocity increases, the plug flow velocity increases with pulse along the axial distance. When the pressure gradient increases, the plug flow velocity increases along the z – axis. The plug flow velocity deceases as the yield stress increases.

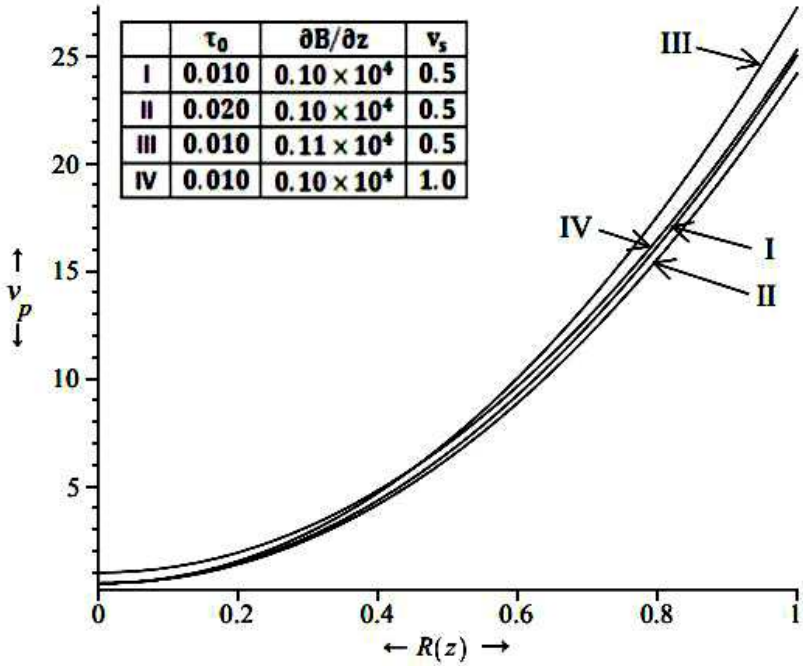
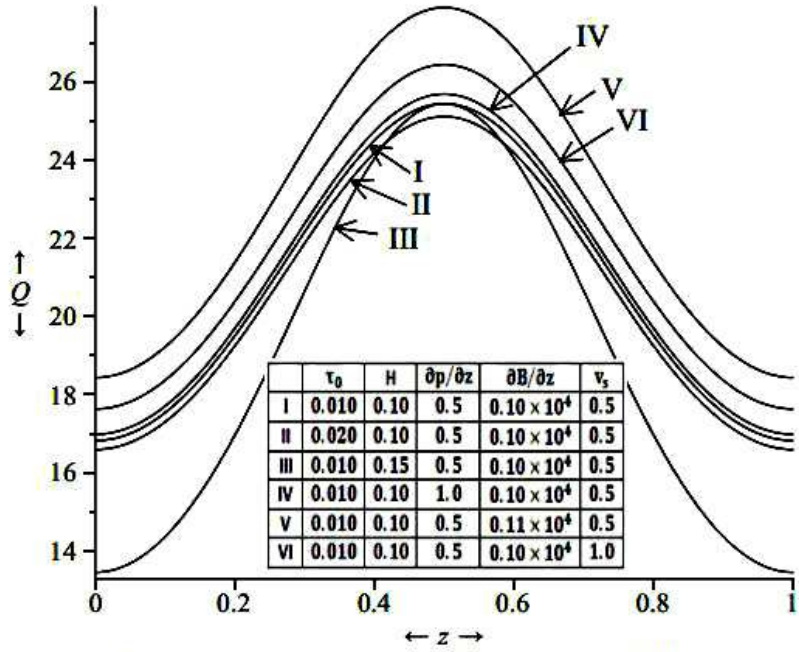


Figure 2 (b): Variation of Plug Flow Velocity Along Radial Distance for Different Values of the Magnetic Field Gradient $\frac{\partial B}{\partial z}$, Yield Stress τ_0 and Slip Velocity v_s.

Figure 2(b) shows the variations in plug flow velocity versus radial distance for the different values of the pressure gradient $\frac{\partial p}{\partial z}$, magnetic field gradient $\frac{\partial B}{\partial z}$, yield stress τ_0 and slip velocity v_s with some fixed value $\tau_c = 0.030$. It clarifies that the plug flow velocity increases along the radial distance. As the magnetic field gradient increases, the plug flow velocity increases very slowly for smaller radial distance but it increases fast as the radial distance increases. When the slip velocity increases, the pug flow velocity increases fast for lower radial distance but it becomes slower along the radial distance. Also the plug flow velocity decreases as the yield stress increases.



	τ_0	H	$\partial p/\partial z$	$\partial B/\partial z$	v_s
I	0.010	0.10	0.5	0.10×10^4	0.5
II	0.020	0.10	0.5	0.10×10^4	0.5
III	0.010	0.15	0.5	0.10×10^4	0.5
IV	0.010	0.10	1.0	0.10×10^4	0.5
V	0.010	0.10	0.5	0.11×10^4	0.5
VI	0.010	0.10	0.5	0.10×10^4	1.0

Figure 3(a): Variation of Volumetric Flow Rate Along Axial Distance for Different Values of the Stenosis Height *H*, pressure gradient $\frac{\partial p}{\partial z}$, Magnetic Field Gradient $\frac{\partial B}{\partial z}$, Yield Stress τ_0 and Slip Velocity v_s.

The variations of the volumetric flow rate obtained through equation (3.4) are shown along the axial distance for the various values of the stenosis height H, pressure gradient $\frac{\partial p}{\partial z}$, magnetic field gradient $\frac{\partial B}{\partial z}$ and slip velocity v_s with a fixed value $\tau_c = 0.030$ in figure 3(a). It shows that the flow flux first increases and after getting a maximum value the peak of the stenosis, it decreases. When the pressure gradient increases, the volumetric flow rate increases slowly with pulse along the axial distance. As slip velocity increases, the flow flux increases fast. The flow flux increases greatly for smaller increments in the magnetic field gradient along the axial distance. The volumetric flow rate decreases slowly with increment in the yield stress along the axial distance.

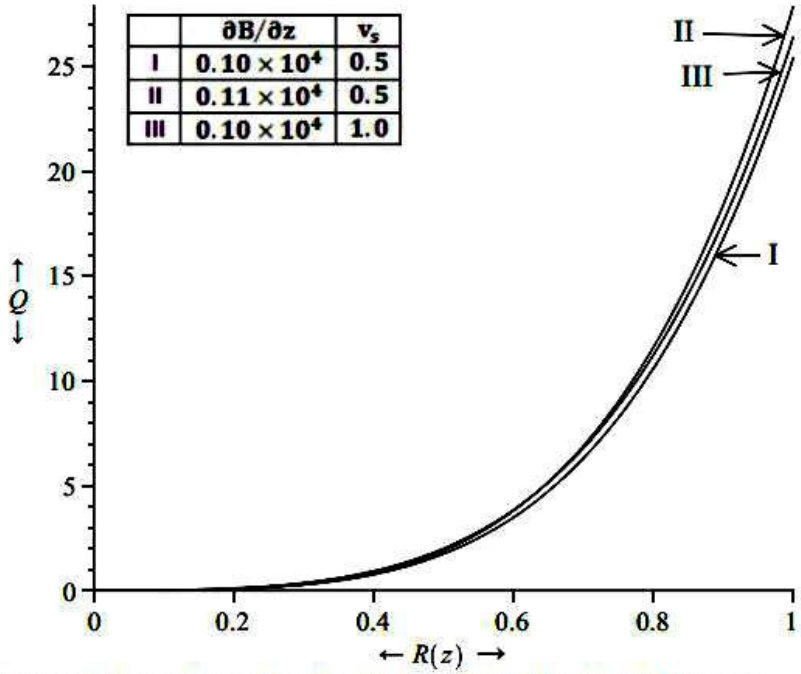
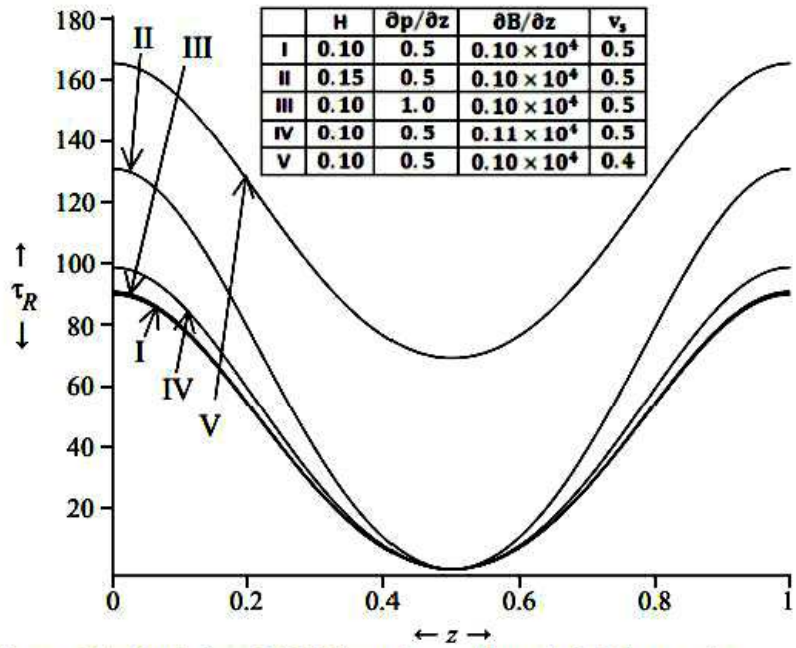


Figure 3 (b): Variation of Volumetric Flow Rate Along Radial Distance for Different Values of the Magnetic Field Gradient $\frac{\partial B}{\partial z}$ and Slip Velocity v_s.

Figure 3(b) shows the changes in the volumetric flow rate along the radial distance for the different values of the magnetic field gradient $\frac{\partial B}{\partial z}$ and slip velocity v_s with a fixed value $\tau_c = 0.030$. The volumetric flow rate keeps on growing along the radial distance. The flow flux increases very slowly for smaller increments in the magnetic field gradient along the radial distance. When the slip velocity increases, the volumetric flow rate increases slowly for lower radial distance but it increases fast as the radial distance increases.



	H	∂p/∂z	∂B/∂z	v_s
I	0.10	0.5	0.10×10^4	0.5
II	0.15	0.5	0.10×10^4	0.5
III	0.10	1.0	0.10×10^4	0.5
IV	0.10	0.5	0.11×10^4	0.5
V	0.10	0.5	0.10×10^4	0.4

Figure 4 (a): Variation of Wall Shear Stress Along Axial Distance for Different Values of the Stenosis Height H, pressure gradient $\frac{\partial p}{\partial z}$, Magnetic Field Gradient $\frac{\partial B}{\partial z}$ and Slip Velocity v_s.

Figure 4(a) shows the variations of the wall shear stress derived through equation (3.5) along the axial distance for the different values of the stenosis height H, pressure gradient $\frac{\partial \mathrm{p}}{\partial \mathrm{z}}$, magnetic field gradient $\frac{\partial \mathrm{B}}{\partial \mathrm{z}}$ and slip velocity $\mathrm{v_s}$ with a fixed value $\tau_c = 0.030$. The wall shear stress keeps on changing from high value to low value at the peak of the stenosis and then again to high value along the axial distance. When the pressure gradient increases, the wall shear stress increases very slowly along the axial distance. It almost coincides with the previous values of the wall shear stress. With increase in the magnetic field gradient, the wall shear stress increases. As the slip velocity increases, the wall shear stress increases greatly along the axial distance.

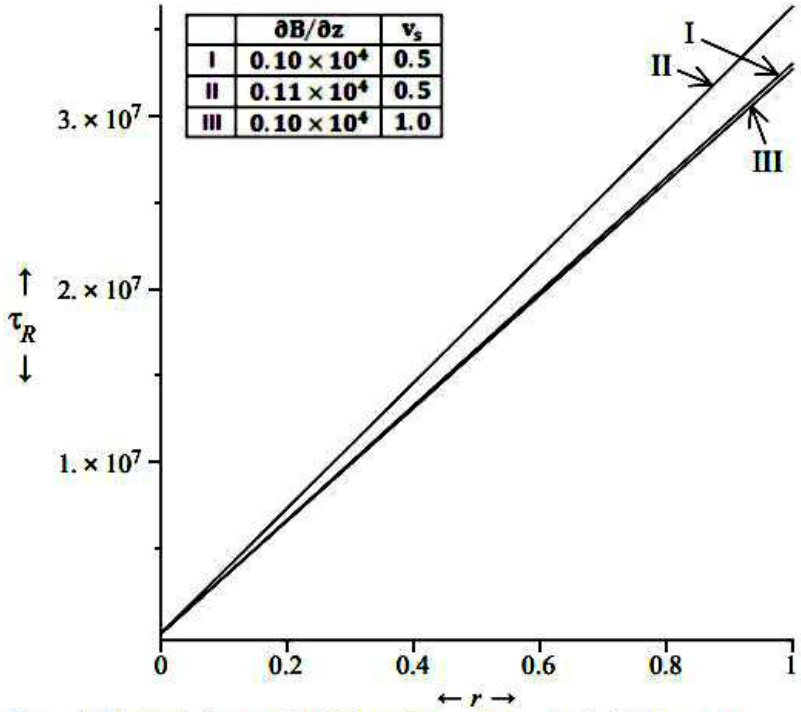


Figure 4 (b): Variation of Wall Shear Stress Along Radial Distance for Different Values of the Magnetic Field Gradient $\frac{\partial B}{\partial z}$ and Slip Velocity v_s.

Figure 4(b) gives the changes in the wall shear stress versus the radial distance for the different values of the magnetic field gradient $\frac{\partial B}{\partial z}$ and slip velocity v_s with a fixed value$\tau_c = 0.030$. It is clear that the wall shear stress increases fast along the radial distance when the magnetic field gradient increases. Also the wall shear stress very slowly along the radial distance as the slip velocity increases.

The graphical representations of variations of some flow characteristics were not very clear due to the very small changes in the corresponding values. Therefore these variations are provided in tabulated forms.

Table 1: Variation of Fluid Velocity in Plug Flow and Non-plug Flow Regions versus Pressure Gradient Along Radial Distance.

$\frac{\partial p}{\partial z}$	$R(z) = 0.0$		$R(z) = 0.5$		$R(z) = 1.0$	
	v_c	v_p	v_c	v_p	v_c	v_p
0.5	0.4999988678	0.4999996700	6.482503006	6.482503808	24.81248750	24.81248830
1.0	0.4999988788	0.4999996732	6.543348722	6.543349516	25.05780843	25.05780922
1.5	0.4999988897	0.4999996764	6.604202524	6.604203310	25.30315227	25.30315306

The variations of axial and plug flow velocities versus pressure gradient along the radial distance are given in Table 1. It is clear from the table that the fluid velocities in both plug flow and non – plug flow regions is increasing with increase in the pressure gradient along the radial distance. The fluid velocity is also increasing when it enters from non – plug flow region to the plug flow region.

Table 2(a): Variations of Volumetric Flow Rate versus Pressure Gradient Along Radial Distance.

$\frac{\partial p}{\partial z}$	Q		
	$R = 0.0$	$R = 0.5$	$R = 1.0$
0.5	0.0	1.757173507	25.44451407
1.0	0.0	1.772444012	25.69050341
1.5	0.0	1.787716250	25.93651237

Table 2(a) shows the variations of the volumetric flow rate versus pressure gradient along the radial distance. When the pressure gradient increases, the flow flux increases along the radial distance.

Table 2(b): Variations of Volumetric Flow Rate versus Yield Stress Along Radial Distance.

τ_0	Q		
	$\mathbf{R = 0.0}$	$\mathbf{R = 0.5}$	$\mathbf{R = 1.0}$
0.010	0.0	1.757173507	25.44451407
0.015	0.0	1.728272593	25.11477613
0.020	0.0	1.706290034	24.86331044

Table 2(b) gives the changes in the volumetric flow rate versus pressure gradient along the radial distance. It is observed that the flow flux increases along the radial distance as the yield stress increase.

Table 3(a): Variations of Wall Shear Stress versus Yield Stress Along Axial and Radial Distance.

τ_0	τ_R					
	z			r		
	0.1	0.4	1.0	0.1	0.4	1.0
0.010	79.301771	7.185297	89.899646	3.3037154×10^{6}	1.3214030×10^{7}	3.3034313×10^{7}
0.015	79.759752	7.323514	90.387237	3.3038088×10^{6}	1.3214217×10^{7}	3.3034608×10^{7}
0.020	80.146851	7.441036	90.799298	3.3038875×10^{6}	1.3214375×10^{7}	3.3034857×10^{7}

The variations of the wall shear stress along axial and radial distances for different values of the yield stress are given in Table 3(a). The wall shear stress first decreases and after a minimum values it again starts increasing along axial distance with increase in the yield stress. The wall stress also increases along the radial distance when the yield stress increases.

Table 3(b): Variations of Wall Shear Stress versus Yield Stress Along Axial and Radial Distance.

$\frac{\partial p}{\partial z}$	τ_R		
	$\mathbf{r = 0.1}$	$\mathbf{r = 0.4}$	$\mathbf{r = 1.0}$
0.5	3.303715444×10^{6}	1.321403087×10^{7}	3.303431371×10^{7}
1.0	3.307015649×10^{6}	1.322723129×10^{7}	3.306731437×10^{7}
1.5	3.310315856×10^{6}	1.324043170×10^{7}	3.310031503×10^{7}

Table 3(b) exhibits the changes in the wall shear stress versus pressure gradient along the radial distance. It is obvious that the wall shear stress increases along the radial distance when the pressure gradient increases.

5 CONCLUSION

The present model deals with the study of the magnetic feature of blood as a Casson fluid. The values of the different parameters used in the analysis have been taken from the work [11.] The analysis of the study shows that the volumetric flow rate and the axial velocity increase along axial distance with pulse when the axial distance, pressure gradient, magnetic field gradient, yield stress and slip velocity increase and the axial velocity in plug flow region along radial distance decreases when yield stress increases but it rises with increase in magnetic field gradient and slip velocity. The axial velocity in both plug and non – plug flow regions and the flow flux decrease along the axial distance with increase in stenosis height. The axial and the plug flow velocity increase with increase in the pressure gradient along the radial distance. The flow flux in radial direction increases when the magnetic field gradient, pressure gradient and the slip velocity increase. The wall shear stress shows fluctuations along the axial distance from higher values to the minimum value and then again to higher values. It increases as the pressure gradient, magnetic field gradient, slip velocity and stenosis height increase in z – direction. Also the wall shear stress increases when magnetic field gradient increases but it decreases as the slip velocity increases. The wall shear stress increases along radial distance with increase in pressure gradient and the yield stress.

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Development of a Campus Based Social Networking (CBSN)

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ABSTRACT: The need for a platform in which student and staff (academic and non – academic) of an institution can communicate and share ideas within the campus in order to have access to huge pool of information of day to day life on the campus without an external intruder cannot be over emphasized. It is a way of bringing life on campus to everyone attention and to people of common idea, knowledge and interest, also to serve as a tool for e-learning and security checking on the campus. To have access to the platform, users have to fill a signup page form that has column for matriculation number for student users' and staff identification number for staff users'. The platform has admin users interface at the back end, who updates the site and verify what has been the latest gist on the campus either for security or institution authority attention to prevent any likely campus breakdown of law and order. Registered users can change profile picture, add friends, update status, send, receive and reply messages, accept friend requests, check notification, create groups or join pre-existing groups, block other users and upload photos to gallery. The platform was developed using html, php, javascript and mysql.

KEYWORDS: Campus, Social, Networking, Institution, Student, Staff.

1 INTRODUCTION

The impact of information communication technology has been felt more in administrative services like admission, registration, and fees payment in institutions than learning, information dissemination and campus social enlightenment or association [1].

Social network can be defined as a social structure made up of individual or organizations called nodes which are tied by one or more specific types of interdependency such as friendship, kinship, common interest, financial exchange, dislike, sexual relationship, beliefs, knowledge or prestige [2].

Reference [3] suggested that the use of social networking site (SNS) that is more appealing to students that will provide more social environment. This is one of the idea behind development of a campus based social networking system (CBSN) with the mindset that it can be used as a tool of e – learning. It worth of noting that Facebook idea was based on something like this but later over shoot its purpose but to prevent such occurrence with this campus based social networking system, before any user can be registered it has to be verified that the person is either a student or staff of the institution by filling matriculation number if it is a student or staff identification number if it is a staff while filling sign up form.

The campus based social networking is developed to offer students and staffs of an institution vast amount of information about one another. And when it is used as an organizing tool, it can provide new ways for student groups to react to members, share information, learn about campus events and mobilize support and action [4].

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In a research carried out among undergraduate student of Kogi State University, Nigeria, [2] observed that out of 282 questionnaire distributed 158 respondents which represent about 56% of the study use Facebook while 44% make use of other types of social networking site and also high use of Facebook was also observed by [5]. This can be associated to different features that were made available in the Facebook site such as ability of users to create profile, search and receive friend request, upload profile pictures, tags pictures, add comment on friends' picture, upload and share information either public or private which has make Facebook one of the fast growing website among the youths. Also has been suggested by [3] if not all some of this features are also available in campus based social networking system for users accessibility.

2 LITERATURE REVIEW

Some school of thought has reasoned that e –learning can be introduced to social networking site especially Facebook which is believed that, is being wildly used by youths especially students but such integration can either lead to wrong learning than right because of social networking site versatility in terms of the users'. But integrating e - learning with campus based social networking system will avoid this type of problem because user population will be students' and institution staffs'.

In a research carried out on students in Pakistan by [6], concluded that social networking site (SNS) is ruining the future of teenagers and children and that SNS has negative impact on education because there is no third party or any other community which could check for what actions were been performed by which users. Reference [5] stated that military authority of United State of America (U.S.A) banned the use of SNS by soldiers in 2007, also that Canadian government banned employees from use or visiting SNS and that U.S.A congress has proposed to block SNS in schools and library.

Reference [7] observed that social networks grabs the total attention and concentration of the students and it diverts students attention to non – educational, unethical and inappropriate actions such as useless chatting, time killing by random searching but that the use of SNS for educational purpose such as online tutorials, online lectures and education material downloading is very good.

Social networking site especially Facebook which has been adjudged as the most used SNS comprises different people with different mindset, opinions and attitudes, also compounded with several tools and resources which makes monitoring who does what, a bit of problem or impossibility.

In a research carried out in Lulea University of Technology, Sweden where 239 undergraduate students' were studied through administered questionnaire by following flow theory, using smartPLS software to test the proposed structural questions showed extensive use of Facebook by student with extraverted personalities leading to poor academic performance but students who are more self regulated and control were not influenced by trust in people who uses SNS [8]. Also, in a research carried out in Kogi State University, Nigeria where 282 undergraduate students' were studied through administered questionnaire showed that Facebook is the most use SNS and that it has negative effect on student academic performance [2]. But, with the campus based social networking system, the system administrator has access at the back end to know who does what.

On the use of social networking site, [9] observed that out of 168 questionnaires administered 51 respondent which makes 30.4% of the respondent indicated that SNS is being used for entertainment while 29.2%, 16.1% and 24.4% of the respondent used the SNS for knowledge, time killing and communication respectively. This shows that entertainment takes precedent above knowledge based activities of the SNS users, from which it can be concluded why users of SNS resulted in low academic performance.

Reference [10] noted that students were socially connected with each other by sharing daily learning experiences and conversation on several topics while [11] argued that extral curricular activities and academic activities were not enough to satisfy some students who has suffered social networking isolation. Hence, social networking is beneficiary to students when it contribute in learning experience as well as social life.

3 RESEARCH METHODOLOGY

Campus based social network was developed using html, php, javascript, and mysql program and is web based.

3.1 SYSTEM PROCESS ILLUSTRATION

The system administrator can login to update the system from the back end or to view what has being the latest gist on the campus or to check who is doing what and bring to the notice of the institution authority any likely bridge of security.

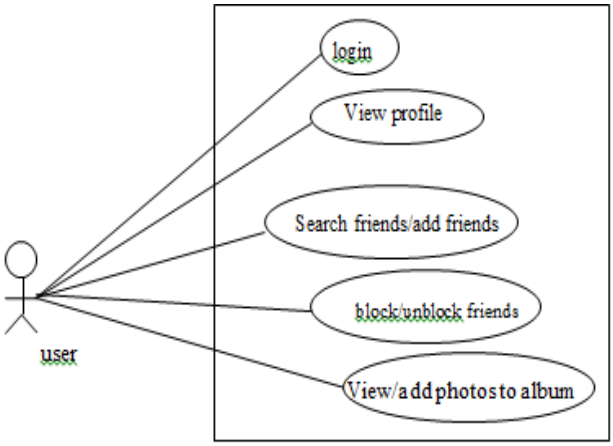


Fig.1. Users' Use Case

Fig.1 shows actions that users' of campus based social networking can perform after registration.

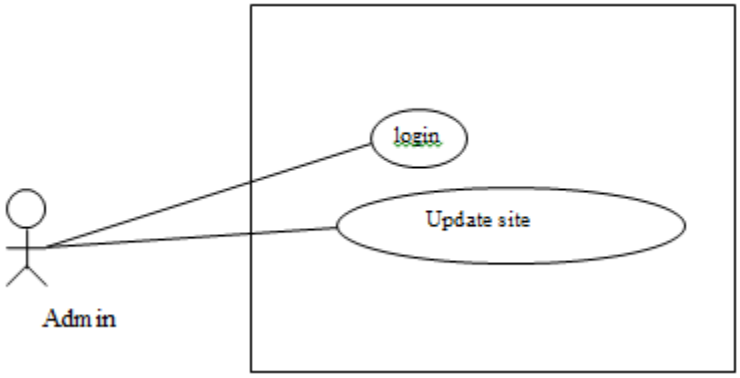


Fig.2. System Administrator Use Case

Fig.2 shows actions that system administrator can perform.

New users' of the campus based social networking has access to sign up page as student or staff of the institution and as such there is opportunity to send and receive message, view profile, search for friends or add friends, block or unblock friends, and also to view or add photos to album, create group and soon.

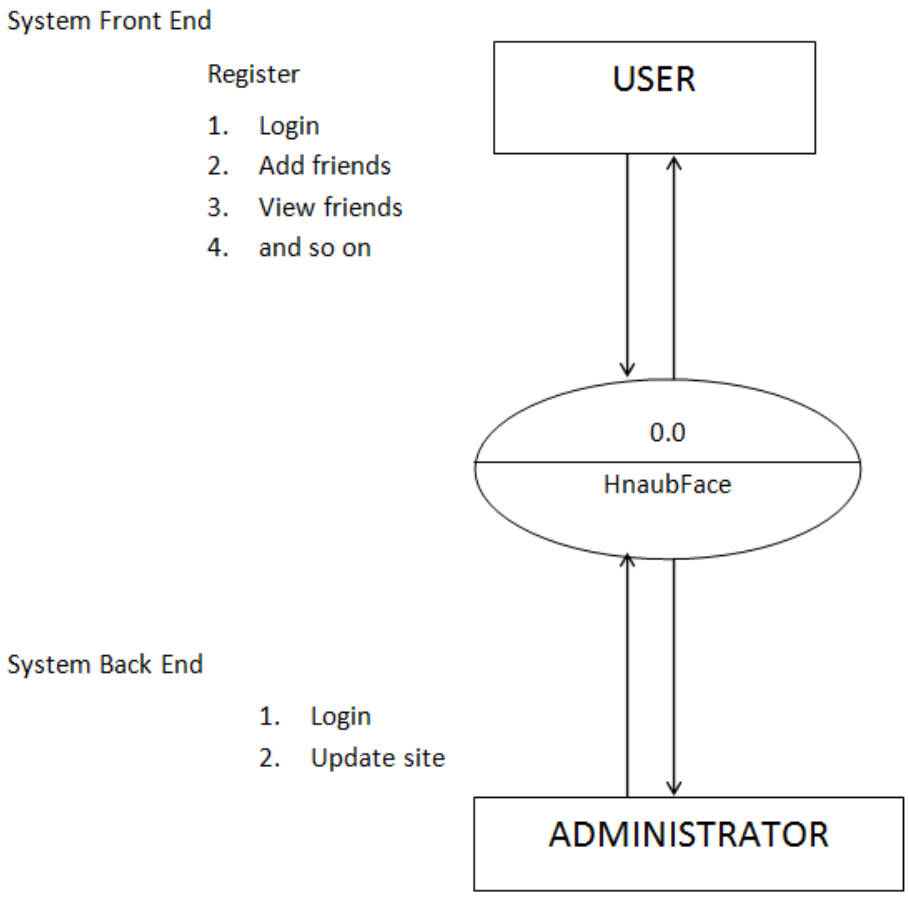


Fig.3. System Illustration

Fig.3 shows system illustration of campus based social networking.

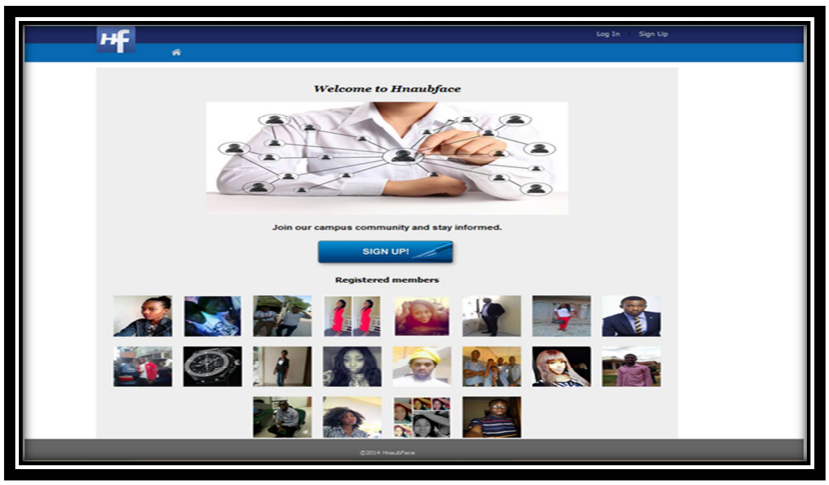


Fig.4. CBSN WELCOME PAGE

Fig.4 shows the welcome page of the developed campus based social networking



Fig.5. CBSN Sign Up Page

Fig.5 shows the signup page of the developed campus based social networking

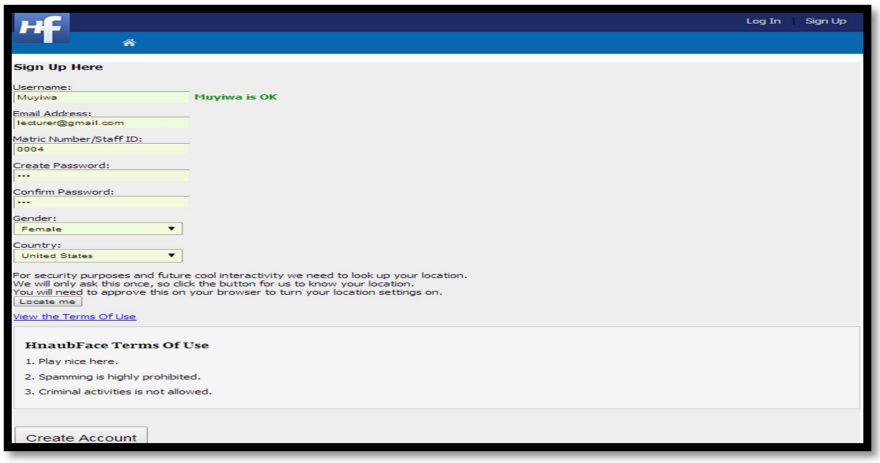


Fig.6. CBSN Staff Registration Page

Fig.6 shows a filled sample of staff registration page of the developed campus based social networking

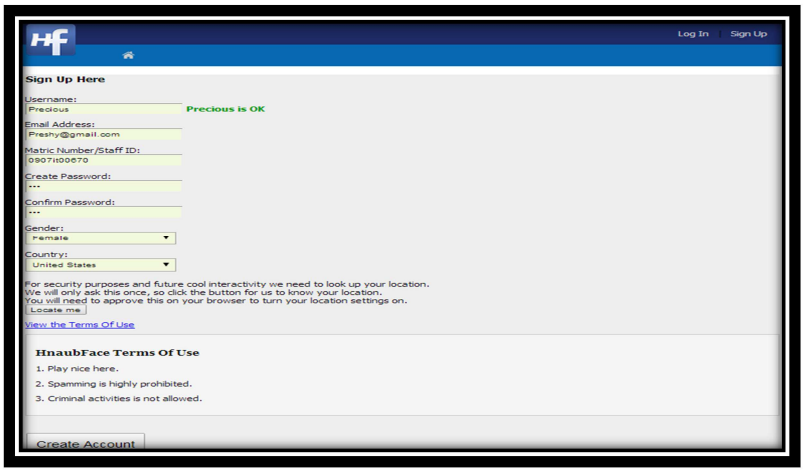


Fig.7. CBSN Student Registration Page

Fig.7 shows a filled sample of student registration page of the developed campus based social networking



Fig.8. CBSN Account Activation Page

Fig.8 shows account activation page of the developed campus based social networking

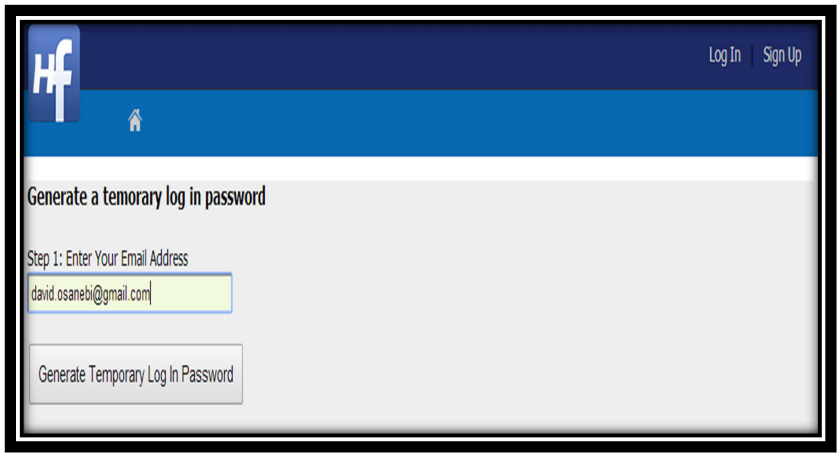


Fig.9. CBSN Temporary Password Generation Page

Fig.9 shows temporary password generation page to be used if any registered member forget the password

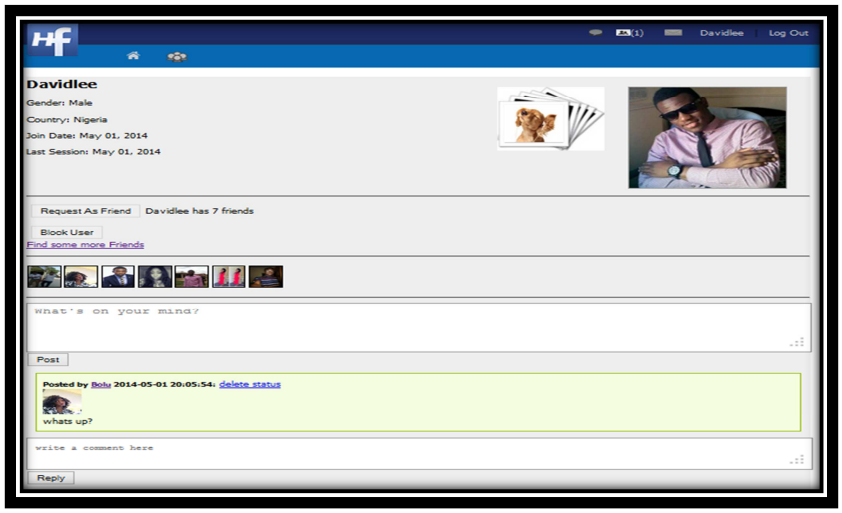


Fig.10. CBSN Users' Homepage

Fig.10 shows users' homepage

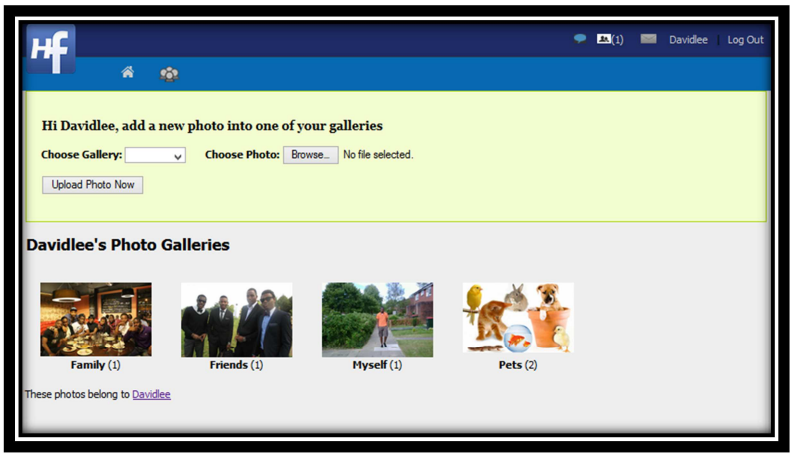


Fig.11. CBSN Users' Gallery Page

Fig.11 shows user's gallery page

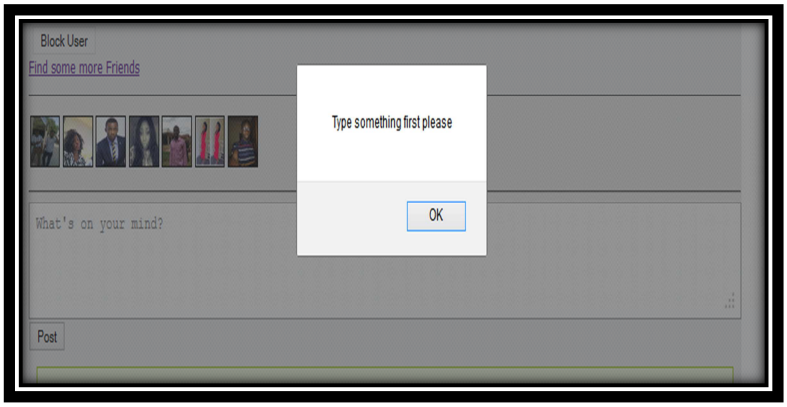


Fig.12. CBSN Users' Post Page

Fig.12 shows response to a request to posting empty post page

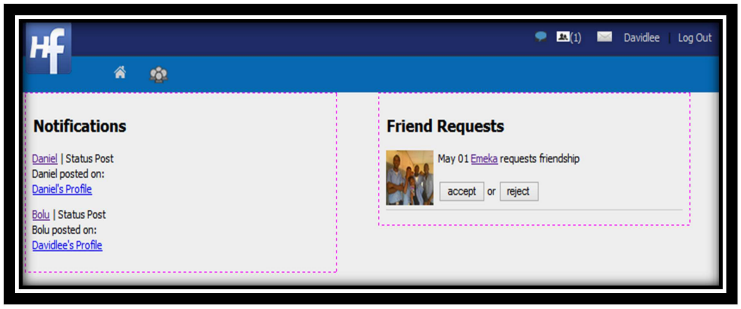


Fig.13. CBSN Users' Friend's Notification Page

Fig.13 shows users' request notification page of the developed campus based social networking

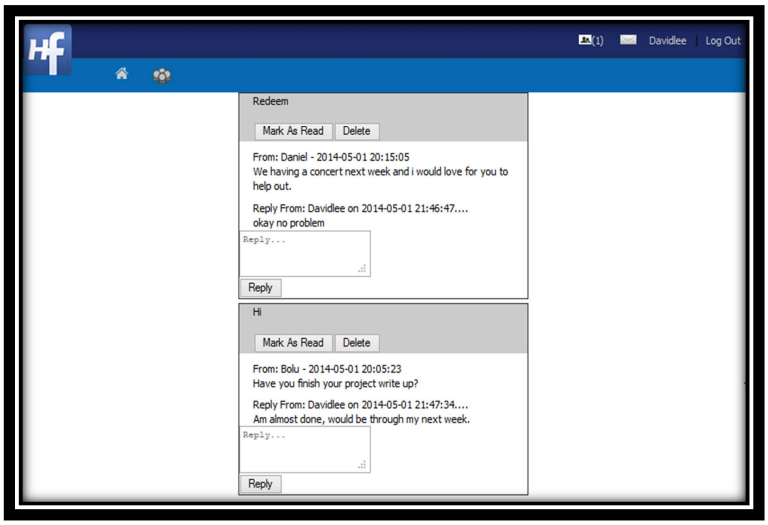


Fig.14. CBSN Users' Message page

Fig.14 shows users' message page of the developed campus based social networking

4 CONCLUSION

The need for development of a campus based social networking (CBSN) is to satisfy desire of youths especially students to socialite and also to help in developing a good academic environment which most commonly used social networks has not been able to achieve, brought about development of CBSN. The restriction in the sign up form will prevent any interested user that is not based on the campus not to be able to register thereby not to be able to have access to the use of the campus based social network. The student users' has to be a registered student of the institution in order to be issued a matriculation number that will allow such student to access the system, also the institution staff will need staff identification number in order to be registered. For the implementation, institution will be required to link the sign up page of CBSN to the school database such that staff identification number and student matriculation number can be compared to the one available in the school database in order to avoid graduated student from using the system or any staff that is no longer in the service of the institution or outsiders.

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Synthèse sur la productivité et la compétitivité de la Firme minière tunisienne en monopole naturel: stratégie de Joint-venture capitalistique et les facteurs de performance

[Synthesis on the productivity and competitiveness of the Tunisian mining Firm in natural monopoly: capital Joint-venture strategy and performance factors]

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ABSTRACT: This article provides a framework for synthesis of the productivity and the competitiveness of Tunisian mining industry which highlights the significant contribution of the Tunisian mining Firm to national economy, being a natural monopoly, which differed remarkably according to key indicators such as using a study for a period between (1999-2012): its Corporate Social responsibility CSR and mine environment protection, their accumulation of human capital, the international Joint-venture (J-V) alliance and their investment. The analyzes on this study period shows two major economic shocks, such as hydrocarbon in June 2007, affecting the production chain of this mining citizen Firm who's most serious in 2011, dates from the revolution. In addition, the Firm was able to overcome the challenges of this date and found an agreement with the social demands of the citizens in the mining Basin and will come to recovery at the average rate of production from 2012 to our days.

KEYWORDS: Productivity, Mining Firm, CSR, Human capital, J-V.

JEL: D42, L72, M14, J24, L24

RESUME: Cet article fournit un cadre de synthèse de la productivité et la compétitivité de l'industrie minière tunisienne qui met en exergue, à l'aide d'une étude pour une période comprise entre (1999-2012), l'apport significatif de la Firme minière tunisienne à l'économie national comme étant un monopole naturel, qui s'est différenciée remarquablement selon des principaux indicateurs comme : sa Responsabilité Sociale RSE et leur protection de l'environnement minier, leur accumulation du capital humain, l'alliance en Joint-venture (J-V) international et leur l'investissement. Les résultats d'analyse sur cette période d'étude montrent deux secousses économiques majeures, comme celle d'hydrocarbure en juin 2007, touchant la chaine de production de cette Firme citoyenne minière dont la plus grave en 2011, date de la révolution. Par ailleurs, la Firme a pu surmonter les défis de cette date transitoire et a trouvé une entente avec les revendications sociales des citoyens du bassin minier et viendra en conséquence de relancer au rythme de production moyen à partir de 2012 à nos jours.

MOTS-CLEFS : Productivité, Firme minière, RSE, Capital humain, J-V.

JEL: D42, L72, M14, J24, L24

Corresponding Author: Mohsen Brahmi

1 INTRODUCTION

Avec un poids économique remarquable, une notoriété mondiale dans le marché des engrais miniers et une stratégie de partenariat et d'alliance nationale et internationale bien dressée, tous ces indicateurs de compétitivité Artus, P., (2004) ont poussé plus la Firme Minière Tunisienne localisée en Bassin miniers (cf. Figure 1) à maintenir ces parts de marchés et de dresser une stratégie de long terme dans leur production [1] et la commercialisation de divers produits miniers. Cette Firme Minière CPGT, créée depuis plus un siècle d'activité en (1897), connue comme le seul et le principal pôle industriel dans le Bassin minier sud a remplie plusieurs rôles dans ces sites miniers. En fait, elle constituait une petite Etat dans un Etat [2], disant qu'elle a remplie presque toutes les activités socioéconomiques que devrait être normalement concrétisés par le Gouvernement. A juste titre d'exemples, cette Grande Firme minière Tunisienne, en se basant sur leur poids économique Chiappin I.R., (2007) et financier, a pu être montré comme une société citoyenne gouvernant plusieurs taches en faveur la société et les citoyens miniers en général (une source d'emploi et des embauches pour les jeunes diplômés miniers, participation régulièrement dans la construction des établissements des services et de santés, maintien l'infrastructure et aide les associations de loisir et les clubs sportifs, etc.).

Toutefois, ce secteur industriel minier (Tunisian mining industry, TMI, CPGT Rapport, Tunis. 2013.) [3] participait régulièrement depuis leur création pour alimenter les caisses de l'Etat par les devises parvenus des exportations du produit minier et participait massivement aux investissements dans les autres régions du pays. Sans oublier sa part remarquable en PIB (4.5% en 2013), ces facteurs constituaient de part et d'autres des indicateurs de performance économique de cette industrie minière gouvernée par la Firme mère en monopole naturel national qui reste même en des situations économiques difficiles Martinet F., (1984), comme celle de 2008 et en 2011, le poumon économique du Gouvernement Tunisien sans exception, (cf. Stat INS, 2013).

Parmi ces secousses économique graves celle de 2008, où la Firme minière à enregistré des agitations sociales du Bassin Minier qui a affecté négativement [4] leur productivité et le rythme de leur production. Les perturbations sociales, qui ont eu lieu, ont eu un impact négatif sur la production [4]. Pendant ce temps, l'activité commerciale à bien performé et le prix de vente élevé a entraîné dans un exceptionnel bénéfice net élevé pour atteindre 951,2 millions de dinars en fin 2008. Même que la crise financière mondiale a affecté négativement la performance [5] commerciale au cours du deuxième semestre de 2008. (INS, 2012. Global Monitoring Report)

Les exportations gravement arrêtés depuis septembre 2008, et la quantité livrée aux entreprises filiales en alliance a chuté de 65 %, étant donné que la demande mondiale pour le phosphate et ses dérivés a diminué. Pendant ce temps, le Firme minière a institué un programme optimiste pour compenser la baisse de l'extraction et la production qui a eu lieu au cours du premier semestre 2009. Ce programme a été réalisé en 95 % pour l'extraction et 93 % pour la production. Malgré les difficultés, le Firme s'est emploie à réaliser ses objectifs afin de renforcer sa compétitivité Farrel, G., and al, (1999) en augmentant la quantité et la qualité de son produit et de moderniser sa gestion [6] en fournissant les mines à ciel ouvert avec des équipements de grande capacité pour faire face à l'augmentation continue du rapport et de diminuer l'extraction des coûts et améliorer [7] le rendement Gregoir, S., and E., Maurel, (1993). Aussi, à travers la poursuite du programme de remise en état de l'appareil de production, y compris les puits et le réseau d'eau industrielle en insérant des techniques dans ces unités. Une généralisation du procédé de flottation dans toutes les usines de lavage pour augmenter la production. La Firme a fait conclure en 2009 le projet présidentiel de la construction de digues pour liquide accumulation riche dans tous les sites de production de récupérer certains de l'industriel eau et recycler et à protéger l'environnement.

Par ailleurs, l'effort remarquable de la Firme à la poursuite du programme de rationalisation de contrôle des coûts et l'énergie, spécialement, en utilisant l'énergie solaire pour le séchage des phosphates. Une intension sociétale en vers les sites miniers concernant la préparer de l'action de recrutement pour satisfaire les besoins en personnel de la société en fin 2008 et en 2012 avec des parts d'équité entre les divers sites miniers. Pour leur gouvernance interne, la Firme minière a fait recourir souvent à améliorer leur système d'information et de communication en obtenant et en développant des applications informatiques pour couvrir tous les domaines de gestion, dont les plus importants : (développer un système complet pour la gestion financière, obtenir une application informatique adéquat des ressources humaines de gestion, etc.).

Cependant, cette Firme citoyenne minière continuera à prendre en charge l'environnement interne et externe en aidant les associations, les clubs de sports et diverses activités culturelles en allouant un budget annuel important (plus de 7 millions dinars). Elle a également tracé des orientations importantes des futurs travaux sociaux parmi ces principaux contributions ; une amélioration du travail social (des clubs de loisir et des associations de retraités), une attention d'avantage aux travailleurs d'être endommagés en cas d'accident de travail. Aussi, elle accordait plus d'attention au travail médical et développer les services de santé (créer des projets dans ce domaine dans les sites minier). Elle a fait recourir au changement et installations de travail à jour pour la maternelle.

Dans le contexte environnemental, elle travaillait pour polir les villes minières et décoller les résidus négatifs de l'activité minière. En contre partie un centre historique pour les mines a été créé pour maintenir sa mémoire historique. Elle a été préoccupée à revoir l'intervention de la société dans les domaines de l'éducation et de la culture en concrétisant davantage d'études sociales et trouver les moyens de les exploiter.

Au cours de l'année 2009, le CPG a vécu deux événements majeurs qui ont grandement touchés ses performances et influencé ses résultats. On cite principalement la poursuite de la crise financière mondiale qui a abouti à une diminution de la quantité exportée du phosphate et ses dérivés et une baisse modérée du prix de vente. Aussi, les inondations dans le Bassin minier à la fin 2009 ont affecté négativement l'ensemble de la zone minier, terrain de production. En termes de production de phosphates, il entraînait une perte de 300 milles tonnes. Sans compter que les quantités de phosphate, prêt à être livré, qui avaient été balayées et ne pourraient pas être se rappelaient et retournées au stock. Malgré ces difficultés, La Firme s'emploie à réaliser son objectif [8] en 2010 afin de renforcer sa compétitivité Nezeys, B., (1993) en augmentant la quantité et la qualité Bellon, B., (1991) de son produit et de moderniser [9] leurs outils de travail.

Le début 2010 a enregistré une certaine stabilité ainsi la quantité exporté à progressé d'enivrent 41%. Les prix des produits miniers sont encore en hausse moyenne cette opportunité a pu augmenter la recette de 27.8%. Alors que l'année de la révolution du jasmin 2011, a provoqué une perturbation touchant toutes les entreprises exportatrices Tunisiennes quelques soient leurs tailles et leurs domaines d'activités (industrielles, des services et commerciales de Zones franches). La Firme citoyenne minière, quand à elle ne fait pas l'exception, a enregistré la plus ride année dans leur histoire. En fait, la révolution a été conjuguée par les perturbations sociétales avec des jeunes (divers niveaux d'études) en chômage demandant l'intégration à cette Grande citoyenne Firme qui constituât le seul pôle industriel dans ces Zones miniers.

Les conséquences multiples, des entraves quasi-totales de la production dans les sites du Bassin Minier (une baisse de productivité de 72% par apport à 2010, rupture du transport du chemin de fer principal moyen de circulation du produit en vrac vers les Usines de valorisation en produit chimiques à usage multiples et un déclin sans précédent du niveau de vente et de commercialisation au pays étrangers (baisse de niveau de vente de 55%, comparais à 2010). Enfin, une entente s'avère très nécessaire au début de 2012 entre les parties, demandeurs d'embouche et de l'intégration, avec la Firme minière. C'est vrai, le bilan des conventions signées par la Firme en faveur les demandes sociétales était lourd du coté financière. Mais, 2013 s'avère la vrai année de l'encrage et de relance économique et le retour réel de la productivité pour ce pôle industriel minier en Bassin minier tunisien et leurs sites miniers les plus productives (cf. Metlaoui, Mdilla et Redayef) qui ont recommencé leurs productions normales. A cet effet, une progression remarquable notée (93% de productivité comparais en 2012), le niveau des ventes et la commercialisation du produit miniers ont progressé aussi à même hauteur de 89% par apport en 2012, vers les marchés étrangers (Européens et Asiatiques) après une rupture d'enivrent une année.

La question centrale que soulève cet article est formulée de la façon suivante : dans cette période d'étude, les indicateurs [10] (Lall S., 2001, Latruffe, L., 2010) de productivité et les facteurs [11] de compétitivité et de même la stratégie de MLT d'alliance en joint-venture capitalistique entreprise par la Firme Minière tunisienne ont-ils évolués dans le temps, vu que les entraves macroéconomiques vécues dernièrement par le pays ?

Nous nous tentons de rapporter des éléments de réponses dans cet article qui est structuré comme suit : Dans la première section de notre travail, nous allons mettre en évidence le cadre théorique de cette industrie minière présentée par la Firme du Bassin minier, qui est plus que centenaire dans leur domaine d'activité, en termes de leurs principaux sites de production et leurs niveaux de productivité. Cette Firme en positon de monopole naturel constitue en seul un pôle industriel incomparable des autres secteurs d'activité.

Dans la deuxième, nous effectuons un état de lieux de la compétitivité de Firme Minière à travers les différentes composantes de la productivité, une extrapolation sur les principaux déterminants économiques et financiers ainsi que d'autres facteurs utiles nous permet d'analyser et de juger le degré de performance atténué par la dite Firme minière Tunisienne. La dernière section apporte autres indicateurs de compétitivité qu'on les consacre à analyser pour identifier leurs effets susceptibles d'influencer positivement la compétitivité internationale de l'industrie minière tunisienne. Parmi ces facteurs on cite le Rating des organisations internationales de notation de moyen et long terme, l'Alliance stratégique en Joint-venture, la stratégie d'essaimage des PME filiales à la Firme mère minière et aussi la rationalisation de l'énergie comme composante essentielle pour compresser les coûts de production.

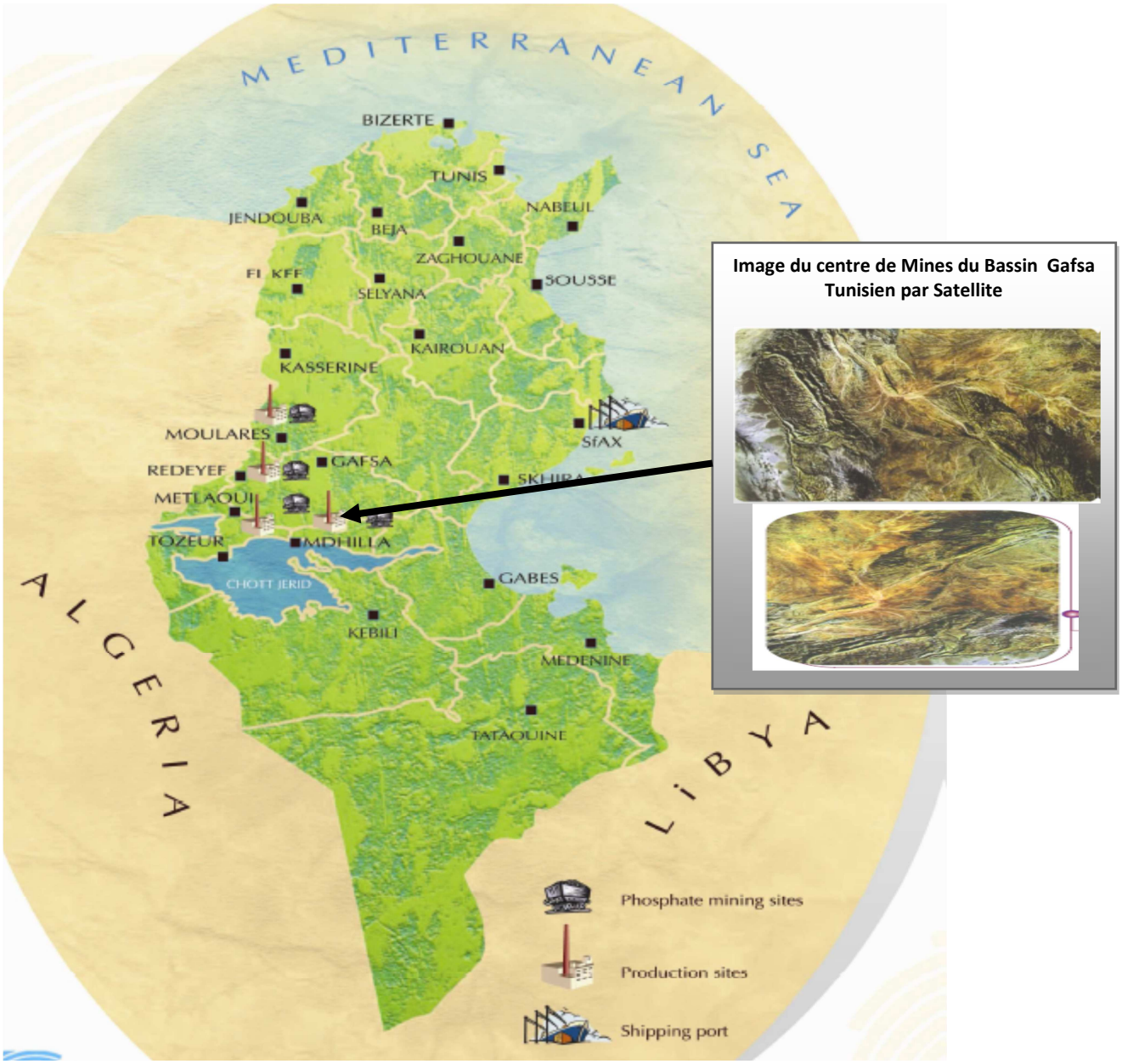


Figure. 1. Localisation : les sites miniers d'exploitation et de production du Bassin Minier Tunisien

Source : Attribution Auteur, Bureau Prospection Géologique et Recherche Mets., CPGT. 2014.

2 EVIDENCE ET BREF ECLAIRAGE THEORIQUE DE L'INDUSTRIE MINIERE : FIRME EN POSITON DE MONOPOLE NATUREL

La date de création de ce pole industriel sous le nom CPCT (1897) gouvernait dans les sites de Bassin Miniers tunisien, lieux très fertile en ressources sous sols miniers, a long de leur histoire de production, cette Firme Minière a pu résister malgré les chocs (pétrolières des 1977, la crise de dette en 1986, fluctuations de demande en produit minier en 1994, la crise Asiatique 1997, la crise financière 2008 et la dernière rupture économique en 2011).

2.1 DIAGNOSTIC FINANCIER ET ETAT REEL

Le capital social a enregistré ces trois dernières années une évolution remarquable (268 Million Dinard en 2010 – 228 Million Dinard en 2009 - 228 Million Dinard en 2008). Et le Turnover- Chiffre d'affaires (Million Dinard) montre des gains financiers appréciables de 783 MD (2010)- 690 MD (2010) – 613 MD (2009)-1406 MD (2008) pour les mêmes années, respectivement.

La capacité de production annuelle (CPA) est de 8,4 Million Tonnes, cette production mettra la tunisien en cette industrie minière dans les premiers places au niveau mondial. En fait, occupe le 5ème rang de production mondiale (RPM), le 3ème rang d'exportation mondial (REM) et le 2^{éme} rang de valorisations des engrais miniers mondial (RVEM). Ces rangs ont permet à cette Firme minière de maintenir leur part de marché et concevoir des stratégies de partenariat avec des sociétés international pour améliorer leur potentiel de compétitivité.

2.2 PRINCIPALES DATES CLES

Parmi les principales années de référence pour cette industrie minière on avance les suivantes :

- 1885 : Date des premières découvertes des minerais phosphatés à Jebel Thelja Metlaoui (Gafsa)
- 1897 : Date de la création de la Société des Phosphates et Chemin de Fer Tunisienne
- 1920 : Date d'entrer en vigueur de la Société des Phosphates Medhilla
- 1976 : Fusion des tous les sociétés en seul Firme minière nommée Société des phospahtes Gafsa
- 1994 : Unification des deux sièges Tunis-Gafsa, et nomination d'un seul PDG.
- 2001 : Programme d'essaimage et stimulation vers les PME filiales de la Firme mère
- 2008 : partenariat/ alliance en joint-venture Tuniso-Indienne

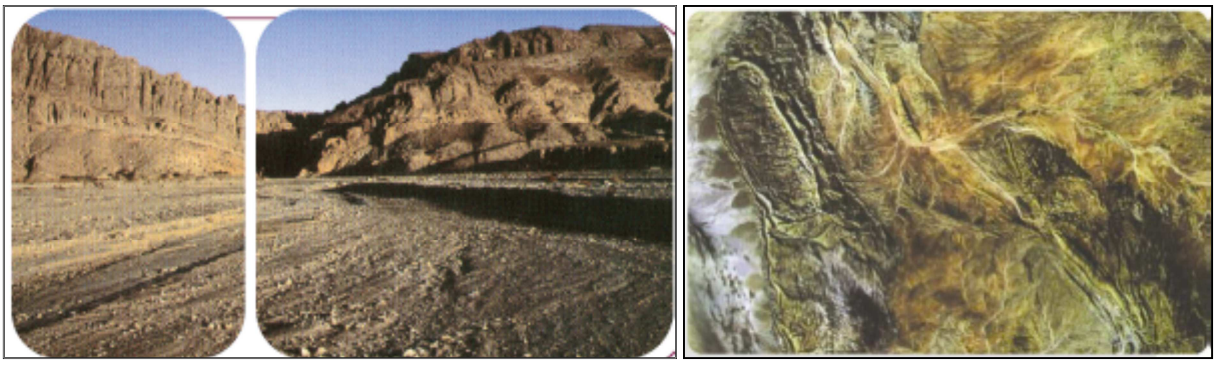


Figure2. Jebel Thelja Metlaoui (Gafsa-Tunisie) lieu de la première découverte des phosphates naturels en 1885, avec une image illustrative par satellite. Bureau Prospection Géologique et Recherche Mets. [12], CPGT. 2013.

2.3 LES SECTEURS D'ACTIVITES : REPARTITION DES SITES MINIERS EN TERMES DE PRODUCTION

Le bassin minier de Gafsa s'étend sur une surface plus de 80Km, de L'Est (Mdhilla) à L'Oest (Moulares et Redayef) passant par le principal site Cœur des mines qui est Métlaoui « petit-Paris, en période de colonisation Française », le grand pôle de l'exploitation et de production du produit minier jusqu'à nos jours en 2012. Tout au long de cette surface, se répartie cinq principaux secteurs de mines pour l'extraction et la valorisation dans des usines nommés Laveries.

Ces cinq secteurs miniers sont ordonnés en termes de volume de production comme suit : (La première principale mine se compose de deux secteurs)

- Secteur Metlaoui I (Carrière Kef Schfaire)
- Secteur Métlaoui II (Carrière Kef Eddoure)
- La deuxième mine : Secteur Mdhilla
- La troisième mine : Secteur Redayef
- La quatrième mine : Secteur Moulares

Tableau.1. Répartition de la chaine de production minière en sites à ciel ouvert et les laveries de valorisation

Les Mines à ciel ouverts (Open cast Mines) - 8 Mines -	Laveries de valorisation (Valorisation Laveries Plants) - 10 Laveries -	Le port d'expédition (Shipping port) - 1seul port -
Mines Metlaoui : Carrière Kef Schfaire Centre	Laveries Metlaoui : Laverie I	Le port de Sfax (Tunisie)
Mines Metlaoui : Carrière Kef Eddoure Centre	Laveries Metlaoui : Laverie II	Le port de Sfax
Mines Metlaoui : Carrière Kef Schfaire Est	Laveries Metlaoui : Laverie III	Le port de Sfax
Mines Metlaoui : Carrière Kef Eddour Est	Laveries Metlaoui : Laverie IV	Le port de Sfax
Mines Metlaoui : Mine de Jallabiaa	Laveries Metlaoui : Laverie V	Le port de Sfax
Mines Medilla : Mine de Mzindaa	Laverie Mdhilla : (I , II et III)	Le port de Sfax
Mines de Redayef	Laverie Redayef : Laverie I	Le port de Sfax
Mines de Moularess	Laverie Moularess : Laverie I	Le port de Sfax

Source : Rapport des mines phosphates (2012). CPGT.

Ces quatre mines composées [13] de cinq secteurs miniers présentent leurs activités (*cf.* tableau 1) dans huit mines à ciels ouverts et dix usines Laveries pour la valorisation en engrais des phosphates marchants de qualité fortement demandé par les pays industriels Européens et ceux émergents (la Chine, l'Inde, etc.). Ces produit et engrais miniers seront exportés (Shipping port) par le port de Sfax qui est la destination final pour l'expédition de la production minière que se soient en vrac et en d'autres produits en emballages.

3 LES INDICATEURS ECONOMIQUES ET FINANCIERS DETERMINANTS DE LA COMPETITIVITE ET LA PERFORMANCE DE LA FIRME MINIERE TUNISIENNE

Les principaux indicateurs Burton JR., (1994) qu'on se base pour décrire [14] la productivité et la compétitivité économique de cette Firme Minière Tunisienne entre (1999-2012) sont la production, la qualité et le volume globale des ventes.

3.1 EVOLUTION DU RYTHME DE LA PRODUCTION DU PRODUIT MINIER (1999-2012)

La Firme minière a conservé un rythme d'exploitation annuel soutenu à long tour de 11.5 Millions de tonnes depuis la fin des années quatre-vingt-dix, jusqu'à 2010. L'année 2011 de révolution Tunisienne a fait l'exception enregistré une grave baisse (2.935 Millions de tonnes, soit le 1/6 de l'exploitation de 2010). Mais ce niveau a été corrigé en 2012, soit 4 fois plus que 2011(*cf.* Tableau 2).

Tableau.2. Evolution du rythme d'exploitation, de production et d'expédition de l'activité minière entre (1999-2012) en (Million de tonne).

	Exploitation Minière	Production (Phosphate Marchant)	Expédition (Phosphate Marchant)	Quantité superficielle Terrassée
1999	10.649	7.568	6.927	98.557
2000	10.975	7.924	7.315	97.339
2001	11.836	8.054	7.401	99.607
2002	11.957	8.437	7.351	102.027
2003	12.648	8.214	7.281	100.672
2004	12.343	8.051	7.285	95.306
2005	12.305	8.220	7.262	100.979
2006	11.763	7.801	7.284	97.555
2007	12.396	8.002	7.415	107.541
2008	11.643	7.539	7.408	106.420
2009	11.276	7.216	6.265	114.951
2010	13.227	8.107	7.347	142.352
2011	2.935	2.281	3.020	59.935
2012	8.947	7.305	6.725	97.089

Source : Direction Production CPG, Annuel rapport, jan. 2013.

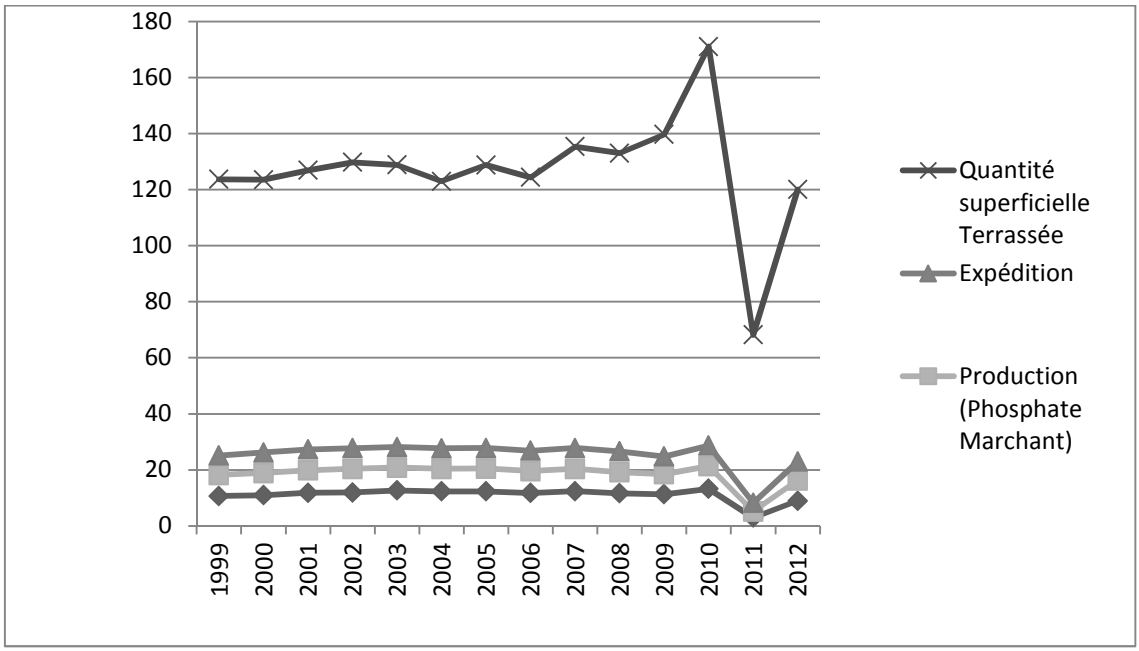


Figure.3. Evolution du rythme d'exploitation, de production et d'expédition de l'activité minière entre (1999-2012)

De son coté la production annuelle des phosphates Marchants à enregistré entre (1999-2010) en moyenne 8.1 Millions de tonnes, ce volume de production était expédié vers les usines du groupe chimique pour la valorisation en engrais minerais plus fertiles. Ces engrais phosphatés sont fortement demandés dans le marché mondial des engrais phosphatés (MMEP). De même en 2011, seulement 3.020 Millions de tonnes (42% du volume total annuel expédié), soit une baisse de près de 58%. Ce volume des phosphates Marchant expédié a repris un niveau croissant de 2.6% plus en 2012 comparé de l'année de la révolution.

La quantité terrassée a enregistré en 2010 le plus haut pic (142.352 Millions de tonnes) comparés aux autres années (1999-2009). Seulement des faibles valeurs sont présentées pour les deux dernières années (2011 et 2012) avec des quantités 59.935 et 97.089 Millions de tonnes, respectivement.

La qualité de P_2O_5 valorisée à partir du phosphate marchant a conservé le même rythme de fertilisation de 29.81% annuellement (*cf.* Tableau) dans les usines filiales de Firme Minière de Gafsa pour la période (1999-2007). Ce niveau a baissé de deux points en 2011, soit 27.52%, pour les mêmes circonstances économiques et sociales y vivait le pays. Bien que 2012, l'année post-révolution, ce niveau est amélioré d'un point de plus pour atteindre à la fin de 2012 un taux de 28.80% qui reflète un nouveau retour à l'état normal et un signe d'incidence [15] positif Chiappin I.R., (2004) pour l'attractivité de la qualité du phosphates Tunisien et ces dérivés dans les marchés étrangers, principalement Européens, clients traditionnels à la Tunisien pour secteur minier.

Tableau.3. Incidence de la qualité du phosphate valorisée P_2O_5 entre (1999-2012)

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Qualité P_2O_5 en (%)	29.57	29.65	29.67	29.87	29.94	29.98	29.11	29.12	29.15	28.94	28.82	28.83	27.52	28.80

Source : Idem. Direction Production CPG, Annuel rapport, jan. 2013.

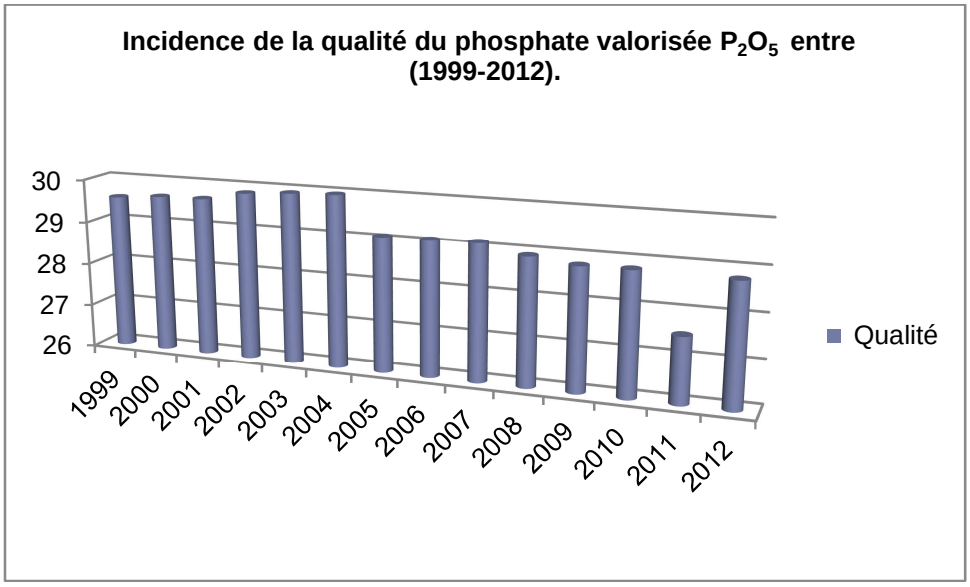


Figure.4. Incidence de la qualité du phosphate valorisée P_2O_5 entre (1999-2012).

Pour améliorer la qualité des phosphates et engrais dérivés fortement demandés par ces propres clientèles, la Firme minière Tunisienne à installé depuis 1978 un centre de recherche de valorisation des engrais miniers qui est dédié à la prospection des substances chimiques permettant la fertilisation du produit minier Tunisien et pour qu'il sera plus compétitif [16] CEPII, (1998) dans le marché étranger face au nouveaux concurrents et ceux traditionnelles (Maroc, Jordanie, etc.).

Ce centre de recherche a les principales finalités suivantes :

- Un travail régulier en lien avec les usines de fertilisation par le prélèvement en permanence des échantillons sélectifs de plusieurs couches des minerais dans la chaine de production.
- Adoption et usages des techniques scientifiques les plus connues dans le domaine des mines.
- Une synthèse régulier de degré de la qualité attend et selon les résultats du cas de concevoir les mesures correctrices au fur et à mesure du processus de production.
- Inciter plus les ouvriers et les salariés de la Frime de l'utilité propice de la qualité et leur contribution à la notoriété du produit minier en général.

3.2 COMMERCIALISATION DE LA GAMME DES PRODUITS MINIERS TUNISIENS EN VOLUME GLOBAL

Après leurs finales valorisations dans les chaines de production aux usines de fertilisations chimiques, qui sont répartis dans trois régions (Mdilla à Gafsa prés de la Firme minière mère, Skhira à Sfax et Gabes usines, par les voies des rails-trains transporteur du produits en vrac), les produits miniers reçoivent un enrichissement par des compositions chimiques pour fournir diverses engrais miniers dans une gamme globale. Où chaque engrais minier sera dédié vers un secteur d'activité spécifique (i.e. vers l'agriculture, l'industrie chimique, l'industrie pharmaceutique, etc.).

Pour connaitre l'évolution du volume des ventes annuelles de la gamme des engrais miniers Tunisiens (*cf.* Tableau) et leur répartition en quantités annuelles exportées vers les clientèles étrangères (principalement en Europe occidental, pays sud-Asiatiques et ceux en Amérique Latine) et celles commercialisées dans le marché local Tunisien.

Tableau.4. Evolution du volume des ventes global des produits miniers en (Million Tonne)

	Exportation		Vente Locale		Total
	Quantité	Différence (%)	Quantité	Différence (%)	
2002	0.692	-	6.451	-	7.143
2003	0.647	- 4.50	6.537	+8.60	7.184
2004	0.652	+ 0.50	6.635	+9.80	7.287
2005	0.766	+11.40	6.528	-1.07	7.294
2006	0.768	+0.80	6.535	+0.70	7.303
2007	1.202	+43.40	6.280	-2.55	7.482
2008	0.887	- 41.50	6.462	+18.20	7.349
2009	0.496	-38.10	5.579	-88.30	6.075
2010	0.699	+20.30	6.582	+10.30	7.281
2011	0.149	- 55.00	3.175	-34.08	3.325
2012	0.697	+55.80	6.509	+33.34	7.206

Source : Idem., jan. 2013. (Attribution auteur)

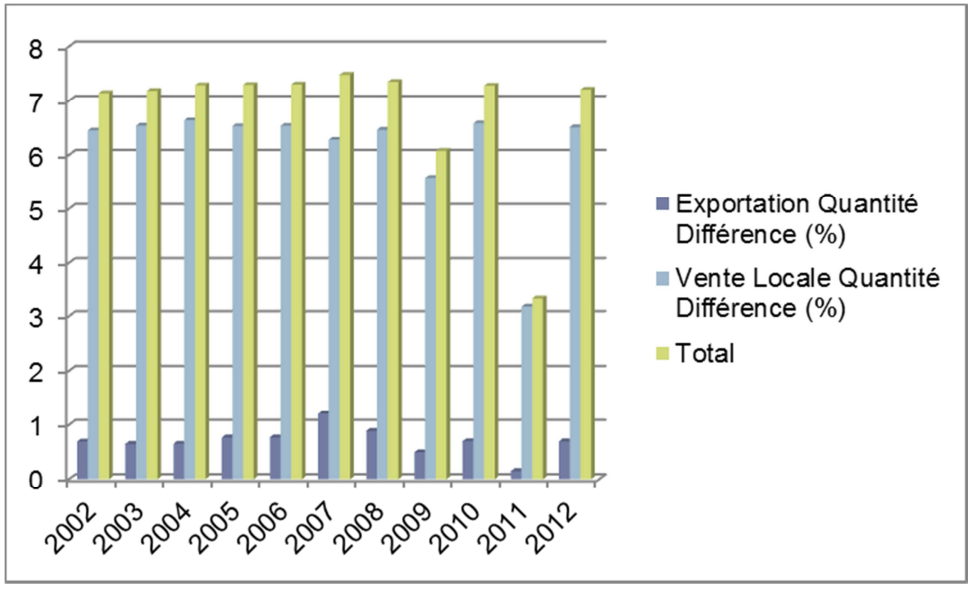


Figure.5. Evolution du volume des ventes global des produits miniers

Sur une période qui s'étale à onze années (2002-2012), nous nous décrivons à partir de ce tableau 4 ci-dessus la répartition [17] des quantités annuelles des engrais miniers concrétisés à l'exportation et les parties restantes pour la vente locale. Pour la quantité exportée annuellement depuis 2002 (*cf.* 0.692 Million Tonne en 2002) était en moyen de 0. 762 Million Tonne. Fort de remarquer comme pour tous les analyse des tableaux auparavant, que l'année 2007 et l'année exceptionnelle (une différence positive +43.40%) représente la plus hausse quantité annuelle vendue depuis 2002, soit un doublement des ventes comparé en 2004 et 2003 où le volume exporté attient en décembre 2007 à 1.202 Million tonne.

Après une année (2007) à forte demande des engrais miniers au marché mondial des engrais phosphatés (MMEP), la demande mondial venait de se stabiliser à leur niveau normal, mais toujours à la hausse (0.887 Million tonne, 2008) avec une baisse de (-41.50%) comparé à l'année 2007. En 2011, l'année de la révolution tunisienne, pas étonnant que le volume des ventes ont été fortement baissés (- 55.00% en différence par rapport à 2010, contre seulement 0.149 Million Tonne, exporté). Mais depuis 2012, le retour à l'état d'équilibre des ventes (0.697 Million Tonne) et la Firme Minière tunisienne a repris leur production quotidienne dans un environnement socio-économique plus sein et calme après des agitations sociales.

Pour les quantités annules vendues dans le marché local Tunisien par la Firme Minière et ces filiales entre (2002-2012) sont de l'ordre de 6.324 Million de Tonnes depuis 2002. Seulement en 2009 (l'année de la poste crise mondiale 2008) et 2011, où les différences de volume des quantités vendues dans le marché local sont rétrécies de -88.30% et -34.08% respectivement, comparés aux autres années de la même période. Le retour à l'état normal serait en 2012 avec une vente de 6.509 Million de Tonnes. Et le rythme c'est accéléré depuis 2012 jusqu'à nos jours vu que le bel avenir des produits phosphatés à diverses utilisations dans le marché mondial avec une forte demande par principalement les pays émergents Asiatiques (Inde, Indonésie, Chine, Singapour, Malaisie, etc.).

Il est capital de rappelé que la Firme Minière de Gafsa Tunisienne est en position de monopole naturel dans le territoire Tunisien, puisqu'elle est le seul exploiteur géologique des montagnes de couches sédimentaires minières en Sud-ouest du pays et qui faisait par la suite leur processus de production en granules minières marchants. Ce positionnement en monopole, laissera depuis plus un siècle d'activité (1897) de gérer le prix et la quantité de ces produits miniers en vrac qui seront destinés en grande quantité pour le marché local sous les demandes des sociétés de fertilisations tunisiennes comme montre le tableau, ci-dessous :

Tableau.5. Répartition du volume des ventes local des produits miniers par client en (Mille Tonne)

	Manufactory Groupe Sfax	Manufactory Groupe Gabes	Manufactory Groupe Mdhilla	Manufactory Groupe Skhira	GRANUPHOS	Société Salakta des Engrais	Société des Engrais Chimiques
2000	636	3519	799	1585	36	21	3
2001	621	3527	819	1598	36	23	6
2002	615	3521	823	1596	37	25	6
2003	624	3532	840	1602	35	23	5
2004	638	3526	824	1606	33	19	8
2005	580	3612	810	1458	39	24	6
2006	621	3534	856	1490	31	21	3
2007	650	3371	811	1374	50	23	7
2008	692	3520	875	1314	38	25	8
2009	572	3069	836	1188	17	0.8	2
2010	536	3761	844	1365	53	21,9	9
2011	341	1700	415	692	41	20	2
2012	487	2961	624	959	48	22,1	3

Source : Idem. Direction Production CPG, Annuel rapport, jan. 2013.

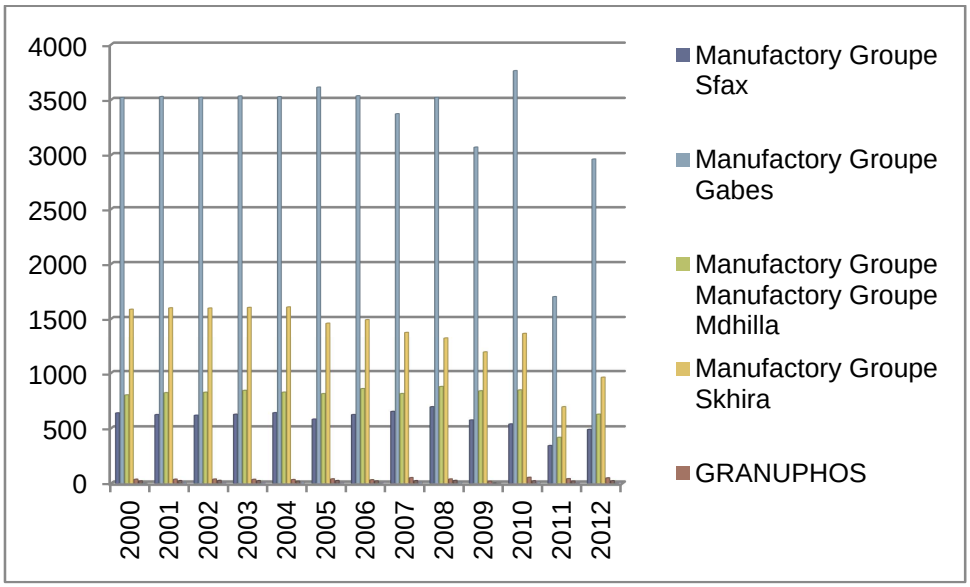


Figure.6. Répartition du volume des ventes local des produits miniers par client

Ce tableau 5, présent les quantités annuelles vendues entre (2000-2012) aux sept principaux clients locaux sur le territoire Tunisien qui sont réparties à titre croissant des quantités vendues (i.e. Société des Engrais Chimiques, Société Salakta des Engrais, GRANUPHOS, Manufactory Groupe Sfax, Mdhilla et Skhira, respectivement). Les quatre groupes de favorisation (Skhira, Gabes, Mdhilla et à Sfax) sont les principaux clients locaux pour la Firme Minière Gafsa, leurs consommations moyen et à long tour de 1420 Mille tonne, 3450 Mille tonnes, 790 Mille tonnes et 602 Milles tonnes, respectivement. Pour les trois autres sociétés, à savoir, GRANUPHOS, Société Salakta des Engrais et Société des Engrais Chimiques leurs quantités sont faibles comparés au premier groupe.

Ainsi, le volume annuel pour cette période (*cf.* Fig.6) ne dépasse pas 40 Mille tonnes pour GRANUPHOS, 24 Milles tonnes pour la Société Salakta des Engrais et 7.5 Milles Tonnes pour la Société des Engrais Chimiques. Même remarque, les quantités ont été baissées presque en moitié en 2011 pour toutes les Sociétés vu la chute de la production du produit minier par la Firme mère minière de Gafsa pour cette année 2011. Par contre le retour s'est franchi en 2012, comme montrent les quantités vendues à ces clientèles locales, mais elles n'attiennent pas leurs valeurs moyennes normales qui seront tenues en 2013.

3.3 ETAT FINANCIERE DE LA FIRME MINIERE : PERFORMANCE FINANCIERE REMARQUABLE

En analysant les états financiers (Bilan, Etat de résultat, Flux de trésorerie) du deux département Finance et Budget de la Firme minière [18] pour ces différents exerces d'activité au 31/12/an de la période (2003-2012), on peut les synthétisés dans un rapport collectif annuel comme montre le tableau ci-dessous.

Tableau.6. Les résultats financiers pour la dernière décennie (2003-2012) en Million TND.

	Les Actifs			Les Capitaux propres et Passifs			
	ANC	AC	Total (Ac)	CP	PNC	PC	Total (Ps)
2003	141	321	462	221	101	107	429
2004	157	306	463	253	97	113	463
2005	206	317	523	300	101	122	523
2006	136	408	544	331	82	131	544
2007	248	415	663	403	92	168	663
2008	566	1134	1700	1300	142	258	1700
2009	389	991	1380	828	153	399	1380
2010	808	767	1575	1049	157	369	1575
2011	636	1097	1733	956	175	599	1733
2012	725	1124	1849	1030	199	650	1849

Source : Direction Générale de Finance CPCT, Dép. Finance. Jan.2013.

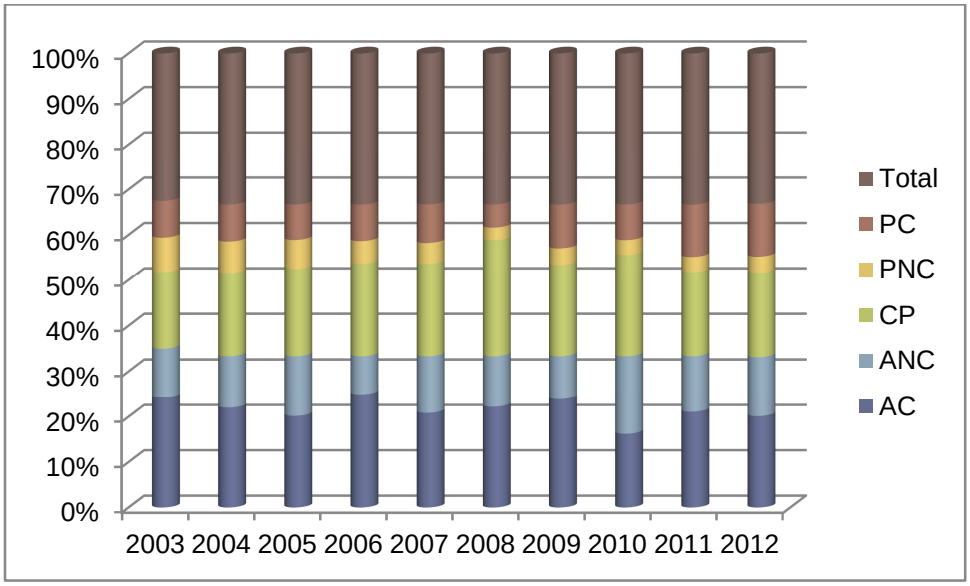


Figure.7. Les résultats financiers pour la dernière décennie (2003-2012) en Million TND.

Note : ANC : Actif non courant, AC : Actif courant, CP : Capitaux propres, PNC : Passif non courant, PC : Passif courant. Ac : Actifs, Ps : Passifs.

A partir des résultats financiers pour la dernière décennie [18], les ANC ont multiplié par deux en 2008 soit un équivalent de 566 Millions TND de même l'actif courant AC est multiplié de 2.5, soit 1134 Millions TND. Dans le même perspective, le total des capitaux propres et les passifs a enregistré un accroissement remarquable passant de 663 Millions de Dinars en 2007 et a triplet en 2008. Cette hausse s'explique par les vols des cours des prix des produits minier dans les marchés mondiaux, suit à la hausse des cours des hydrocarbures en juin 2007.

Par ailleurs, la hausse des cours des produits miniers s'est accompagnée par une forte demande des pays émergents (Chine, Inde, Indonésie) pour les diverses produits chimiques miniers pour la fertilisation des l'agriculture et l'usage pharmaceutiques et la fabrication détergents de lessive à partir des compositions phosphatés. Fort de constater que malgré un petit redressement des prix des produits minier, leur rente économique reste très satisfaisante et rapportant des gains surprenants depuis 2009 jusqu'à nos jours, soit un total de capitaux propre de 1030 million de Dinars tunisiens à la fin 2012. Bien que le rythme de vente reste encore encouragent pour les pays miniers, le cas de la Tunisie, malgré les perturbations économiques et sociales qu'elle vécue dernièrement.

Pour le résultat annuel des revenus nets (*cf.* tableau ci-dessous), une synthèse des dix derrières années nous permettra de fournir les données suivantes :

Tableau.7. Résultat annuel des Revenues nets collectés des ventes entre (2003-2012) en Million TND

	Résultat annuel		Revenu net
	Revenu collecté	TVA	(après déduction des charges extra)
2003	251	142	29
2004	240	131	25
2005	290	189	47
2006	330	210	54
2007	403	268	99
2008	1406	1242	951
2009	613	460	269
2010	783	605	375
2011	590	466	187
2012	687	553	243

Source : Direction Générale de Finance CPCT, Dép. Budget. Jan.2013.

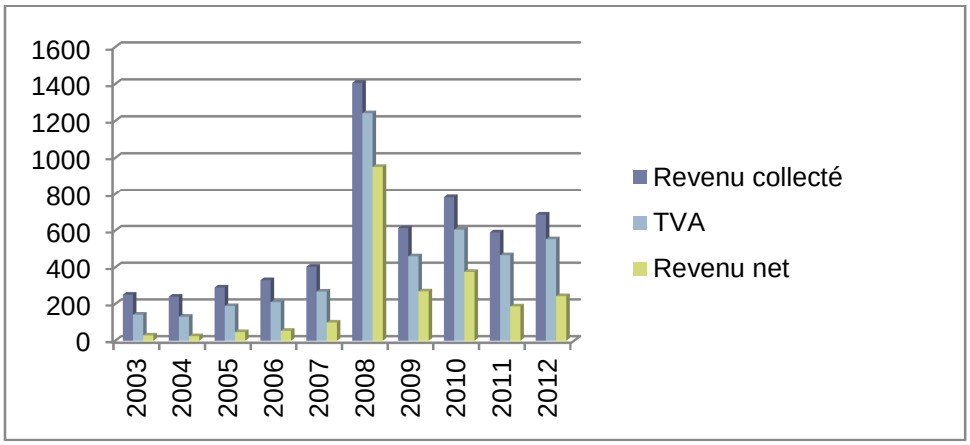


Figure.8. Résultat annuel des Revenues nets collectés des ventes entre (2003-2012) en Million TND

A partir du Tableau 7 et la Fig.8, on note que le revenu net (après soustraction du TVA et autres charges) a enregistré un gain d'encaisse inattendu depuis une vingtaine d'année, soit 951 Million TND à la fin de 2008 (11 fois celui de 2007 et prés de 4 fois du revenu net en 2009). Cette hausse des encaissements enregistrés suite à la hausse des prix des produits miniers ont des retombés très positifs pour la Firme minière [18] Tunisienne. Ce qui a permis de redresser les dépenses de production des années antérieurs (2003-2006) et enregistré un gain excédent qui s'est poursuivit en 2009 à 2012, soit 243 Millions TND. Par cet effet, l'équilibre budgétaire est atteint depuis 2008 procurent une plus value remarquable permettant de créer des nouveaux investissements et renforcé la prospection des nouveaux marchés niche pour le produit miniers Tunisien.

Par ailleurs, une part de cet excédent des flux de devise, ont été tournés vers le développement régional du Bassin Miner de Gafsa, terrain d'exploitation et de production de minerais sous-sols. Alors que la grande part sera versée dans la caisse de gouvernement Tunisien, comme pour toute autre sociétés publiques.

Au final, cette industrie minière qui participe à plus de 4 % au PIB tunisien en 2012, reste encore le principal secteur économique où s'appuie l'Etat Tunisienne pour soutenir l'économie dans les différentes circonstances économiques graves : comme celle de la fin 2008 et la période post-révolution depuis 2012 à nos jours.

3.4 Repartition Du Capital Humain De La Firme : Niveau Hierarchique, Formation Et Charges Sociales

La Firme Minière tunisienne se base plus sur ces propres ressources humaines dans leur production et la prospection des marchés. En effet, ce capital humain se répartit en quatre classes qui sont en synergie d'ensemble pour assurer en d'autres termes la cohésion en lieu de travail. Pour la période d'étude (1999-2012), le nombre total annuel est quasi le même, 5625 personnes en 1999 et 5513 personnes en 2012. La Firme Minières de Gafsa fait des recrutements annuels qui se différent d'une année à l'autre et selon les postes vacants enregistrés par le département des affaires de personnels [19].

Il n'est pas étonnant que le nombre des agents d'exécution et les agents superviseurs regroupent la quasi-totalité des ressources humaines de cette Firme minière Tunisienne (*cf.* Tableau ci-dessous), la raison est simple c'est le fait de la nature d'activité de cette Firme minière qui exige un grand nombre de mains d'œuvres d'exécutions dans les mines et les carrières d'extraction des roches phosphatées. Contre seulement un nombre réduit des Cadre et des dirigeants.

Tableau.9. Evolution en nombre des ressources humaines entre (1999-2012)

	Cadres Supérieurs et Dirigeants	Cadres Moyens	Agents Superviseurs	Agents d'exécutions	Total
1999	461	214	3867	1082	5625
2000	452	241	3901	1102	5696
2001	472	293	3962	1147	5874
2002	486	249	4051	1214	6000
2003	494	265	4084	1268	6111
2004	499	271	4110	1343	6223
2005	498	311	4197	1199	6205
2006	492	303	3989	999	5783
2007	480	298	3784	730	5292
2008	507	307	3769	902	5485
2009	482	298	3485	771	5036
2010	460	293	3383	762	4898
2011	433	289	3047	1819	5588
2012	401	280	3013	1819	5513

Source : Direction Affaires Administratives des Personnels, Dép. Ressources Humaines, CPGT Fév.2013.

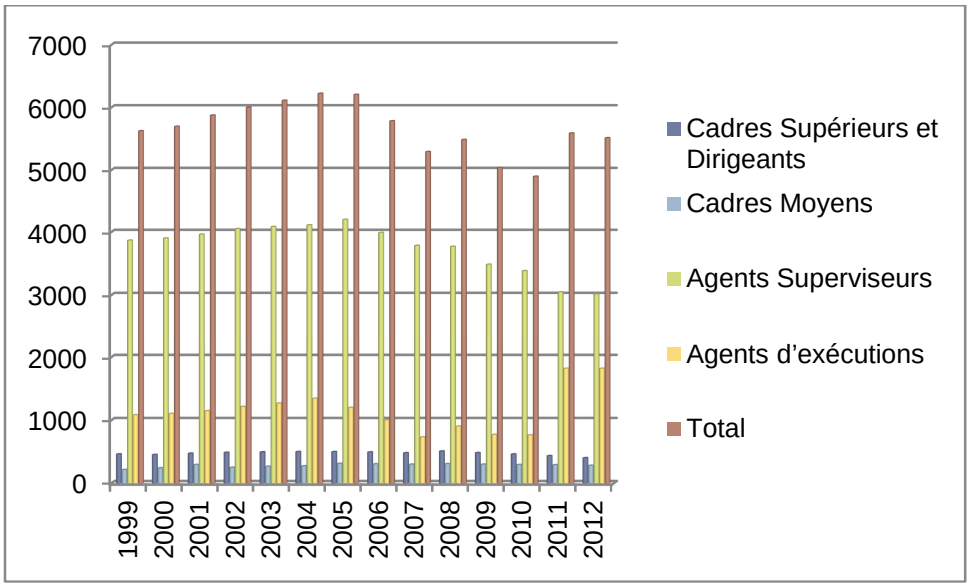


Figure.10. Evolution RH : Capital humain

On peut regrouper ces ressources humaines en deux groupes. Le premier referme les Cadres Supérieurs et Dirigeants et les Cadres moyens le total est 401 et 280 respectivement en 2012, soit un total de 681personnels [19]. Pour le deuxième groupe (Agents superviseurs et d'exécutions) le total n'a pas trop changé comparé en 1999 (4949 ouvriers) et 4832 en 2012. Malgré que la Firme minière en 2011 à fait embaucher remarquable comparé aux autre années, prés de 1000 ouvriers, pour calmer les pressions sociales des jeunes miniers demandeurs d'emploi et de trouver une entente avec les parties syndicales de la Firme Minière de Gafsa.

3.4.1 LA POLITIQUE DE LA FORMATION PROFESSIONNELLE DES RESSOURCES HUMAINES

La Firme Minière Tunisienne consacre une importance propice pour les formations professionnelles des leurs ressources humaines (Cadres et ouvriers) sans exception. Cette stratégie de stimulation et d'enrichissement du savoir-faire et l'usage des innovations technologique n'est pas nouvelle pour cette citoyenne Firme Minière. En fait, vu l'utilité de ces formations, la Firme à créée un département spécifique pour le suivit de tous les sièges et connaitre les besoins en nombre des personnes pour suivre des formations et la spécificité de la formation poiur chaque direction de la Firme Minière qui doivent être tenus

par des experts (professionnels appartenant de la Firme minière Gafsa Tunisienne et ceux académiques du milieu universitaire).

Mais la Firme passe au-delà de ces types de formations, par le fait d'envoyer pour des besoins très spécifiques un groupe de ces cadres à l'étrangers (en France, en Allemagne et à l'Inde) pour suivre des formations en deux à trois mois, nommé voyage-formation tous les 5 cinq ans où le dernier était en 2010, sur les techniques scientifiques des nouveaux équipements miniers et leurs procédures de production. A leurs retours de ces formations à l'étrangers, ces parties bien formées à leurs tours faisant la formation aux autres personnes. C'est vrai que l'ensemble de ces formations sont des charges supplémentaires supportées (*cf.* Tableau 10, ci-dessous) par la Firme minière mais avec une minoration du salaire brut des personnes conçues par la formation.

Tableau.10. Planning des formations et les coûts assumés par la Firme minière

	Nombre des participants (Personnels et ouvriers)	Périodicité (en jours)	Coût de Formation (Million TND)	Coût de formation/ Salaire brut (en %)
1999	1692	117548	9.68	7.1
2000	1603	108267	8.51	6.8
2001	1578	106664	6.75	6.5
2002	1597	107503	6.69	6.2
2003	1641	107619	6.71	6.3
2004	1663	106664	6.75	6.5
2005	2295	92286	7.18	6.3
2006	3546	101301	8.30	6.7
2007	3596	114744	9.50	8
2008	2665	58031	6.10	4.9
2009	1207	43446	4.40	3.3
2010	1779	99722	7.70	5.8
2011	785	8414	1.80	1.3
2012	3952	124893	10.60	11.2

Source : Direction Affaires Administratives des Personnels, Dép. Ressources Humaines, CPGT Fév.2013.

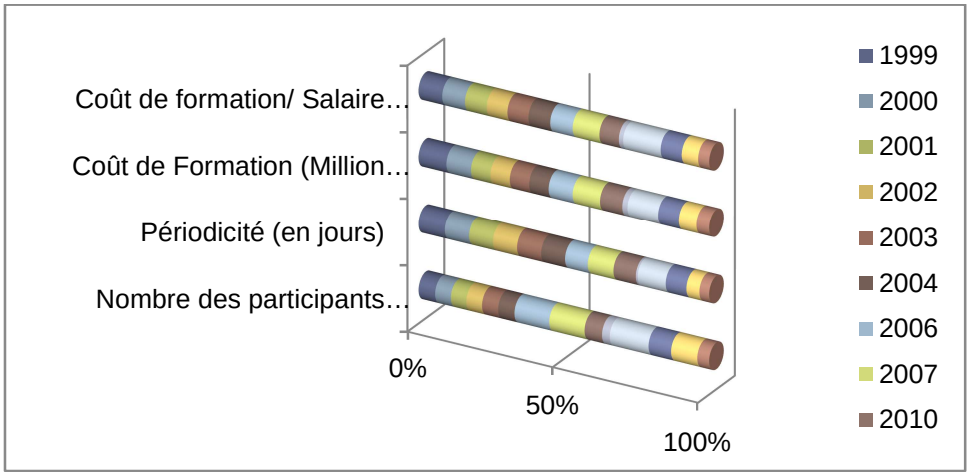


Figure.11. Planning des formations et les coûts assumés par la Firme minière

Une vue d'ensemble de ce tableau montre en clairvoyance, pour une période qui dépasse dix ans (1999-2012), que le nombre des participants que se soient Cadres supérieur, inferieurs et/ouvriers est en accroissement annuel depuis 1999 (1692 personnes). Ce nombre est doublé en 2005 et même triplet en 2007 et remarquablement en 2012 où il atteint 3952 participants. Ce croissement des personnes vient de fait s'ajuster avec l'augmentation des nouvelles embouches faite par la Frime en fin 2011. De même la périodicité de ces formations est dans un intervalle de (92286 J -124893 j), seulement en 2011, sous les faits de la baisse de la production étant l'année de la révolution.

Les cous de formation sont de 6.10 Millions de Dinars en 2008 à10.60 Millions de Dinars en 2012. Pour les autres années sont en moyen de 7.23 Millions de Dinars, seulement un faible coût assumé par la Firme en 2011 qui n'atteint pas 2 Millions

TND. Dans la même perspective de raisonnement des coûts, le pourcentage annuel des coûts de formation par rapport au salaire bruts entre (1999 et 2007) est à l'ordre de 6.7 %. Une baisse importante de 1.3% enregistrée en 2011, mais d'un coup se multipliée par 11 fois, soit 11.2% le coût de formation sur salaire brut en 2012.

3.4.2 LES SALAIRES ET CHARGES SOCIALES : DECAISSEMENT SIGNIFICATIVE

Comme elle était connue dans leur cadre législatif, La firme minière est publique et l'Etat Tunisienne est la principale actionnaire de plus de 97% de leurs actifs. Cette Firme minière qui est constitue le seul pole industriel pour ces zones miniers sud-ouest de la Tunisie support autres que ses propre dépenses de production, des charges salariales et un masse salarial (*cf.* Tableau 11, ci-dessous) très important comparais aux autre sociétés de taille équivalent.

Tableau. 11. Affectation des salaires et les charges sociales en (Million Dinar)

	Masse salarial (sans C. S)	Charges sociales (C.S)	Total
1999	461	214	5625
2000	452	241	5696
2001	472	293	5874
2002	486	249	6000
2003	494	265	6111
2004	499	271	6223
2005	498	311	6205
2006	492	303	5783
2007	480	298	5292
2008	507	307	5485
2009	482	298	5036
2010	460	293	4898
2011	433	289	5588
2012	401	280	5513

Source : Direction Affaires Administratives des Personnels, Dép. Ressources Humaines, CPGT Fév.2013.

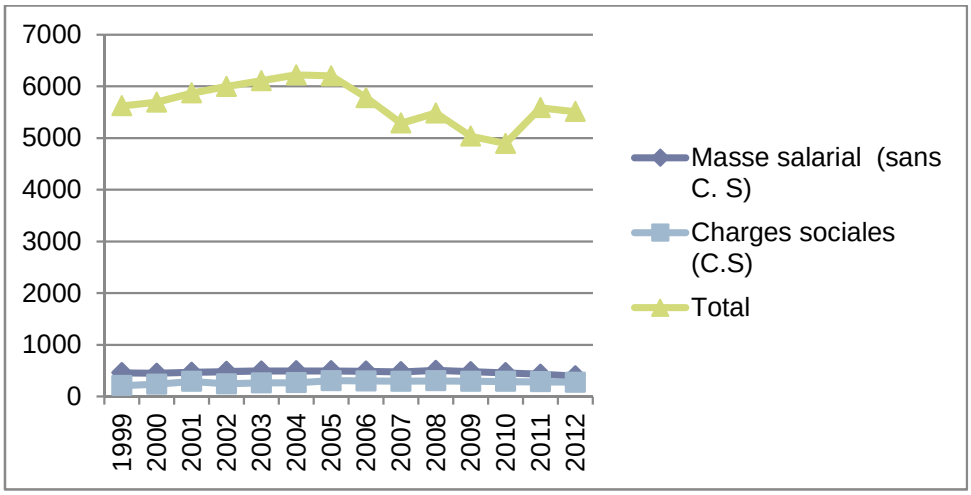


Figure.12. Affectation des salaires et les charges sociales

En raisonnant en termes de la somme du masse salarial et les charges sociale, depuis (1999-2012), on pourra dégager trois dates essentielles où la somme totale à nettement augmentée. La première en 2002 (6000 Millions Dinars), la deuxième en 2005 (6205 Millions Dinars) et la dernière d'un équivalent de 5588 Millions Dinars en 2011. Pour ces trois années précitées, dans plus de dix ans, représentent en fait les moments de recrutement faite par la Firme minière selon ces propres besoins de mains d'œuvres et des cadres.

C'est pour cette raison que le total des charges salariales a augmenté d'une année à l'autre. Le plus remarquant, en 2011, malgré les difficultés économiques et financière pour l'année de la révolution, cette citoyenne Firme Minière Tunisienne a continué à verser les salaires et les suppléments des primes et charges sociales pourtant le rythme de productivité était sous ces niveaux habituels. Ca montre bien le degré de performance financier et leur remarquable poids économique comparé à autres entreprises et sociétés Tunisiennes dans d'autres secteurs d'activités pour la même période difficile économiquement de 2011. Ca prouve en final la capacité de cette citoyenne Firme minière a géré les graves situations socio-économiques et de sortir avec un minimum de dégât, comme c'était fait en 2011 et 2008.

3.5 RSE ET ROLE SOCIAL ENVERS CES REGIONS MINIERES : SECURITE ET PROTECTION DE L'ENVIRONNEMENT

Comme pour toute industrie minière dans les pays en développements miniers (Tunisie, Maroc, Congo, Jordanie, etc.), la polémique Mines-Environnement [20] reste encore à nos jours la principale préoccupation des dirigeants miniers dans ces pays.

3.5.1 ENVIRONNEMENT MINIER ET SECURITE PROFESSIONNELLE TRAVAILLEURS MINIERS

Le cas ici de l'industrie minière Tunisienne, à travers la Firme mère des phosphates Gafsa, ne cache pas les impacts négatifs sur l'écologie (Santé de citoyen miniers, Biodiversité animal-végétal et Dégradation des tissus végétaux des montagnes, etc.) et l'environnement du Bassin Minier Tunisien en général.

Fort de remarque que l'effort de ces pays en développements miniers restent encore dans leurs premiers chemins si nous le comparons avec les states achevés par les pays homologues industrialisés miniers (le Canada, l'Australie, les Etats-Unis, l'ex-URSS, etc.) qui ont pu trouver un certain équilibre Mines-Environnement dans les sites exploités.

Ainsi, sous les effets positives en registrés par ces pays industrialisés miniers, le ministère de l'industrie et des mines Tunisien a incité, depuis le début des années 90's du dernier siècle, la Firme Minière Gafsa opérant dans le Bassin Miner Tunisien de créer un Département environnement et sécurité [20], indépendant dans le statut de cette Firme qui soit consterné pour la question de l'environnement et la sécurité des citoyens miniers.

Tableau.12. Sécurité professionnelle et accident du travail

	Nombre des accidents	Fréquence (en %)	Degré de Gravité (en %)
1999	235	1,62	1,30
2000	234	1,61	1,29
2001	231	1,57	1,24
2002	201	1,32	0,93
2003	198	1,27	0,89
2004	194	1,22	0,83
2005	182	1,14	0,75
2006	176	1,19	0,78
2007	157	1,14	0,75
2008	168	1,12	0,69
2009	178	1,20	0,80
2010	110	0,82	0,59
2011	95	0,62	0,47
2012	58	0,41	0,27

Source : Direction environnement, Dép. Sécurité et santé, CPGT Fév.2013.

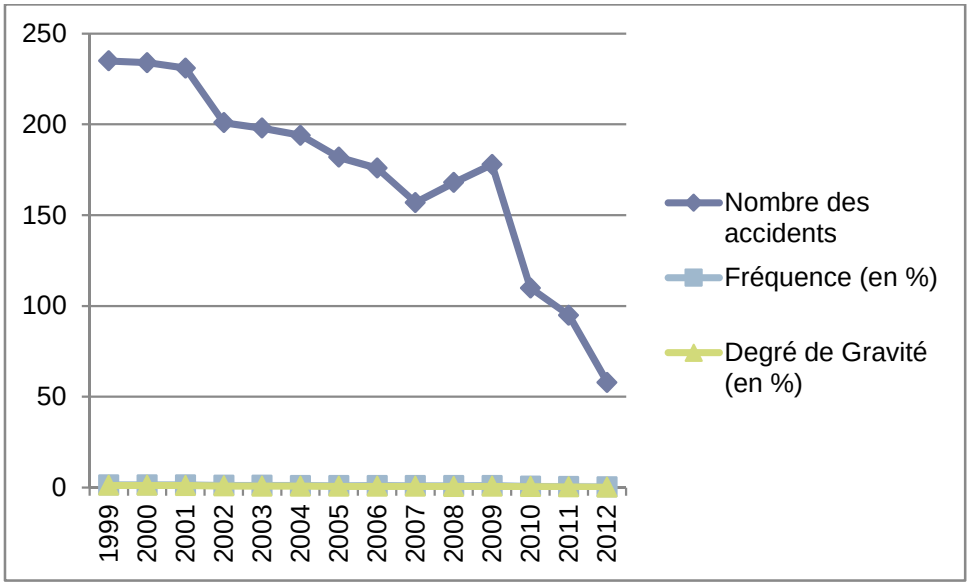


Figure.13. Sécurité professionnelle et accident du travail

Concernant la sécurité professionnelles, d'après le tableau ci-dessus, le taux des accidents des miniers dans le lieu de travail était très élevé au début de 2000 (234 accidents en 2000, soit 1.61% et un degré de gravité soit 1.29%). Mais, vers la fin du la première décennie du 2000, Ce nombre des accidents venaient de rétrécir et leur taux de gravité s'aligne avec cette baisse. En effet, la fréquence des accidents en 2012 soit le ¼ de celui en 1999. Et le nombre des accidents ont enregistrés seulement 58 avec un degré légère de gravité des accidents prés de 0.27% en 2012.

Ces résultats sur la sécurité professionnelle des travailleurs miniers dans cette Firme Minière prouve en clairvoyance une amélioration du milieu du travail et l'usage des meilleurs mécanismes de sécurités tenus pour sauvegarder la santé et la sécurité des miniers dans ces sites de production. Où le travailleur minier constitue le nerf principal voire même la source capitale pour le maintien de cette industrie minière et leur progrès pour les années futures.

3.5.2 RESPONSABILITE SOCIALE RSE

A par la sécurité des travailleurs miniers, la question de l'environnement et la Responsabilité Sociale entreprise RSE par la Frime minière Tunisienne reste au cœur des stratégies (*cf.* Tableau 13, ci-dessous). En fait, cette Firme Minière Tunisienne a obtenu en 2008 le « premier prix de la meilleure Entreprise Sociale » gouvernant [21] Ingham, M., (1995) dans le territoire national qui a investit remarquablement dans l'éduction sportive de leurs salariés pour assurer leurs bien formes (le club sportif de la Firme minière créé depuis 1989, qui participe à plusieurs compétions nationales).

Tableau.13. Responsabilité Sociale RSE de la Firme et protection de l'environnement

Projets d'accumulation des boues miniers après usages des eaux de laveries. (7 projets)	Parcours de création du projet (%)	Restant de création du projet (%)	Entrée en vigueur du projet
P1. Bassin Laverie I,II et III à Métlaoui	84 (Déc.2005)	16 (Sep. 2006)	Déc. 2006
P2. Bassin Laverie III Mdilla	48 (Déc.2004)	52 (Sep. 2005)	Sep. 2005
P3. Bassin Kef Edour.Métaloui	75 (Déc.2005)	25 (Sep. 2006)	Déc. 2006
P4. Laverie Redayef	73 (Déc.2008)	27 (Sep. 2008)	Sep. 2009
P5. Laverie Moulares	73 (Déc.2008)	27 (Sep. 2008)	Sep. 2009
P6. Laverie I et II Mdilla	20 (Déc. 2008	80 (Sep. 2008)	Sep. 2010
P7. Laverie III Mdilla	72 (Déc.2008)	28 (Sep. 2008)	Août. 2009

Source : Direction environnement, Dép. Sécurité et santé, CPGT Déc.2011.

Comme montre ce tableau 13, la Firme a député depuis 2004 jusqu'à 2009 de créer sept projet sous forme des grands bassins d'accumulation des boues miniers et des eaux usées par les usines et les laveries des phosphates marchants. Ces bassins d'accumulations des boues miniers ont été construits dans l'extrémité des sites miniers pour qu'ils soient le plus loin possibles des habitats où vivaient les citoyens miniers. La surface qui soit tenue diffère d'un site à un autre, soit en générale de 35 à 600 hectares).

Ces projets sont répartis en deux phases entre (Déc.2004-Sep.2010). Les premiers sites les plus productifs concernés qui constitue 75% du production dans le Bassin Minier à savoir (P1.Bassin Laverie I, II et III de Métlaoui, P2. Bassin Laverie III Mdilla et P3. Bassin Kef Edour.Métaloui). Pour les projets P1 et P3 sont fonctionnels en déc. 2006, alors que le projet P2 est entré en vigueur de puis Sep. 2005. Ces trois projets (P1, P2 et P3) ont permet chaque année de rassembler, respectivement, 3 Million m^3, 2.5 Million m^3 et 1.5 Million m^3 des boues miniers. Soit un total de 7 Million m^3 des eaux usées et boues miniers des laveries, à partir de 2008. Ces boues cumulées dans ces bassins représentent 63% du total des Boues versés (12 Million m^3) auparavant dans les rives et les oueds à la proximité des usines de lavages.

A partir de la fin de 2008, quatre autres projets d'accumulation des boues miniers ont été mis en place dans les sites miniers suivant : Redayef (P4, Sep.2009), Moulares (P5, Sep.2009), Mdilla I , II (P6, Sep.2010) et III (P7. Sep.2009).

Ces projet de réassemblage des boues miniers ont des capacités d'accumulation respectives, de 1.5 Million m^3, 1 Million m^3, 3 Million m^3 et 2.5 Million m^3. Ces projets d'accumulation des boues miniers représentent 8 Million m^3, équivalent à 57%, du total versé (14 Millions m^3) dans les rives et les oueds à la proximité des usines de lavages.

Au final, ces projets ont un impact positif sur l'environnement et la société qui ont permis de stocker les substances fines minières dans des bassins à l'extérieur de zones d'habitation des citoyens miniers par des canaux sous terrains. Ils ont été comme une nouvelle technique et une alternative réelle pour éliminer l'écoulement direct de ces substances fines dans les oueds et la rivière de Thelja. Une fois que ces bassins de cumulation arriveront à des stades de pleine saturation, autres nouveaux bassins seront habituellement construits pour recevoir les quantités de rejets miniers à transposer. Et ainsi de suite, ce projet des bassins constituât jusqu'à 2012 une alternative plus rationnelle pour protéger l'environnement et l'écosystème naturel dans ces zones miniers face à l'incidence néfaste de l'industrie minière.

Ajoutant aussi les techniques de séchages avec l'eau mouillée pour minimiser l'empoussièrement des granules de boudes fines cumulées dans l'air et l'arrosoir régulier des chemins de circulations des engins de transport du produit minier. Tous sont des procédures ont été mises en place par la Firme minière de Gafsa, depuis plus une vingtaine d'années pour atteindre les normes internationaux de la protection de l'environnement minier. Fort de constater aussi que cette Firme minière Tunisienne n'hésite pas à acquérir toute les nouveautés techniques dans le domaine de protection de l'environnement minier et consacre un budget annuel en cette matière de 3.1 Million TND en 2012, contre 2.7Million TND en 2011 (Statistiques bureau recherche environnement minier, Sep.2012).

4 RATING DES ORGANISATIONS DE NOTATION ET LA POLITIQUE DE GOUVERNANCE DE MOYEN ET LONG TERME : ALLIANCE STRATEGIQUE EN JOINT-VENTURE, ESSAIMAGE ET RATIONALISATION DE L'ENERGIE

Le rôle de ces organisations internationales de notation est de refléter l'état économique et financière réel des Entreprises et permettre en contre partie de divulguer ces informations aux investisseurs étrangers et stimuler leurs envies dans divers secteurs d'activités économiques.

4.1 NOTATION INTERNATIONALE DE LA FIRME PAR LES ORGANISATIONS DE RATINGS

Parmi les organismes internationaux de notation 'Rating' [22] à statut légal, on peut citer l'Agence Fitch Ratings internationale (AFR). Celle-ci publiait des rapports annuels sur l'état actuel et de moyen de long terme pour la Firme Minière Tunisienne. Depuis la fin 2008, suite au gain remarquable enregistré par cette Firme Minière, l'Agence rating a modifié positivement la notation de cette Firme en (*cf.* tableau ci-dessous):

Tableau.14. Les notations de l'Agence Rating (AFR) attribuées à la Firme Minière Tunisienne entre (2008-2012)

	2007	2008	2009	2010	2011	2012
National de long terme (TUN)	AA-	AA+	AA+	AA+	AA+	AA+
National de court terme (TUN)	F1	F1+	F1+	F1+	F1+	F1+
Horizon (National)	Positive	Stable	Stable	Stable	Stable	Stable

Source : AFR, Bureau Afrique, Div. planning et développement CPG, Jan. 2013.

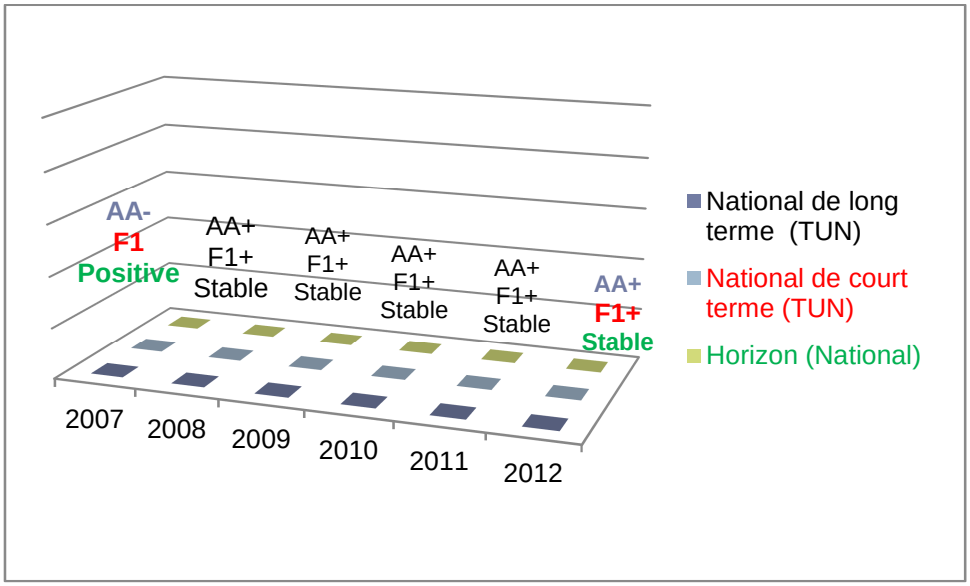


Figure.15. Les notations de l'Agence Rating (AFR) attribuées à la Firme Minière Tunisienne entre (2008-2012)

Ces notes qui sont attribuées par l'agence Fitch Ratings depuis 2007 (AA-, F1 et positive) ont été améliorés suite à l'effort remarquable en termes de productivité et du volume d'exportation enregistrés par la Firme Minière Gafsa en (AA+, F1+ et Stable) de 2008 jusqu'à 2012. La crise financière mondiale 2008 a légèrement touché la Firme minière comme pour toutes sociétés exportatrices, mais elle a pu la supporté pour sortir avec un minimum de dégâts financiers. C'est pour cette raison les experts de notation de cette Agence de ratings ont modifiés leur notation (du négative AA- au AA+ et de positive en situation Stable de long terme).

4.2 LA STRATEGIE DE PARTENARIAT : ALLIANCE AVEC JOINT-VENTURE CAPITALISTIQUE

En 2008, la Firme minière de Gafsa tunisienne a conclu un accord de partenariat avec la société International Indienne pour assurer plus leur compétitivité [25], [23] et [24] internationale (Fagerberg, J., 1998, Rexecode C.O.E., 2009, Debonneuil, L. and L., Fontagne, Durand, M., et C., Giorno, 2007). Cette nouvelle société en joint-venture capitalistique Tuniso-indienne réclamée leur entrée en vigueur en 2011 sous le nom TIFERT : La société Tunis-Indienne des Engrais miniers. Ainsi ce projet d'association procurera la production de 360 000 tonnes d'acide phosphorique et dérivés sous la transformation de prés de 1.5 Million de tonnes des Phosphates marchants.



Figure.16. Joint-venture capitalistique entre la Tunisie et L'Inde pour la fertilisation des engrais chimiques (TIFERT) en 2008.

La Firme Minière tunisienne détient 35% du capital total sous cet accord (Dussauge, P., B., Garrette , 1990, Dymsza, W.A., 1988. , EL Youssefi, M., 2000. , Hennart J.-F., M., Zeng, 2005. , Franko ,L.G., 1971) de Joint-venture capitalistique avec une Firme Indienne TIFERT ([27], [28], [29] et [31]), et 65% pour la Compagne International Indienne. Ce projet est créé dans la communauté SKHIRA Sfax (à 89% achevé en 2010), à part leur source d'emploi pour cette région devrait obéir à certaines spécificités écologique et environnementales telles que :

- Usage des TIC pour rationaliser les émissions des poussières et les gaz dégagés.
- Maitrise des eaux usées par les usines TIFERT de fabrication des engrais chimiques
- Créer un Fond de protection de l'environnement et gestion des déchets miniers
- Maintenance régulière des flux de transport des produits chimique selon les nomes internationaux.
- Conserver la maitrise de l'énergie et voir autres ressources substituables naturelles

Cependant, la Firme Minière de Gafsa depuis 2008 a augmenté aussi sa participation comme associé dans des diverses sociétés (STEC, TIFERT, GRANUPHOS, STTPM, Pôle de Tech. G, S. plantation et Environnement, FERDOCM) à titre d'alliance stratégique et dans d'autres comme partenaire associé, le cas de TIFERT Tuniso-Indienne. Les principales sociétés où la Firme minière tunisienne détient des parts remarquables de leur capital social sont synthétisées dans le tableau ci-dessous entre (2008-2011).

Tableau.15. Principaux participations en Joint-venture de la Firme minière depuis 2008 dans le capital d'autres Sociétés nationales et étrangères (Million TND)

Les sociétés	Part de participation en 2008 Capital (%)	Total des Actifs détenus
STEC	17.73	57.10
GRANUPHOS	6.84	13.30
Pôle de Tech. Gafsa	40.00	69.51
TIFERTTunisoIndienne	35.00	71.46
FERDCM	76.26	12.00

Les sociétés	Part de participation en 2009 Capital (%)	Total des Actifs détenus
STEC	11.73	73.8
GRANUPHOS	10.27	09.20
Pôle de Tech. Gafsa	37.20	19. 10
TIFERTTunisoIndienne	35.00	71.46
FERDCM	76.27	18.40

Les sociétés	Part de participation en 2010 Capital (%)	Total des Actifs détenus
STEC	10.27	74.70
GRANUPHOS	10.27	14.10
Pôle de Tech. Gafsa	40.00	21.40
TIFERTTunisoIndienne	35.00	70.08
FERDCM	76.98	24.30

Les sociétés	Part de participation en 2011 Capital (%)	Total des Actifs détenus
STEC	10.61	23.30
GRANUPHOS	12.24	21.60
Pôle de Tech. Gafsa	52.31	30.41
TIFERT Tuniso-Indienne	35.00	78.74
FERDCM	71.51	17.00
STTPM	51.27	10.00
S.SPS	08.21	01.19
S. plantation et Environnement Metlaoui	10.89	02.00
S. plantation et Environnement Redayef	10.89	02.00
S. plantation et Environnement Moulares	10.89	02.00
S. plante et Environnement Mdhilla	10.89	02.00

Source : Département recherche et développement CPGT, Division planning stratégie. Fév.2012.

Note :

- STEC : Société Tunisienne des Engrais Chimiques, (locale Tunisienne)
- TIFERT : La société Tuniso-Indienne des Engrais miniers, (ETANGERE, exerce leur activité en Tunisie)
- GRANUPHOS : Société des engrais Phosphatés, (locale Tunisienne)
- FERDOCM : Fond de Rénovation et Développement des Centres Miniers, (locale Tunisienne)
- Pôle de Tech. G : Pôle de Technologie Gafsa, (locale Tunisienne)
- S. plantation et Environnement : Les quatre sociétés de plantation et de l'environnement
- STTPM : Société Tunisienne de transport des produits Miniers, (locale Tunisienne)

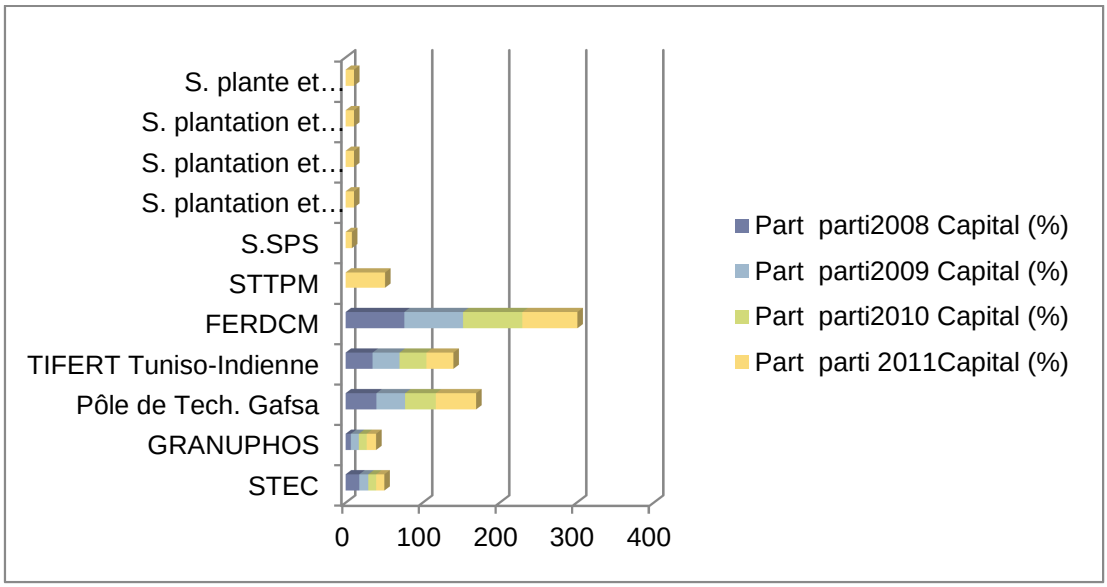


Figure.17. Principaux participations de la Firme minière depuis 2008 dans le capital d'autres Sociétés nationales et étrangères (Million TND)

La Firme minière a suivi la stratégie des alliances en joint-venture (Hoffman, W. H., R., Schlosser, 2001, Kanter, R.M., 1994, Luo, Y., 1997, Merchant, K.A., 2005, Nguyen, H. L., J., Larimo, 2008) avant 2008. Les principaux parts d'association en capital ([32] à [36]) sont déjà faits avec des sociétés à l'échelle nationale de grande taille comme (i.e. STEC : Société Tunisienne des Engrais Chimiques10.61% en 2011, GRANUPHOS : Société des engrais Phosphatés 12.24%, Pôle de Tech. G : Pôle de Technologie Gafsa 52.31%) et une participation en capital remarquable de 71.51% dans le FERDOCM (Fond de Rénovation et Développement des Centres Miniers).

Toutes ces participations en capital avec ces dives compagnies, depuis les années quatre-vingt-dix du dernier siècle, se progressent à nos jours avec un rythme de participation stable voire même croissant pour la fin 2011 (*cf.* Figure 17).

4.3 LES STRATEGIES D'ENCOURAGEMENT DE L'ESSAIMAGE ET CREATION DES PME

Sur la base du programme national d'encouragement à la création des PME/TPE par les propres salariés des entreprises publiques tunisienne (le cadre de la stratégie d'essaimage), la Firme Minière de Gafsa a pris l'initiative pour stimuler leurs cadres et leurs personnels d'entamer cette stratégie depuis 1996, en supportant financièrement et techniquement ces nouveaux promoteurs dans divers activités (industriel, Services, TIC, Agriculture, Tourisme, Textile, matières substantielles, etc.) dans leurs premières années de leurs projets.

Tableau.16. Principaux projets d'investissement suivant la stratégie d'essaimage national encouragée par la Firme Minière tunisienne CPGT entre (2008-2012).

	Projets créés en 2008		Projets créés en 2009		Projets créés en 2010		Projets créés en 2011		Projets créés en 2012	
	(PME)	%	(PME)	%	(PME)	%	(PME)	%	(PME)	%
L'Industrie	12	25	31	37	37	32,74	20	17,69	26	22,2
Les TIC	03	07	-		40	35,39	-		21	17,9
Les Services	14	29	25	28	-		50	44,24	36	30,7
L'agriculture	05	10	11	13	15	13,27	11	09,75	11	09,4
Le Tourisme	03	07	-		-		-		02	01,7
Les matières substantielles	05	10	10	12	10	08,84	10	08,84	08	06,8
Le Textile et patrimoine	06	12	06	07	11	09,73	11	09,73	13	11,1
Total	48	100	85	100	113	100	113	100	117	100

Source : Idem, Division planning stratégie. Mars, 2013. (Attribution auteur)

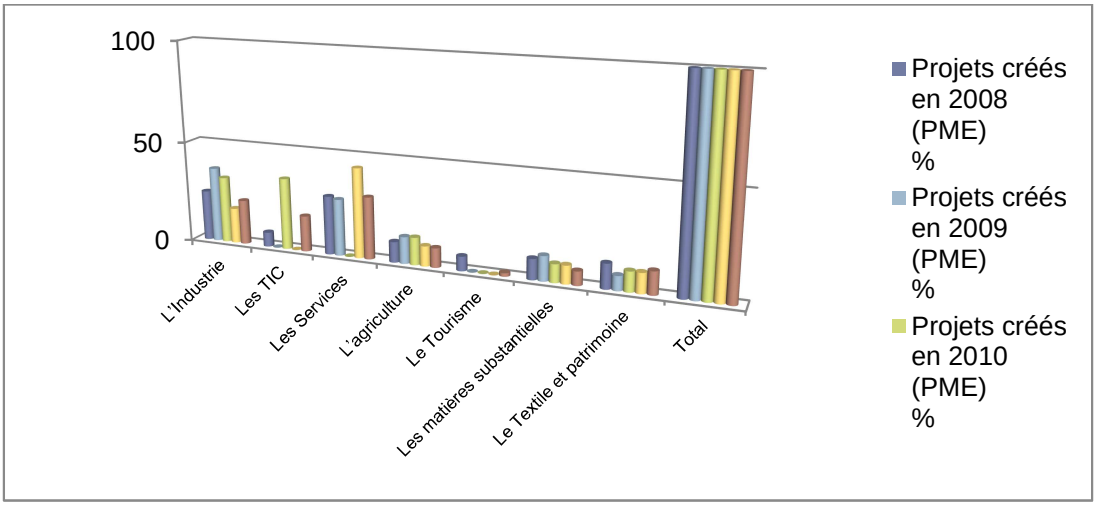


Figure.18. Principaux projets d'investissement suivant la stratégie d'essaimage national encouragée par la Firme Minière Tunisienne entre (2008-2012).

Ce tableau16 (*cf.* Figure 18) montre bien que sur les cinq derrières années (2008-2012) il y a eu un accroissement des nombres des projets créés (TIC du 03 projets à 21 projets en 2012, soit 7 fois plus, le secteur des services du 14 en 2008 à 36 projet en 2012 soit prés 2.5 foi, de même secteur industriel à progressé 2.2 fois pour la même période, etc.) avec une diversité des secteurs d'investissement (*cf.* tableau)par ces nouveaux salariés promoteurs pour enrichir le tissu industriel dans ces zones miniers et en même temps seront comme des petites Entreprises d'embauches des jeunes miniers demandeurs d'emploi.

En fait, cette stratégie d'essaimage à double piliers, le premier atout c'est la diversité du tissu industriel vers autres investissements productifs très utiles. Le deuxième atout c'est minimiser la pression sociale du problème du chômage qui atteint 68% des jeunes actifs miniers en 2011. Ces projets d'investissement ont créés 12% d'emploi directe en 2010 (Selon Satis. Département ressources humaine, 2010).

4.4 LES PROGRAMMES DE RATIONALISATION DE L'ENERGIE : EFFORT DE LA FIRME MINIERE ET RESULTATS OBTENUS

Après la fin de crise asiatique à la fin des années 90's, la Frime Minière Tunisienne ne fait pas l'exception, elle était touché par la hausse des cours des carburants. C'est pour cet effet, et précisément en 2005, la Firme Minière de Gafsa a eu recours à des stratégies de rationalisation de consommation et l'usage de l'énergie pour contrecarrer l'incidence négative de la hausse des cours de pétrole sur le coût de la production. Pour facilité l'exécution réelle de ces stratégies, la Firme a créée un organe légal en 2005 de management et de l'audite interne en collaboration avec tous les sièges de production et de valorisation des produits miniers dans le bassin minier Gafsa et les usines filiales. Cet organe de contrôle et de l'usage rationnel de l'énergie a contribué remarquablement pour assurer les objectifs dressés dans ces stratégies parmi lesquels :

L'ENERGIE ELECTRIQUE

- Assurer la maintenance régulière des réseaux électrique propre de la Firme.
- Faire un diagnostic périodique dans les différentes Unités de production (Usines et Laveries) et connaitre les fuites pour agir à temps relatif.
- Rationalisation de l'usage et la consommation d'électricité dans les différents départements administratifs de la Firme.
- inciter plus à l'usage des équipements miniers économique pour maitriser les coûts de production.

LES CARBURANTS

- La maintenance régulière des Engins lourds et les équipements miniers du terrain constituent le principal pilier pour maitriser les factures des hydrocarbures.
- La mise à niveau des centres de valorisation des engrais miniers et les machines de transformation des minerais.
- Faire une étude scientifique dans les carrières d'exploitation minière dont l'objectif est un détournement partiel vers l'usage de l'énergie naturel solaire à la place de pétrole.

- Installation des miroirs capteurs de l'énergie solaire dans les Usines de valorisation des phosphates marchants qui constitue une rente économique pour la Firme.
- Raccourcir les circuits de transports du produit minier pour maitriser la consommation de l'énergie par les équipements de transports (Engins lourds, Camions, Train vaguons).

Les principaux résultats de ces stratégies sont (*cf.* Laboratoire d'études et de recherches de Métaloui, Gafsa Nov., Tunis 2013):

- En 2008, Gains économique de 1800 Tonnes équivalent de 700 Mille Dinars Tunisiens.
- En 2009, Gains économique de 565 Tonnes équivalent de 220 Mille Dinars Tunisiens.
- En 2010, Gains économique de 535 Tonnes équivalent de 200 Mille Dinars Tunisiens.
- En 2011, (année de la révolution tunisienne, gain moins important que 2010)
- En 2012, Gains économique de 1200 Tonnes équivalent de 624 Mille Dinars Tunisiens.
- En 2013, Gains économique de 1902 Tonnes équivalent de 835 Mille Dinars Tunisiens.

5 CONCLUSION

Cette étude de recherche à pour objectif de faire une synthèse du diagnostic réel de la Firme Minière Tunisienne, tenue comme la principale pôle industriel dans le Bassin Minier, à travers plusieurs indicateurs[38]de performance (économique, financière et de coopération stratégique en Joint-venture Philippart, P., (2001) [37]) Garelli, S., (2000) que nous avons tenu en considération. Nous avons basé sur les dernières statistiques entre (1999-2013) à partir de l'I.N.S (Jan., 2014) et les données de différents Départements de la Firme (Déc., 2013), sur cette période d'étude on a analysé, interpréter et argumenter chaque indicateur suivant le degré de leur évolution et les principales causes qui ont été survenus au cours de cette même période.

Les résultats dégagés nous nous permettons de s'en sortir de deux principales dates articulateurs pour cette Firme minier terrain d'étude. La première qui plus générale, celle de la crise financière 2008, à travers de laquelle cette Firme minière Tunisienne a été touché comme toute autre entreprise exportatrice. Mais le degré était un peu léger et au contraire le bilan financier de Firme a enregistré un flux d'encaissement inattendu, à la fin 2008. Ces gains de devises sont dus en fait à la forte demande du produit minier dans le marché mondial par les pays émergents (i.e. principalement des pays Asiatiques) qui s'est accompagné par une hausse des prix qui a dépassé toutes les prévisions et qui ont continué en (2010 et 2013) toujours à la hausse mais à moindre pic que 2008.

La deuxième date qui n'est pas très loin, celle de 2011, ou le pays a entré dans un état de la récession économique notamment tous les secteurs sont gravement touchés à cause de l'année de la révolution tunisienne. C'est évident que la toutes les entreprises et les sociétés publiques que privés ont été entrés dans une phase de déclin de la productivité qui n'a pas duré longtemps puisque la relance économique de ces secteurs de même que celui de l'industrie minière s'est lancé dés le début de 2012 avec des niveaux moyens mais sont encourageants, comme le cas ici de cette industrie minière.

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