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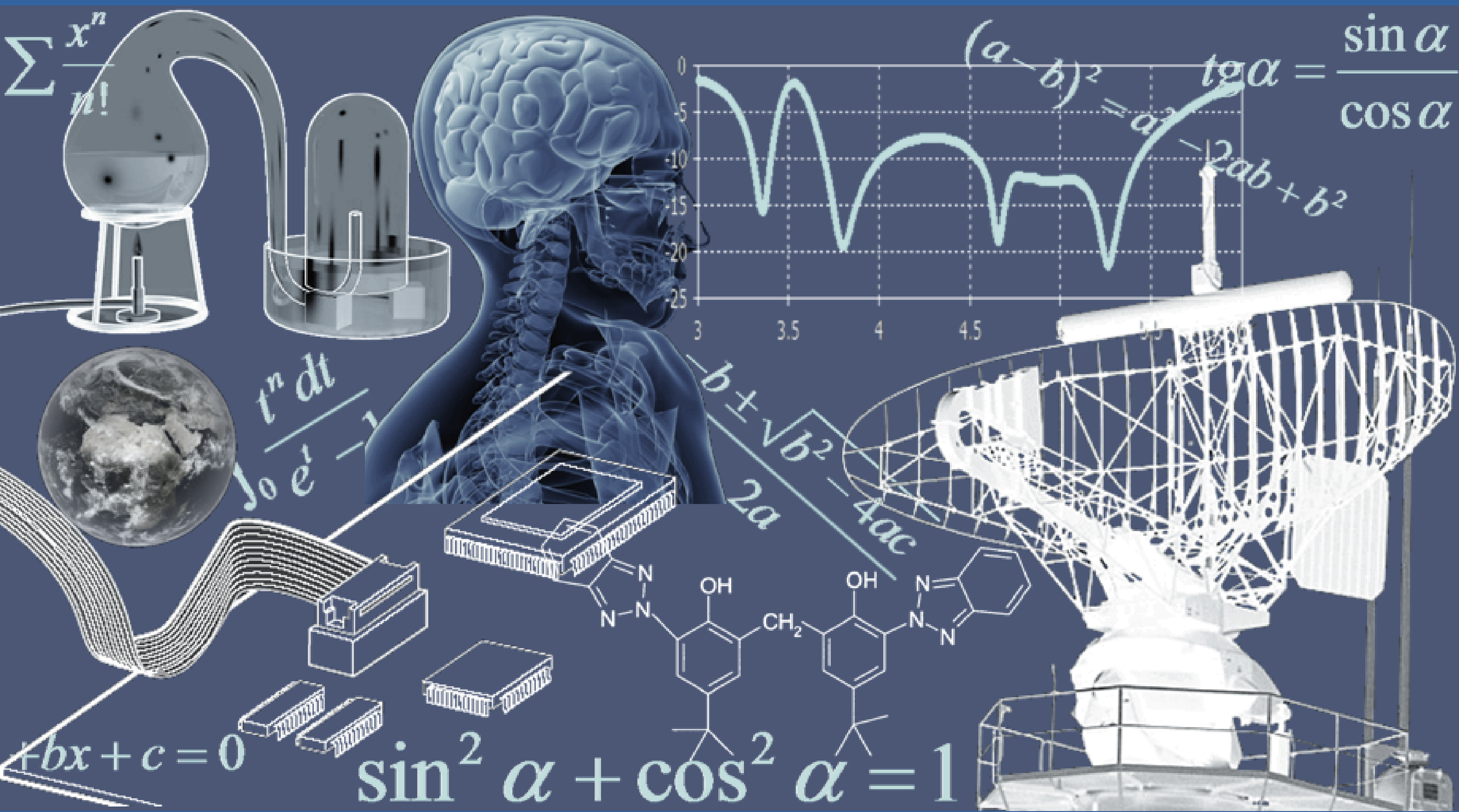

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L'impact de la Serpentinisation sur les Gisements de Nickel, de Chromite et de Cobalt du district Minier De Bou Azzer, (Anti-Atlas Central)

[Impact of Serpentinization on Deposits of Nickel, Chromite and Cobalt, Mining District of Bou Azzer, (Central Anti-Atlas)]

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ABSTRACT: Several mineralizations types are associated with ophiolite of Bou Azzer (i) in transition area the nickel mineralization are scattered (ii) podiform chromite deposits and associated PGE (iii) gold and palladium mineralization of Bleida Far West cashed by basic rocks of cumulates (vi) hydrothermal stockworks mineralizations of cobalt, nickel, arsenic and gold of Bou Azzer. The genesis of those mineralizations is result of both hydrothermal and tectono-magmatic processes.The results show that a primary paragenesis of magmatic origin with pentlandite, chromospinelle, and cobaltiferous and nickeliferous magnetite has been highlighted in Ambed massive where the serpentinization of ultramafic rocks is partial, and it is probably associated with Fe sulphides. However, the mineralogical assemblages identified in Aghbar and Bou Azzer East massive where serpentinization is total are composed on secondary minerals of polydymite cobaltiferous, millerite cobaltiferous, orcelite and magnetite cobalti-nickeleferous. These mineralizations could come during serpentinization from mutation of a primary mineral pargenesis formed on olivine and pentlandite+pyrrhotite aggregates. For chromite mineralization, the Scanning Electron Microscope observations show a textural relationship between serpentine minerals and chromite crystals which reflect a precocious serpentinization setting on same time of chromite pods. The genesis of cobaltiferous hydrothermal mineralizations is basically related to the serpentinization process. In tectonical term, serpentinization modify serpentine plasticity and provide doming phenomenon and has important contribution on genesis and structural context of Bou Azzer mineralized corps. In chemical level, serpentinization control the mobility of nickel and cobalt exist in primary ultramafic minerals which marked in arsenides, sulfides and iron oxides.

KEYWORDS: mineralizations, hydrothermal, basic rocks, pentlandite, polydymite cobaltiferous, millerite cobaltiferous.

RESUME: Plusieurs types de minéralisations sont associés à l' ophiolite de Bou Azzer et correspondant essentiellement à (i) des minéralisations disséminées de nickel dans les termes de la zone de transition de la série ophiolitique (ii) des gisements de chromite podiformes et les PGE associés (iii) des minéralisations à or et palladium de Bleida Far-West encaissées par des roches basiques des cumulats (vi) les minéralisations filoniennes hydrothermales de cobalt, nickel, arsenic et or de Bou Azer. La genèse de ces minéralisations est le résultat de plusieurs processus hydrothermaux et tectono-magmatiques superposés. Dans le massif d'Ambed où la serpentinisation des roches ultrabasiques n'est que partielle, une paragenèse primaire d'origine magmatique à pentlandite, chromospinelle et magnétite cobaltifère et nickélifère a été mise en évidence et serait probablement associée aux sulfures de Fe En revanche, dans les massifs d'Aghbar et de Bou Azer Est où la serpentinisation est totale, l'assemblage minéralogique identifié est composé essentiellement de minéraux secondaires de polydymite cobaltifère, millerite cobaltifère, orcelite et magnétite cobaltifère et nickélifère. Ces phases pourraient provenir du remplacement, lors de la serpentinisation, d'une paragenèse minérale primaire formée, en plus de l'olivine, d'agrégats de pentlandite+pyrrhotite. Pour ce qui est de la chromite, les relations texturales relevées au microscope électronique à balayage entre les minéraux serpentineux et les cristaux de chromites stipulent une serpentinisation précoce synchrone de la mise en place des pods de chromite. En ce qui concerne les minéralisations filoniennes hydrothermales de cobalt, la serpentinisation a joué un rôle primordial pour leur genèse. La serpentinisation a modifié les propriétés de plasticité des serpentines et a favorisé le phénomène de doming, panafricains et tardipanafricains, et dont le rôle est majeur dans la genèse et la structuration des corps minéralisés de Bou Azer. Sur un plan chimique, la serpentinisation a conditionné la mobilité et le lessivage du nickel et du cobalt contenus dans les minéraux ultramafiques primaires en les reconcentrant dans les arséniures, sulfures et oxydes de fer.

MOTS-CLEFS: Minéralisation, Roches basiques, Hydrothermal, Pentlandite, Polydymite cobaltifère, Millerite cobaltifère.

1 INTRODUCTION

La boutonnière de Bou Azzer–El Graara est située dans l'Anti-Atlas central à 45 km à vol d'oiseau au SW de Ouarzazate (GPS : N30°31'16.17", W 6°54'37.15", alt. 1350m). Cette boutonnière jalonne l'accident majeur de l'Anti Atlas «l'AMAA» et correspond à l'érosion d'un pli hercynien, ayant affecté la couverture cambrienne et laissant apparaître les dépôts protérozoïque [1]. Elle est orientée WNW-ESE, selon une longueur de 60 Km et une largeur variable entre 5 et 20 km, comprend deux districts miniers : (i) le district à Cobalt, Nickel, Arsenic, Argent, et Or de Bou Azzer à l'ouest ; (ii) le district à Cu et Or de Bleïda à l'est.

Cette boutonnière est compte plus de 100 corps minéralisés en arséniures de cobalt. Des travaux d'exploration récents menés ont permis de mettre en évidence un autre type de minéralisation à nickel et chrome encaissée par les roches ultrabasiques. Ces gisements sont à priori de grandes tailles mais à teneur modérée sans PGE confirmés jusqu'à maintenant. Toutefois, les modèles génétiques de sa mise en place restent très controversés, autant que le modèle métallogénique et l'âge de la minéralisation en Co, Ni, Au, Ag restent sujets à débat entre les différents auteurs ayant travaillés sur le secteur.

La distribution de la minéralisation Co-Ni-As de Bou Azer le long des contacts serpentinites et diorites quartziques orogéniques ou au sein des serpentinites et les hypothèses proposées pour ces minéralisations placent le phénomène de serpentinisation au cœur des processus de genèse. Cette dernière qui fait l'objet du présent travail, comme un phénomène clé dans le transfert de la matière.

Cette publication a pour but de présenter, le rôle de la serpentinisation sur la propriété des serpentines et sur la mobilité et le leaching du nickel et du cobalt contenus dans les minéraux ultramafiques primaires et aussi l'impact de cette serpentinisation sur les principaux gisements minéralisés de cobalt, chromite et Nickel de Bou azzer, suivant un étude basé sur la caractérisation minéralogique et métallographique , au microscope électronique à balayage et à la diffraction aux rayons X (Laboratoire d'analyse, Réminex Managem) et des analyses géochimiques effectuées de l'ICP au laboratoire de "Stewart Geochemical and Essay" en Russie.

2 CONTEXTE GEOLOGIQUE DE LA BOUTONNIERE DE BOU AZZER

La boutonnière de Bou Azzer-El Grâara correspond à une structure antiforme varisque qui s'est superposée à une zone de suture panafricaine matérialisée par l'accident majeur de l'Anti-Atlas [2]. Cette suture est soulignée par la présence d'une ophiolite complète considérée parmi les plus anciennes du monde Qui .affleure; en plus de Bou Azzer, dans fenetre de Khzama au massif de Siroua (**Fig.1**)

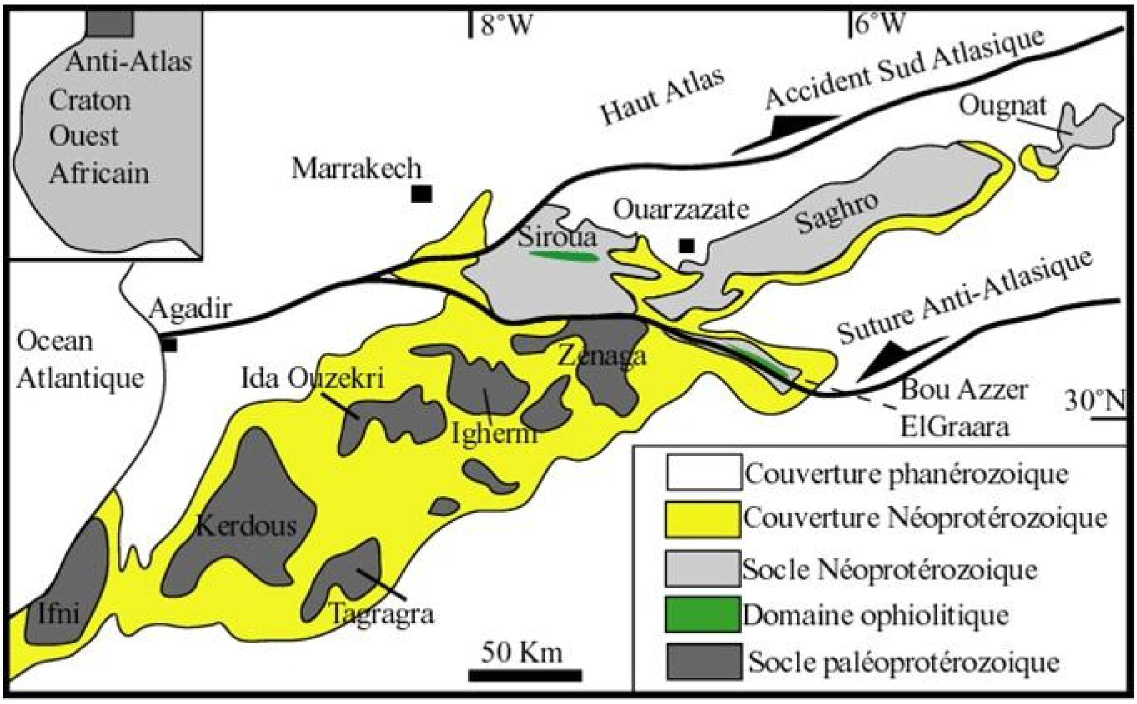

Fig. 1. Suture panafricaine de Bou Azzer- Siroua dans l'Anti Atlas.

D'après les dernières subdivisions stratigraphiques adoptées pour les terrains de la boutonnière de Bou Azzer El Graara central ([3], [4], [5]), **(Tableau.1**), Les terrains précambriens affleurant dans cette boutonnière sont subdivisés en deux grands ensembles lithologiques et structuraux:

Un ensemble magmato-métamorphique, plus ancien, d'âge néoprotérozoïque inférieur et moyen (tonien et cryogénien).

Un ensemble postérieur non-métamorphique d'âge néoprotérozoïque supérieur et terminal (cryogénien supérieur et Ediacarien).

L'ensemble métamorphique est formé d'empilements complexes d'écailles tectoniques résultant de la collision panafricaine, et qui comportent, i) des orthogneiss et des métagabbros au sud (Igrane, Tazigzaout, Oumlil et Bou Azzer), autrefois décrits comme des terrains paléoprotérozoïques (PI) ([6],[1]) et dont le protolite a été ultérieurement daté aux alentours de 750 Ma ([7],[8]) ; ii) des dépôts de la plateforme néoprotérozoïque établie sur la marge nord du craton ouest-africain (Groupe de Taghdoute-Lkest), auxquels est associée la minéralisation cuprifère de Bleïda; iii) des séries volcano-sédimentaires de Tichibanine-Ben Lgrad au nord dont l'affinité d'arc est bien établie ([9],[10]) ; et enfin, iv) le Complexe ophiolitique de Bou Azzer qui, bien qu'incomplet et fortement démembré, présente toutes les unités typique d'une suite ophiolitique ([1],[11]). L'ensemble de ces unités métamorphiques est recoupé par des diorites syntectoniques datées aux alentours de 650 Ma ([12]).

L'ensemble non-métamorphique repose en discordance majeure sur le substratum panafricain et comporte : i) à la base, les séries clastiques du Groupe de Tidilline, redressées et plissées dans des couloirs faillés lors des derniers stades de la tectonique panafricaine, et ii) les coulées pyroclastiques et dépôts volcano-détritiques du Groupe d'Ouarzazate qui repose en discordance angulaire sur celui de Tidilline. Les couches sédimentaires du Cambrien font suite sans hiatus important à ces dépôts fini-précambrien (Ediacarien).

Table 1. Nomenclature des dernières subdivisions lithostratigraphiques adoptés pour la boutonnière de Bou Azzer-El Graara.

Age		Complexe/Groupe/formation
Néoprotérozoïque supérieur à Cambrien Inférieur	Ediacarien supérieur et Cambrien	Groupe de Tata Formation d'Adoudou
Néoprotérozoïque supérieur et terminal ***(Ensemble non métamorphique)***	Ediacarien supérieur (NP3)	- Groupe de Ouarzazate (580-534 Ma) - Groupe de Tidilline (625-600 Ma)
Néoprotérozoïque moyen ***(Ensemble métamorphique)***	Cryogénien supérieur (NP2s)	Groupe de Bou Azzer - El Graara : - Complexe ophiolitique de Bou Azzer El Graara - Suite volcano-sédimentaire de Skouraz (environ 660-640Ma)
	Cryogénien inférieur (NP2i)	Complexe plutono-métamorphique d'Assif n'Bougmmane – Takroumt (750-700Ma)
		GroupeTichibanine - Ben Lgrad (760 Ma)
	Tonien à Cryogénien (NP1-2)	Groupe Tachdamt – Bleïda (environ 800Ma)

La carte structurale de la boutonnière présentée ci-dessous (**Fig.2**) prend en considération la nouvelle répartition stratigraphique basée sur les données géochronologiques récentes découvertes dans la boutonnière.

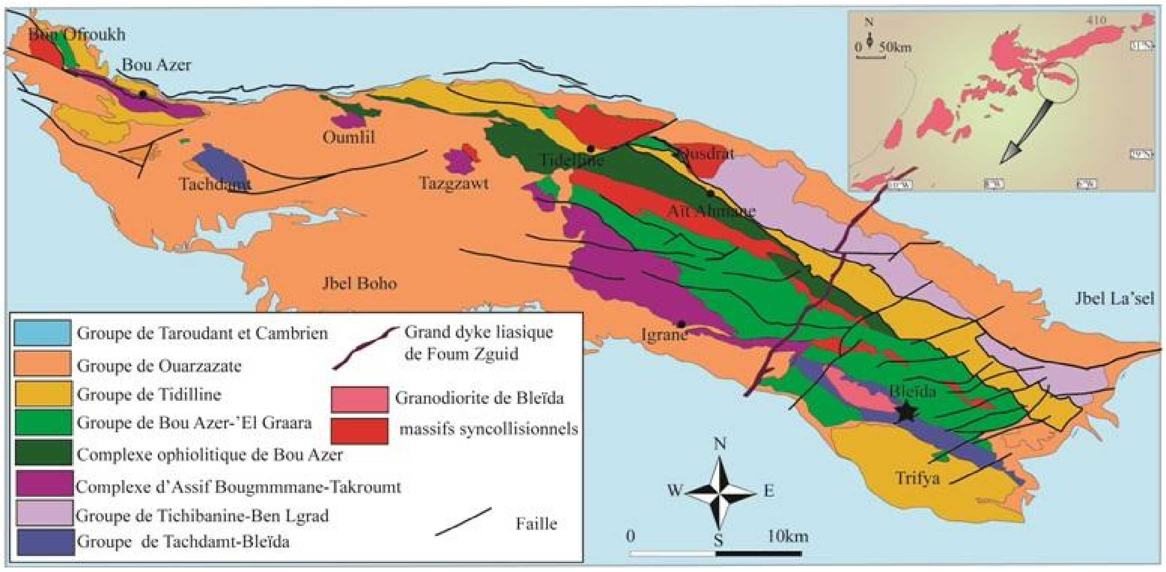

Fig. 2. Schéma structural de la boutonnière de Bou Azzer-El Graara

La distribution de la minéralisation Co-Ni-As de Bou Azzer le long des contacts serpentinites ophiolitiques/diorites quartziques orogéniques ou au sein des serpentinites, impose la serpentinisation qui fait l'objet du présent travail, comme le phénomène clé dans le transfert de matière. Nous nous sommes basés sur la caractérisation minéralogique au microscope en lumière transmise et réfléchie, au microscope électronique à balayage et à la diffraction aux rayons X (Laboratoire d'analyse, Réminex Managem) et des analyses effectuées par ICP au laboratoire de "Stewart Geochemical and Essay" en Russie.

3 MATÉRIEL ET MÉTHODES

L'approche adoptée pour répondre aux objectifs cités a débuté par une cartographie fine des secteurs serpentinisés, afin d'identifier les lithologies présentes dans ces zones ainsi que leurs relations structurales.

L'observation des échantillons au microscope optique a ensuite été nécessaire pour documenter la nature des minéraux, les textures et les structures minéralogiques, ainsi que pour caractériser les différentes phases de serpentinisation et les paragenèses.

Cette publication a pour but de présenter, le rôle de la serpentinisation sur la propriété des serpentines et sur la mobilité et le leaching du nickel et du cobalt contenus dans les minéraux ultramafiques primaires et aussi l'impact de cette serpentinisation sur les principaux gisements minéralisés de cobalt, chromite et Nickel de Bou azzer, suivant un étude basé sur la caractérisation minéralogique et métallographique , au microscope électronique à balayage et à la diffraction aux rayons X (Laboratoire d'analyse, Réminex Managem) et des analyses géochimiques effectuées de l'ICP au laboratoire de "Stewart Geochemical and Essay" en Russie.

4 ETUDE PETROGRAPHIQUE ET MINERALOGIE DES SERPENTINITES

Aussi bien à l'échelle de l'affleurement qu'à l'échelle de la lame, les roches mantelliques de Bou Azzer, montrent des cisaillements et des fracturations intenses dans lesquels se font des cristallisations du chrysotile et de la lizardite en différents épisodes. Selon les endroits la serpentinite peut être talcifiée ou carbonatée ([1], [13], [14]). Un autre type d'altération hydrothermale a été répertorié, il s'agit de la liswénitisation ([15]).

La serpentinisation à Bou Azzer, s'est effectuée en deux phases : une serpentinisation pseudomorphique matérialisée par de la serpophite isotrope préservant la forme primaire des cristaux d'olivine, avec souvent des aiguilles d'antigorite fibro-radiée. La brucite est assez fréquente dans les serpentinites de Bou Azzer, elle se présente sous forme d'inclusions au sein des serpentines ([13]). Ces structures sont traversées d'un réseau de veinules, en remplissage de fractures ouvertes, où se disposent par ordre chronologique : l'antigorite, la lizardite et le chrysotile. Ces veines sont également soulignées par de la magnétite secondaire et des sulfures (chalcopyrite et pyrite essentiellement). Ces paragenèses opaques sont liées à la serpentinisation. En effet les serpentinites de Bou Azzer, sont dominées par l'antigorite, les espaces interstitiels et les plans de schistosité sont soulignés par des lamines épaisses de magnétite visibles macroscopiquement et microscopiquement. Cet auteur avance que la serpentinite a constitué un stock initial pour la minéralisation de Ni-Co de Bou Azzer, reconcentrée tardivement par les événements tectono-magmatiques ayant eu lieu tardivement.

4.1 DONNEES DE TERRAIN

A Bou Azzer, la serpentinisation a affecté le quasi totalité des roches ultrabasiques. Dans le cadre de notre travail nous avons procédé à une cartographie fine des massifs serpentineux, afin de déterminer les éventuels variations de faciès zonalité et gradients. Nous nous sommes focalisés sur les massifs d'ouest en Est : Mechoui, Ambed, Ait Ahmane et Ait Abdallah.

L'étude de terrain a mis en évidence un gradient tant à l'horizontale qu'à la verticale. En effet, les roches ultrabasiques de la partie ouest de la boutonnière notamment au niveau du secteur de Bou Offroh sont totalement serpentinisées tandis que le processus de serpentinisation est partiel à Ambed et presque absent plus à l'Est dans certaines zones au niveau d'Ait Ahmane et Ait Abdellah. A une échelle verticale et au niveau de toute la boutonnière, nous avons répertorié des plots (butes témoins) de roches ultrabasiques et partiellement serpentinisées. Ces observations nous amènent à supposer que la serpentinisation des formations ultrabasiques des ophiolites de Bou Azzer a affecté d'une manière homogène l'ensemble de la série et que les gradients actuels sont conséquents des niveaux d'érosion qui s'approfondissent de l'est vers l'ouest.

4.2 LA MINERALOGIE DES SERPENTINITES

La serpentinisation a provoqué la transformation des harzburgites et des dunites avec la néoformation des minéraux tels que la lizardite, lizardite-chrysotile, lizardite-antigorite et antigorite de manière accessoire, la serpophite, la bastite et des carbonates. Les chromospinelles sont transformés en magnétite, stichtite et parfois la brucite.

Dans les zones à fort autométamorphisme hydrothermal au niveau de secteur de Mechoui, les serpentines se transforment en listwénites, produit ultime du phénomène de la serpentinisation. Elles sont à compositions variables selon l'intensité du métamorphisme, avec une association complète à carbonate, breunnerite, quartz, magnétite et fuschite avec des reliques d'antigorite et des chromospinelles.

Au contact avec les dykes, les gabbroïdes et les granitoïdes, les serpentines deviennent chloriteuse, avec de l'amiante en petits filonnets minces et dans des textures rubanées matérialisant l'avancement des fronts de métasomatose.

Les roches intrusives présentent également des empreintes des transformations métasomatiques aux contacts avec les serpentinites. Elles sont matérialisées par des franges de roddingites à vésuvianites et grenats sur des puissances centimétriques.

Certains filons et dykes sont entièrement transformés en giobertite et magnésite ([16]) comme dans le cas du massif d'Ambed et Ait Ahmane.

La serpentinisation des ultrabasites a eu lieu avant la phase panafricaine B1 et s'est poursuivi durant cette phase ([1]). Durant la mise en place de la diorite, le métamorphisme de contact a induit la rodingitisation de la diorite et la talcification des serpentines. Il se développe une frange métasomatique métrique le long du contact constituant la roche hôte des minéralisations argentifères.

La carbonatation des serpentines a eu lieu en deux phases :

Une première carbonatation a eu lieu en relation avec les accidents majeurs B2. La serpentine est alors transformée en une carapace à quartz breunerite et fuschite. La texture de la roche ne montre pas d'orientation préférentielle pouvant témoigner de la déformation B1. Toutefois, cette carbonatation fossilise les structures de la serpentine ce qui, à l'affleurement reflète des linéaments planaires semblables à une fabrique fossilisée par les altérations.

Ces formations sont recoupées par le Précambrien III et pourrait être synchrone du dépôt de Tiddiline.

La deuxième carbonatation est matérialisée par le développement des carbonates ferrifères. Ces derniers sont issus de la transformation des listwénites et la libération du manganèse concentré en liseré le long des fractures sous forme psylomélane.

Les altérations hydrothermales proprement dites sont associées aux filons minéralisés. Une silicification intense de la diorite en relation avec la bréchification hydraulique. Deux types de texture sont relevés. Une silicification sous forme de stockwerk à proximité du filon qui passe progressivement à une silicification quasitotale de la diorite aboutissant à des corps quartzeux de puissance métrique. Dans la zone à stockwerk, la diorite est hématitisée avec une séricitisation des plagioclases, les biotites se transforment en chlorite.

Ces altérations dessinent une zonalité par rapport au centre du filon, en effet, en allant vers les périphéries, la chloritisation est la plus dominante et s'associent spatialement à la zone à sulfures. La frange d'altération peut excéder 20 m dans les zones de convergence de plusieurs croiseurs.

Le stade ultime de cette altération correspond à une troisième phase de carbonatation à laquelle sont associés les arséniures. Les carbonates regroupent la dolomie et la calcite en cristaux idiomorphes bien développés. Le chlorite magnésien en rosettes occupe les interstices.

A l'échelle microscopique, la carbonatation des serpentines est se matérialise par : (i) Disparition progressive des minéraux serpentineux; (ii) Leur remplacement par le talc dans un stade intermédiaire ensuite; (iii) La progression de la calcite; (iv) Certains minéraux tels que la magnétite sont observés à tous les stades. (**Fig.3**).

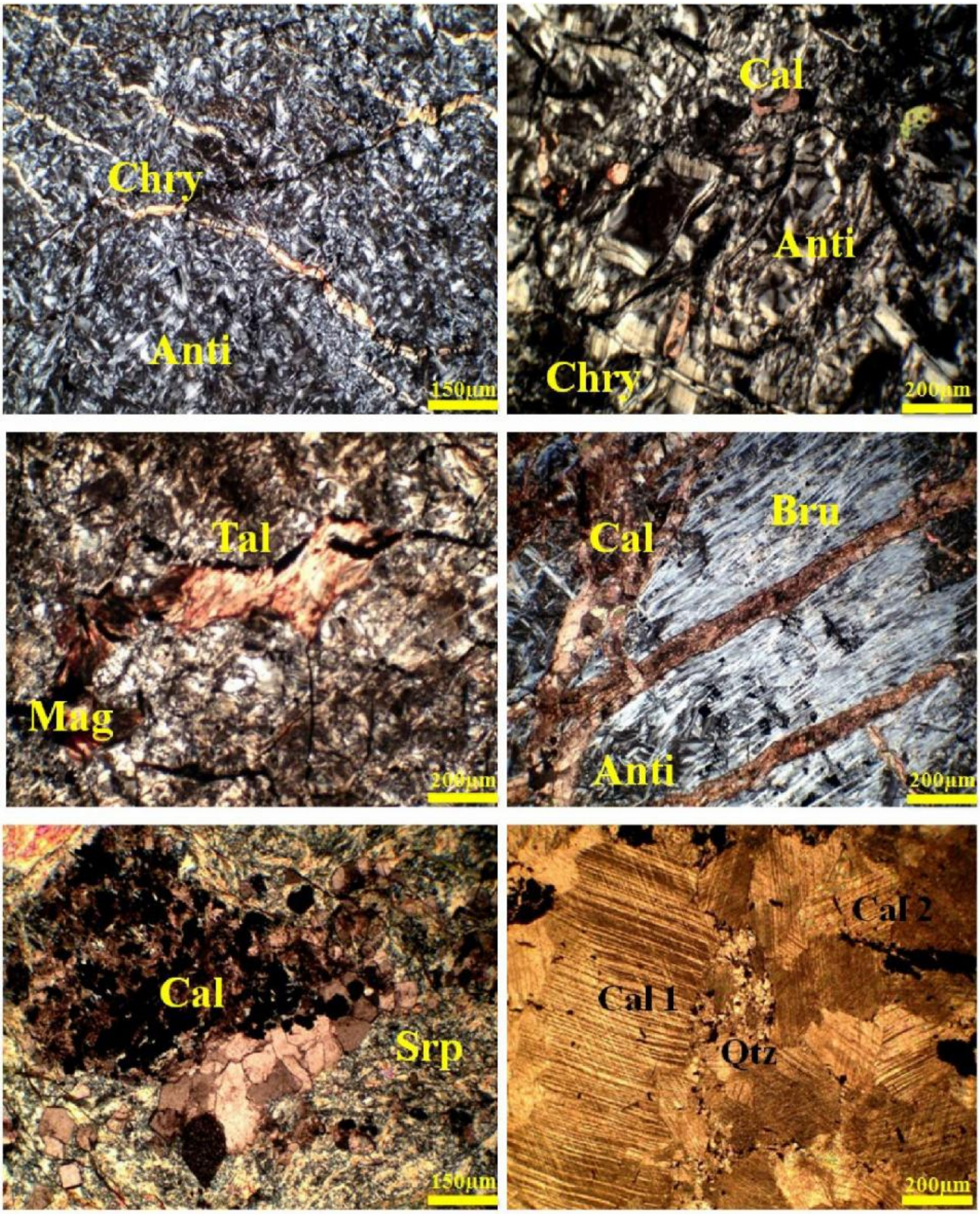

Fig.3 : Observations microscopiques des serpentinites encaissantes, des amas carbonatés et quartzo carbonatés (Anti : Antigorite, Chry : chrysotile, cal : calcite, Tal : Talc, Bru : Brucite, Mag : Magnétite, Srp : Serpentine, Qtz : Quartz)

5 L'IMPACT DE LA SERPENTINISATION SUR LES GISEMENTS DE COBALT, NICKEL ET CHROMITE

La distribution des structures minéralisées est contrôlée par une multitude de facteurs physiques et chimiques tant à l'échelle régionale qu'à l'échelle locale et la lithologie de la roche hôte constitue l'un de ces facteurs. A Bou Azzer, la quasi-totalité des minéralisations sont encaissées dans la diorite quartzique et les rhyolites du Précambrien III. En effet, et en combinant les drains et les amas de contact, la diorite encaisse 33 structures minéralisées avec 45% du volume utile global, la rhyolite en représente 51% avec 29 structures minéralisées et le reste entre les roches basiques les roches carbonatées de l'Adoudounien. Les espèces minérales ne suivent pas la même tendance comme le montre le tableau **(Tableau.2)**.

Table 2. Répartitions des espèces minérales par gisement (wt %)

Gisement	Espèces minérales (%)				
	Smaltine / Skutterudite		Safflorite / Loëllingite		Sulfo-arséniures de Fer et de cobalt
Mechoui		62	33	1	2
Bou-Azzer Est		65%	20		15
Filou II		98			1
Filou II Est		98			1
Filou 7/5		75	20	1,3	2,5
Aghbar		65,2	31,8		3
Tamdrost		67,3	32,7		
Bouismas		42,2	57,6		0,15
Ait Ahmane		47,8	50		2,2

En effet, la famille de la Smaltine / Skuttérudite domine au centre de la boutonnière en regard de la löellingite qui a tendance à se développer vers l'Est. Pour les sulfoarséniures, ils sont particulièrement élevés à Bou Azzer Est et très faiblement à Bouismas. **(Fig.4)**.

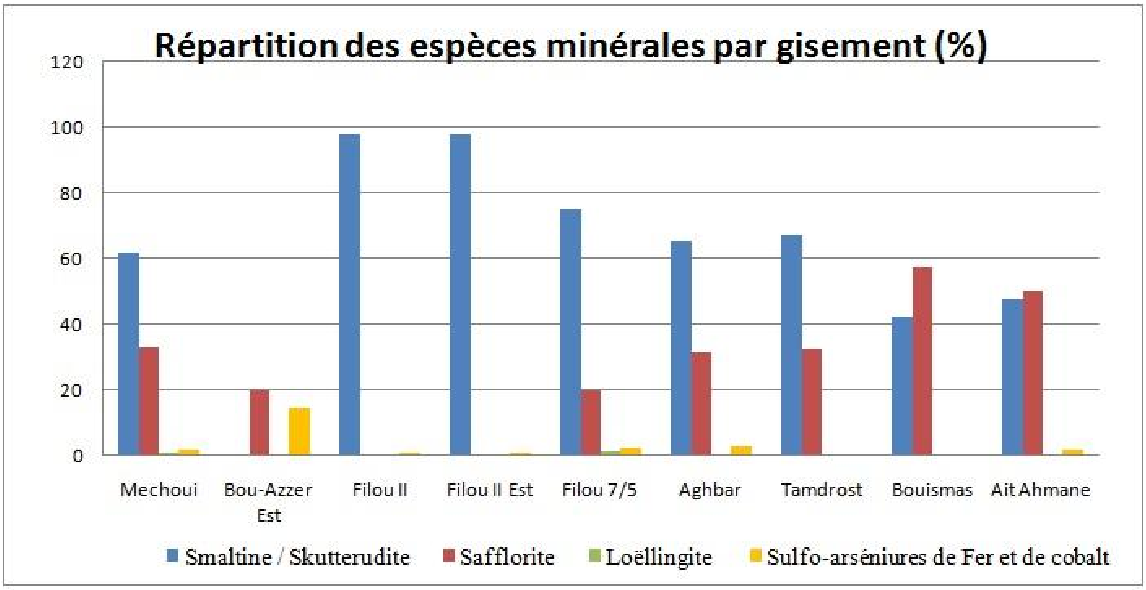

Fig.4 .Diagramme montre la répartition des espèces minérales par gisement à l'échelle de Bou Azzer (wt %)

D'une manière générale, la skuttérudite (**CoAs3)** est le minéral porteur de la grande partie du cobalt de Bou Azzer. Sa teneur intrinsèque en cobalt varie de 7,6% à 27,81%. Une zonalité entre les gisements se dessine en allant de l'ouest en Est. Les gisements de la partie ouest sont plus riches en cobalt (**Figure 5, A**). Cette teneur baisse à partir du gisement d'Aghbar jusqu'à Ait Ahmane. Il en va de même pour l'or qui est associé au cobalt et dont le contenu métal est plus important dans les gisements de l'ouest de la boutonnière. Il est également à signaler que sa teneur en nickel augmente aux dépens de cobalt en s'approchant des serpentines. Le fer est aussi corrélé négativement au cobalt dans la skuttérudite.

Pour la cobaltite, la teneur en cobalt oscille entre 15,71% et 32,78%. La moyenne s'établit à 28,40% en cobalt (**Figure 5, B**). Elle suit une tendance opposée à celle de la skuttérudite en termes de zonalité. En effet la cobaltite des gisements Est est appauvrie en cobalt. Sur un autre plan et en fonction du chimisme, trois types de cobaltite ont été répertoriées. La cobaltite nickélifère pour la quelle la teneur en nickel atteint 13%. Une cobaltite aurifère dans laquelle la teneur en cobalt est également faible et la troisième qui correspond au pôle cobaltifère. De ce fait, le cobalt et le nickel sont corrélés négativement dans la cobaltite (**Figure 5, C et D**).

Pour ce qui est de la série löellingite-safflorite, la teneur en cobalt varie entre le pôle purement ferrifère à plus de 24% en cobalt. Des variétés nickélifères ont été également révélées surtout pour les löellingites.

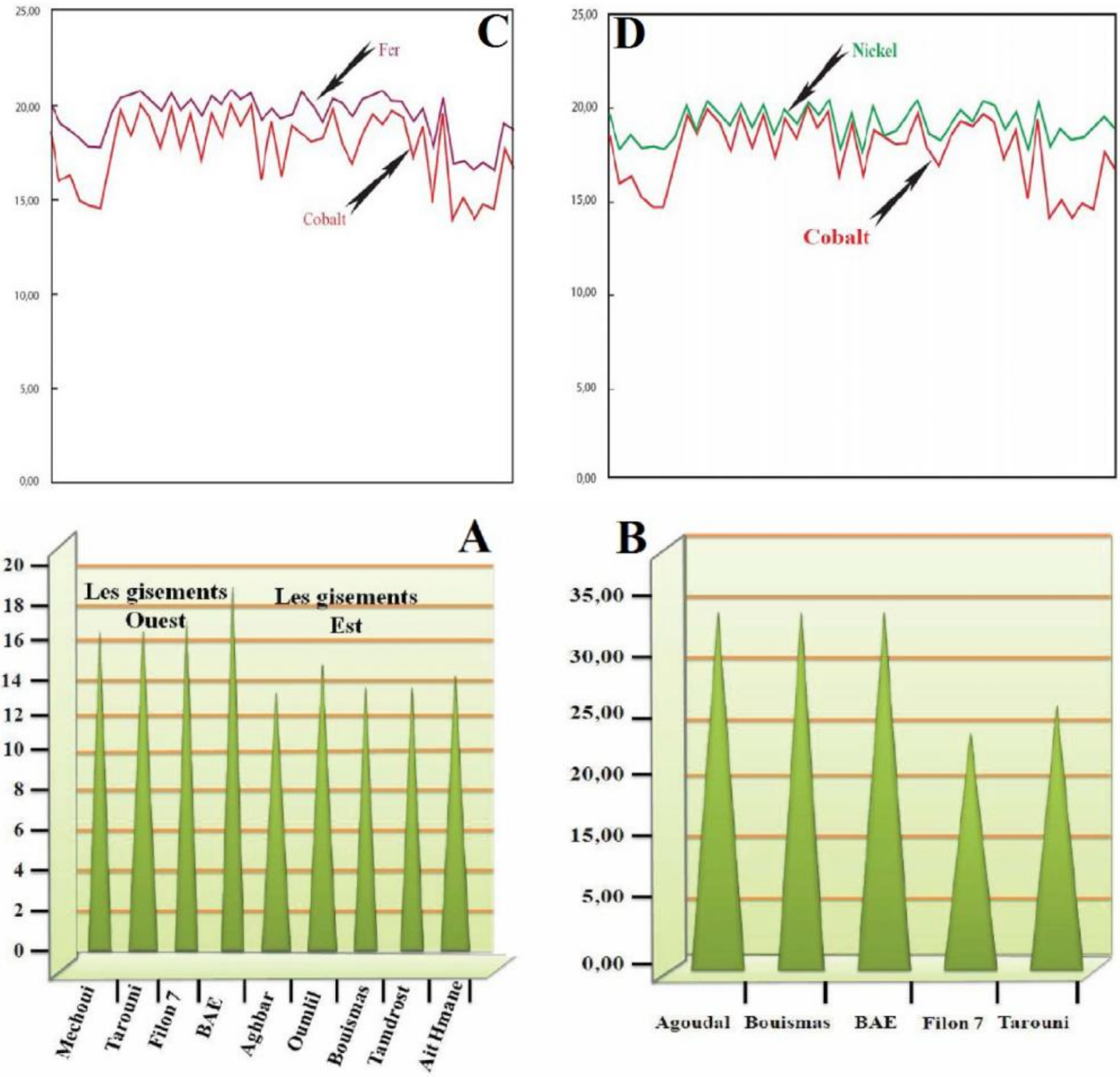

Fig.5. A : Evolution de la teneur de la skuttérudite en wt% des gisements de Bou Azzer de l'Ouest à l'Est ; B : Evolution de la teneur de la cobaltite en wt% des gisements de Bou Azzer de l'Ouest à l'Est ; C : variation des teneurs en Cobalt et en Fer dans la Skuttérudite dans Bou Azzer Centre ; D : variation des teneurs en Cobalt et en Nickel dans la Skuttérudite dans Bou Azzer Centre)

5.1 LE ROLE DE LA SERPENTINISATION SUR LES MINERALISATIONS COBALTIFERES :

En fonction de la composition de l'olivine solution solide entre la forstérite à magnésium et la fayalite pôle ferrifère, les réactions qui régissent la serpentinisation sont les suivantes :

- Fayalite+eau→magnétite +aqueuse silice +hydrogène ($3Fe_2SiO_4 + 2H_2O \rightarrow 2\ Fe_3O_4 + 3SiO2 + 2\ H_2$)
- Forstérite+ silice aqueuse →serpent e ($3Mg_2SiO_4+SiO_2+4H_2O \rightarrow 2\ Mg3Si2O5(OH)_4$)
- Forstérite+eau→serpentine brucite ($2Mg_2SiO_4 +3H_2O \rightarrow Mg_3Si_2O_5\ (OH)_4 +Mg\ (OH)_2$)

Cette dernière réaction décrit l'hydratation de l'olivine avec de l'eau seulement pour donner la serpentine et la brucite $Mg(OH)_2$. Après la réaction, les produits à faibles solubilités (silice aqueuse ou des ions magnésium dissous) peuvent être transportés au-delà de la roche par diffusion ou advection. En présence de dioxyde de carbone, la serpentinisation produit la magnésite ($MgCO_3$) ou générer du méthane (CH_4) selon les équations suivantes :

- A faible concentration de CO_2 et un pôle ferrifère de l'olivine

(Olivine + eau + acide carbonique → serpentine + magnétite + méth)

- Si l'olivine est fortement magnésienne on obtient :

(Olivine +eau + acide carbonique → serpentine + magnétite + magnésite + si)

La serpentinisation est en fonction de la composition des roches ultramafiques magmatiques, le chimisme du fluide et le système ouvert ou fermé du processus. Dans le cas de Bou Azzer, les pyroxènes sont aussi serpentinisés. Les olivines contiennent du nickel et du cobalt à des teneurs respectives de 3900 et 200 ppm. Le fluide est probablement chargé en calcium et en magnésium comme en témoigne les dépôts de la magnésite et des masses de listwénites.

Dans ces conditions, la serpentinisation se serait produite dans un système ouvert avec apport de l'acide carbonique, du calcium et de l'eau **(Fig.6).** En plus de la serpentine et de la magnétite, ils se forment des carbonates de calcium et de magnésium ainsi que des carbonates de nickel et de cobalt. Le stock en cobalt est finalement reconcentré dans minéraux facilement lixiviable comme la magnétite et les carbonates. L'action des fluides hydrothermaux et l'apport de l'arsenic des sédiments et du soufre des saumures vont conduire à sa reconcentration sous forme d'arséniures, sulfo-arséniures et sulfures.

En ce qui concerne la partie du nickel et du cobalt associés aux sulfures, la serpentinisation a également joué un rôle important dans sa redistribution et en concomittance avec la transformation de l'olivine. Généralement, les roches ultra-mafiques non altérées peuvent renfermer des sulfures magmatiques, telles que la pyrrhotite, la pentlandite et la chalcopyrite. Les différences de compositions minéralogiques entre les roches ultra-mafiques non altérées et celles transformées en serpentines suggèrent un contrôle de la minéralogie des sulfures secondaires de Ni-Co-Fe-S par les réactions chimiques intervenant lors de la serpentinisation. Les assemblages minéraux des sulfures secondaires de ces métaux dépendent du degré de serpentinisation. Une serpentinisation partielle dans laquelle l'olivine est transformée en serpentine, magnétite et pentlandite avec le transfert chimique du contenu en cobalt, nickel et fer. La pyrrhotine primaire monoclinique et la pentlandite sont transformées en pyrrhotite hexagonale, mackinawite et la magnétite avec une redistribition des concentrations en fer, soufre, nickel et cobalt. Dans certains cas, la mackinawite est absente et peuvent apparaître des minéraux de heazlewoodite et de godlevskite. Il est aussi possible que la pyrrhotine secondaire soit monoclinique ou même absente. Dans le cas de Bou Azzer, la serpentinisation est totale et les phases minérales secondaires sont différentes. Elles regroupent la polydymite, la millerite et l'orcélite.

Dans la magnétite, la proportion pondérale du cobalt varie de 6,74 à 8,5%. La polydymite contient 50,86% de nickel et 4,38 % en cobalt. Elle contient des inclusions d'orcélite dont les analyses ont révélé 60,81% poids en nickel. La millérite est aussi cobaltifère avec des teneurs respectives de 57,77% en nickel et le cobalt qui s'échelonnent entre 3,13 et 5,36%.

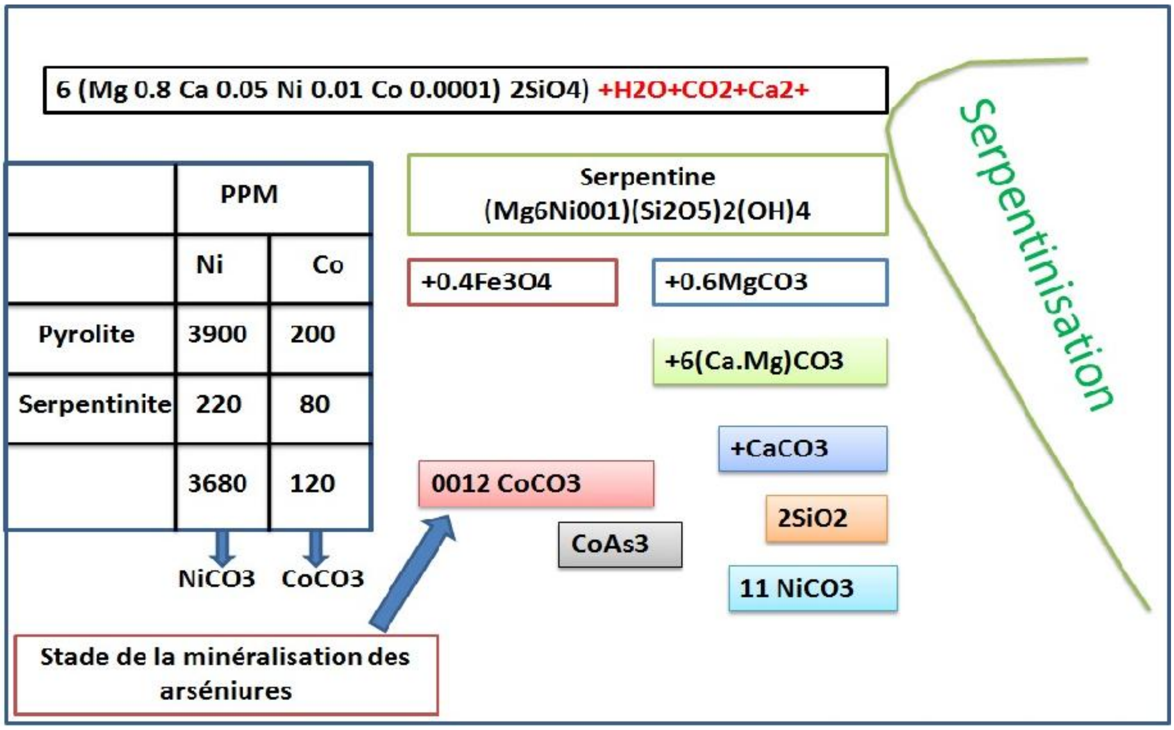

Fig.6. la mobilité du cobalt et Nickel dans le processus de la serpentinisation

5.2 LE ROLE DE LA SERPENTINISATION SUR LES MINERALISATIONS MAGMATIQUES

5.2.1 LA CHROMITE

Les gisements de chromite podiformes associés aux ophiolites de Bou Azzer sont concentrés dans la partie Est de la boutonnière. Ils se présentent sous forme de petits corps losangiques orientés et à la croisée d'un système de fractures traduisant leur mode de mise en place. La tectonique qui affecte ces corps est polyphasée. La phase synchrone à leur mise en place est transtensive et en témoignent les formes de « pulls aparts » commune aux pods.

A une échelle microscopique, la chromite est souvent xénomorphe à subautomorphe en grains millimétriques, disséminée ou en îlots multigranulaires, souvent associée à la magnétite notamment dans la région d'Inguijem et Talc. Les grains de chromite sont généralement altérés, ou fracturés et sont cernés par des liserés et des auréoles de chlorite et de stichtite (carbonate de chrome et de magnésium, hydraté).

Deux catégories de chromitites sont remarquables microscopiquement selon le degré de déformation. Certaines chromitites sont peu déformées, où les nodules aplatis montrent une direction (S0) perpendiculaire à la direction d'aplatissement des nodules. D'autres chromitites sont plus déformées, et montrent généralement deux directions qui se superposent. Une direction précoce (S0) mimant un clivage et parallèlement laquelle s'alignent parfois des inclusions silicatées. Cette direction limitée aux cristaux de chromite paraît antérieure à la serpentinisation et serait magmatique. Une direction tardive (S1) qui (S0) et traverse l'ensemble de la chromitite. Cette dernière direction se manifeste par une fracturation en pull à part des chromitites massives, qui montrent des contours rectilignes ou en dents de scie témoignant d'une dissolution tardive. Elle est représentée par des fractures ouvertes remplies de minéraux serpentineux et serait contemporaine à la serpentinisation.

A Bou Azzer, la serpentinisation est accompagnée par la formation de la magnésioferrite et également par la transformation dans certains cas de la chromite en magnésiochromite. De la chalcopyrite, la millérite, la bravoïte et d'autres alliages de Ni-Co sont également observés, au cœur des minéraux serpentineux des ultramafites de Bou Azzer **(Fig.7.a).** La magnétite ($Fe^{+2}Fe_2^{+3}O_4$) et la magnésioferrite ($Mg^{+2}\ Fe_2^{+3}O_4$) sont fréquentes dans les serpentinites de Bou Azzer. Elles forment des liserés d'altération coronitique autour de la chromite et la magnésiochromite, et soulignent des plans de schistosité ou de cisaillement dans les tectonites, ce qui témoigne de leur caractère secondaire. Elles sont associées à la serpentine, dont elles sont contemporaines. Le Fer nécessaire à la formation de ces deux minéraux est sans doute lié à la serpentinisation.

Les relations texturales relevées au MEB (microscope électronique à balayage) entre les minéraux serpentineux et les cristaux de chromites stipulent une serpentinisation précoce synchrone de la mise en place des pods de chromite **(Fig.7.b).**

Les chromitites de Bou Azzer se caractérisent par un faible rapport [P-PGE / I-PGE] typique des chromitites ophiolitiques de type alpin, pauvres en sulfures, avec prédominance des I-PGE, des teneurs variables en Rh, et de faibles teneurs en Pt et Pd. [19]. La somme des teneurs en (PGE) des chromitites d'Inguejjem-Aït Ahmane est d'environ 187-221 ppb.

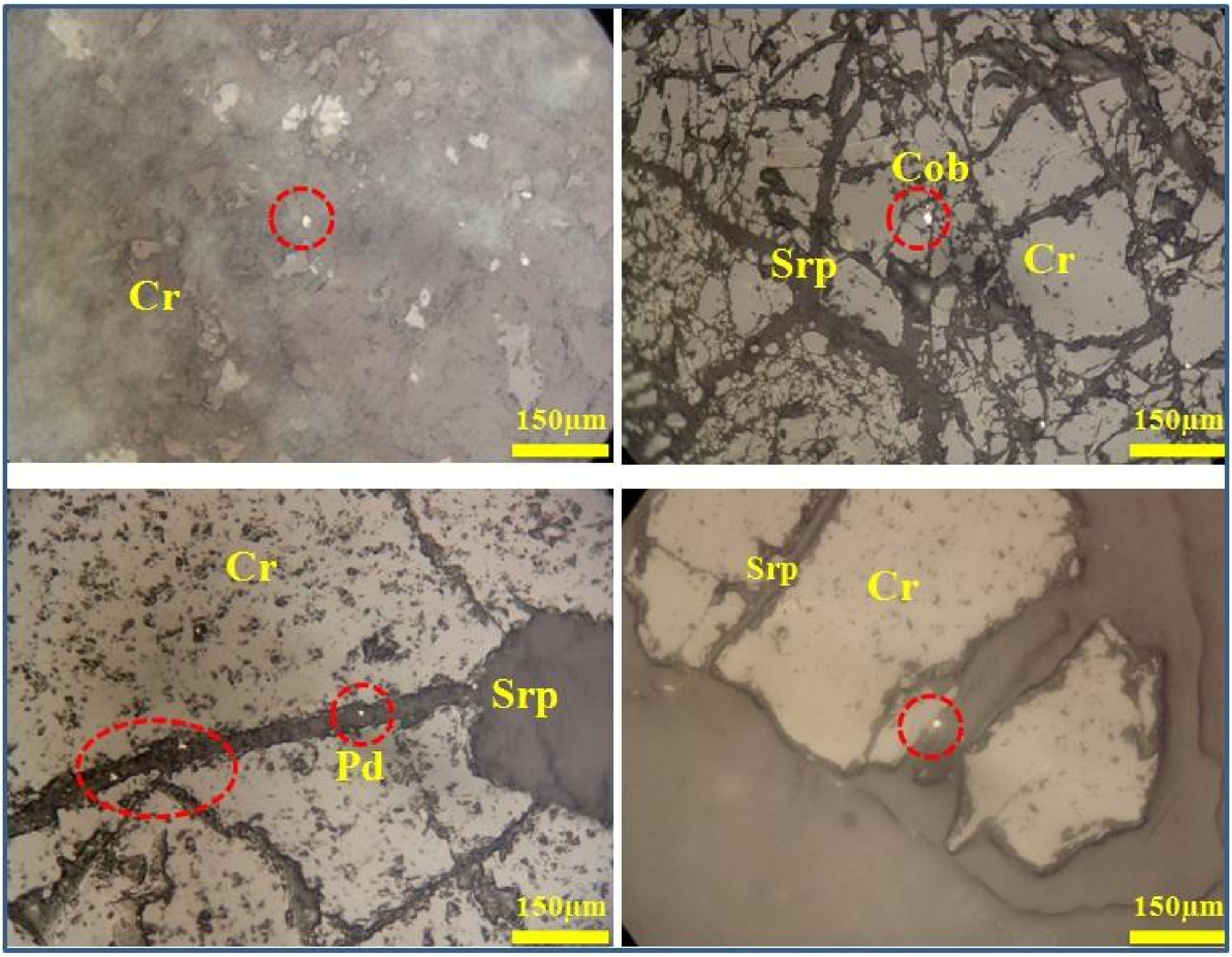

Fig.7.a.: Microphotographie montre des alliages de Ni-Co qui sont observés, au cœur des minéraux serpentineux (Cr : chromite, Srp : serpentine, Pd : pentlandite, cob : cobaltite)

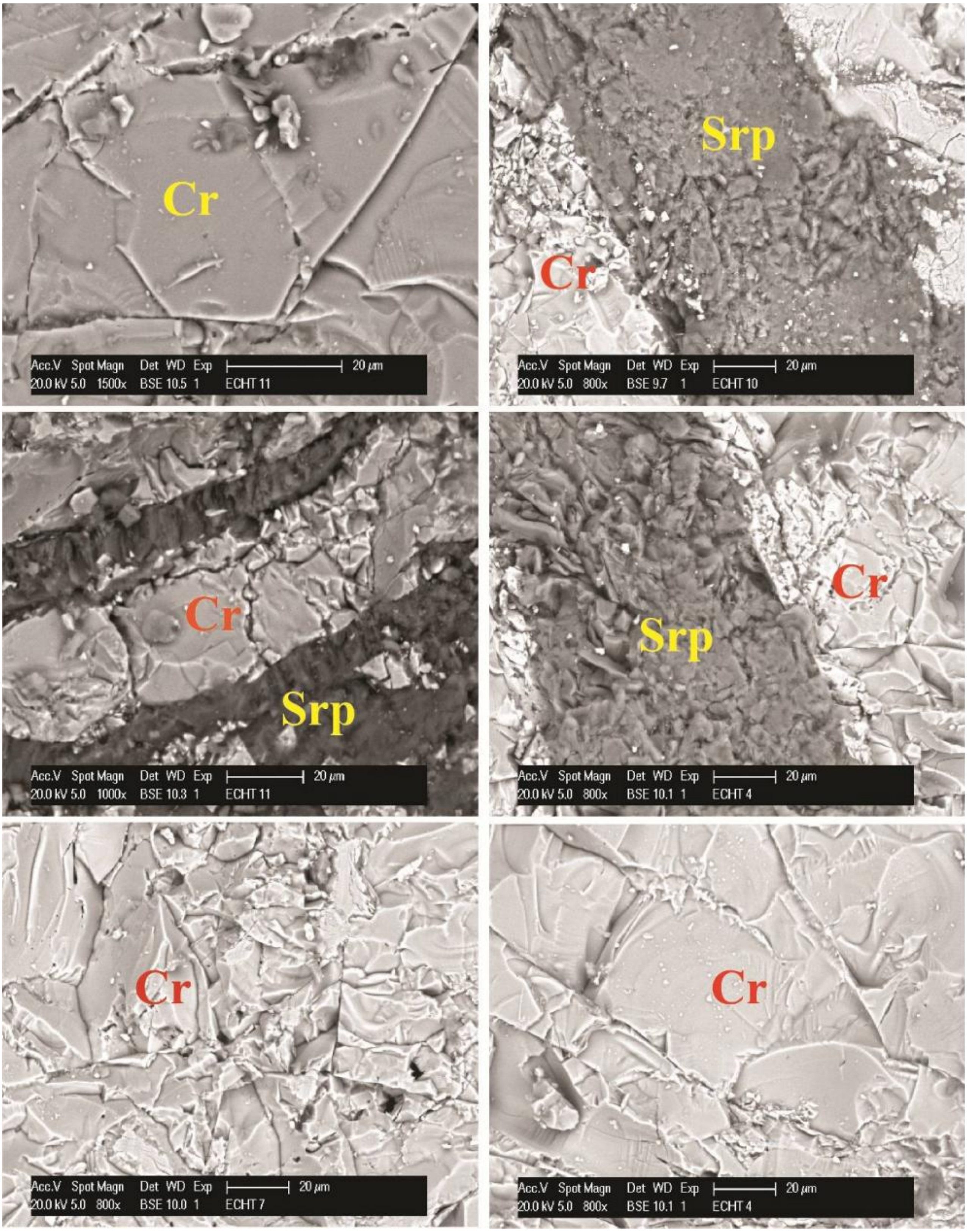

Fig.7.b. Microphotographie montre les relations texturales relevées au MEB (microscope électronique à balayage) entre les minéraux serpentineux et les cristaux de chromites (Cr : chromite, Srp : serpentine)

5.2.2 LES SULFURES DE NICKEL

A Bou Azzer, le Nickel est exploité comme un sous produit de cobalt et fait partie intégrante de la paragenèse minérale sous forme des arséniures, des sulfo-arséniures et des sulfures comme décrit dans les chapitres précédent. Durant son histoire, Bou Azzer aurait produit plus de 3000 tonnes métal de nickel. Le modèle génétique établi est identique à celui du cobalt, selon lequel le nickel proviendrait de la serpentine par effet des altérations successives qui l'ont affectées depuis la serpentinisation jusqu'aux altérations exogènes qui se sont succédées. Le filon 51 est un cas de gisement à Nickel dominant et le cobalt en sous produit.

Un autre type de Nickel a été mis en évidence et correspond à la garniérite issue des altérations météoriques des serpentines et concentrée localement dans la carapace d'Ambed mais sans valeur économique. Par ailleurs, les études géochimiques réalisées sur le massif des serpentines par le service géologique de la Compagnie minière de Tifnoute Tiranimine (CTT-Bou Azzer) a révélé des teneurs élevées qui dans certains cas sont comparables à certains gisement exploités dans le monde et peuvent atteindre 0.27 % avec le chrome pour une teneur moyenne de 14%. Les superficies minéralisées sont de grandes extensions et dépassent plusieurs milliers de m^2. Les secteurs les plus minéralisés sont au niveau du secteur Ambed et Ait Ahmane mais également à Bou Azzer Est et à Aghbar. Les espèces minérales porteuses du nickel identifiées dans les massifs de serpentinite sont:

- La Polydymite cobaltifère ($NiNi_2S_4$) :

Au microscope métallographique la polydymite se présente sous forme de petites plages à contours irréguliers et de taille pouvant atteindre 60µ x 50µ. En lumière naturelle, cette polydymite présente une couleur jaune **(Fig.8, A).** En lumière polarisée, certaines plages de polydymite correspondent à des agrégats formés de plusieurs grains.

L'analyse chimique ponctuelle semi quantitative réalisée sur la polydymite, à l'aide du MEB, est représentée par le spectre **(Fig.9)** et par la composition chimique pondérale et atomique correspondante.

L'examen du résultat de ce pondérale en nickel de cette polydymite remarquable du cobalt, avec une proportion de une substitution de Co à Ni et confère ainsi à cette polydymite, un caractère cobaltifère.

En peut trouver aussi une association intime entre la polydymite cobaltifère et la magnétite cobaltifère. En effet ces phases minérales sont généralement regroupées en agrégats **(Fig.8, B).** Certains grains de polydymite peuvent contenir de la magnétite sous forme de fines inclusions **(Fig.8, C).** Les agrégats formés de polydymite et de magnétite peuvent prendre différentes formes.

Ces agrégats de polydymite et de magnétite correspondant à un assemblage minéral secondaire, peuvent résulter de la transformation lors de la serpentinisation d'agrégats minéral d'origine magmatique composé initialement de pentlandite et de pyrrhotite.

La polydymite peut aussi trouvée libre dans les minéraux de la serpentine **(Fig.10, A)** est rarement associée à la magnétite cobaltifère avec laquelle elle peut former des agrégats.

Les grains de polydymite présentent souvent des contours capricieux et une taille variable entre quelques microns et quelques dizaines de microns, La magnétite est également assez abondante et se présente sous forme de grains aux contours irréguliers. **(Fig.10, B).** Les grains de magnétite peuvent indiqués un caractère cobaltifère ou plutôt un caractère nickélifère **(Fig.10, C).**

L'analyse chimique ponctuelle réalisée au MEB sur différents grains de polydymite indique une proportion pondérale du nickel variable entre 56.11 wt% Ni et 50.98 wt% Ni. La composition pondérale du cobalt est comprise entre 5.48 wt% Co et 5.87 wt% Co

- L'Orcelite ($Ni_{5-x}As_2$)

Au microscope métallographique, en lumière naturelle, l'orcelite présente une teinte blanc rosâtre. En lumière polarisée, elle présente une faible anisotropie. L'analyse chimique ponctuelle semi quantitative réalisée au MEB (microscope électronique à balayage) montre une proportion en nickel de 60.81 wt% Ni **(Fig.11).**

La magnétite :

L'examen réalisé au microscope métallographique montre une présence en quantité appréciable de magnétite. Cette dernière se présente sous forme de grains de taille micrométrique **(Fig.10, D).** Un autre type de magnétite se développe au niveau des contours et dans les fractures des phénocristaux du chrome-spinelle **(Fig.10, E).**

- La magnétite nickélifère et chromifère :

La magnétite se développe au détriment du chrome-spinelle. Cette magnétite clairement secondaire se localise dans les microfissures recoupant les grains du chrome-spinelle et dans les bordures de ces grains **(Fig.10, F).** L'analyse chimique ponctuelle semi quantitative réalisée au MEB, indique une teneur en nickel variable entre 9.60 wt% Ni et 11.51 wt% Ni **(Fig.12**). Le chrome est présent à une teneur échelonnée entre 2.03 et 7.73 wt% Cr.

- Chrome-spinelle nickélifère :

Le chrome-spinelle est présent sous forme de grains épars dans le La taille des grains varie de quelques µm à 0.5mm **(Fig.8, D)**. L'analyse chimique ponctuelle semi quantitative réalisée au MEB, montre la présence du nickel et du zinc avec des proportions significatives. La composition pondérale en zinc varie entre 3.04 et 8.80 wt% Zn. Le nickel est détecté à une teneur de 1.55 wt% Ni **(Fig.13).**

- La Millerite (NiS) :

L'analyse chimique ponctuelle réalisée à l'aide du MEB a permis de se rendre compte la présence de la millerite cobaltifère. Dans cette dernière le nickel présente une proportion comprise entre 58.91 wt% Ni et 62.62 wt% Ni **(Fig.14).** Le cobalt rentre avec une teneur échelonnée entre (3.13 wt% Co et 4.67 wt% Co).

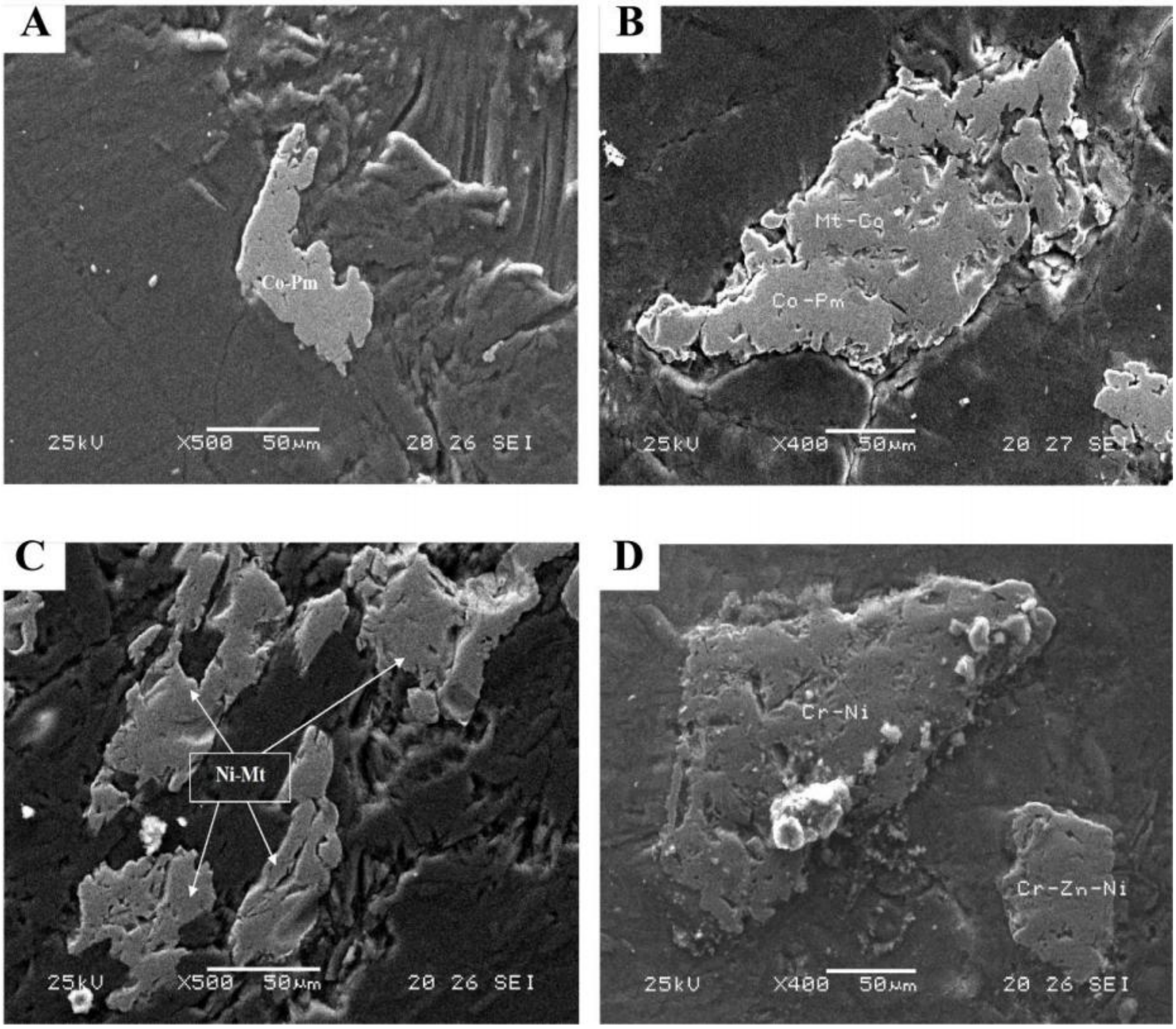

Fig.8. Les espèces minérales porteuses du nickel identifiées dans les massifs de serpentinite par microscope électronique à balayage (Co-Pm : Polydymite cobaltifère, Mt-Ni : Magnétite cobaltifère, Cr-Ni : magnétite chromifères et Nickélifères, Ni-Mt : magnétite nickélifère, Cr-Zn-Ni : Chrome-spinelle zincifère et nickélifère)

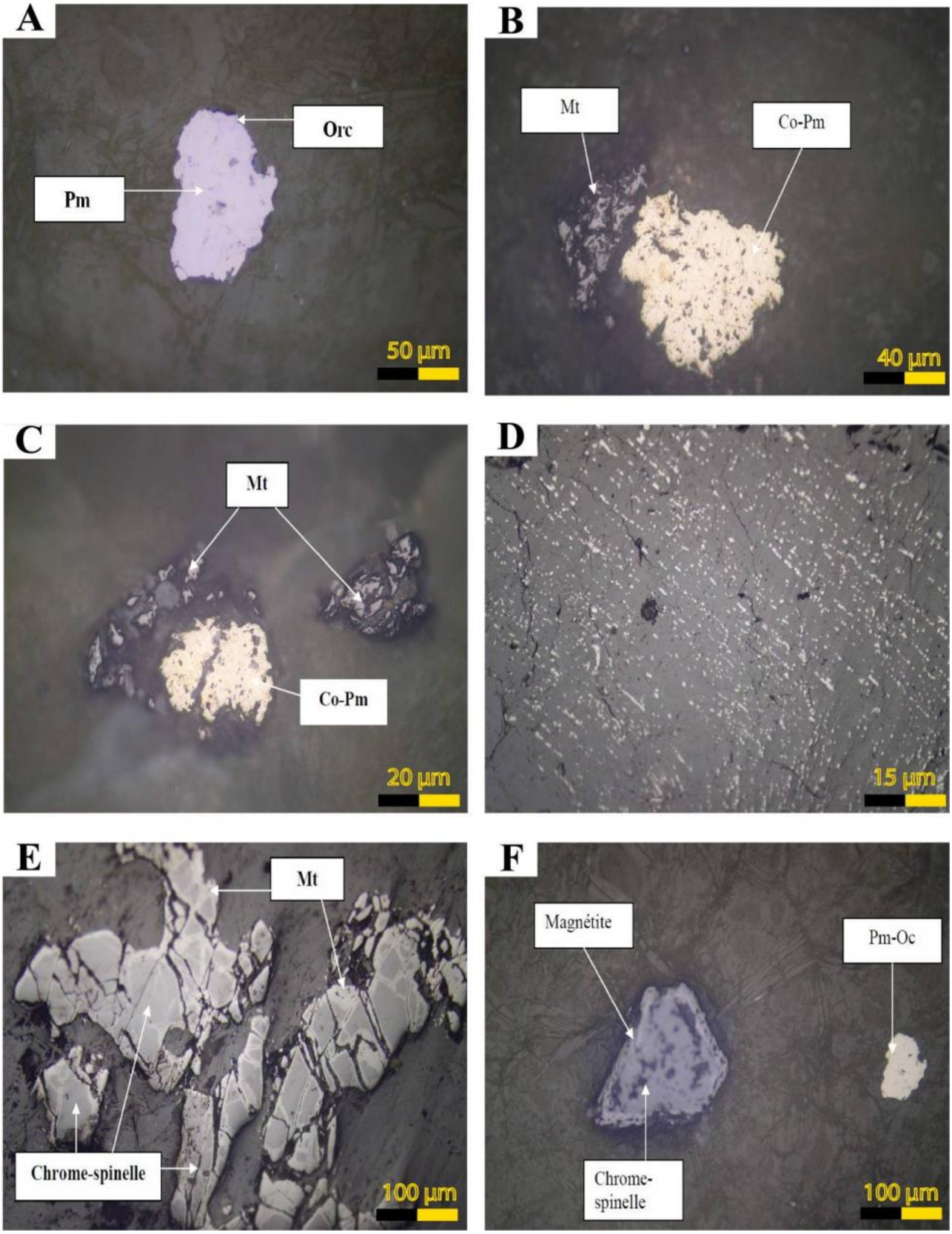

Fig.10. Observations métallographiques des espèces minérales porteuses du nickel identifiées dans les massifs de serpentinite (Pm : Polydymite, Orc : orcelite, Mt : Magnétite, Co-Pm : Polydymite cobaltifère).

A la lumière des données acquises à l'issue de l'étude minéralogique, nous retenons les faits marquants suivants :

La détection du nickel dans la polydymite (50,86 wt% Ni) cobaltifère (4.38 wt% Co), dans le Chrome-spinelle nickélifère (1.55 wt% Ni), dans la magnétite nickélifère (jusqu'à 11 wt% Ni) en dans l'orcélite (60.81 wt% Ni), correspondant à un arséniure de Ni.

L'association intime entre la polydymite cobaltifère et la magnétite cobaltifère : Ces agrégats de polydymite et de magnétite correspondant à un assemblage minéral secondaire, peuvent résulter de la transformation lors de la serpentinisation d'agrégats minéral d'origine magmatique composé initialement de pentlandite et de pyrrhotite.

L'Identification de polydymite cobaltifère, millerite cobaltifère, magnétite nickélifère et magnétite cobaltifère et abondance remarquable des grains de polydymite.

La formation de toutes ces phases minérales porteuses de nickel est contemporaine de la serpentinisation des roches ultrabasiques du complexe ophiolitique de Bou Azzer. La roche hôte est profondément serpentinisée.

Ces phases nickélifères sont formées par remplacement d'une paragenèse primaire d'origine magmatique, et constituée très fort probablement de pentlandite, de sulfures de Fe (pyrrhotite et/ou pyrite). Un processus identique est plausible dans le massif d'Ambed, où existe occasionnellement des grains de pentlandite. Dans tous les gisements où elle est connue, l'orcélite est le seul arséniure de Ni stable pendant la serpentinisation : elle cristallise généralement au dessous de 400-450 °C aux dépens d'une paragenèse primaire à nickéline + maucherite ($Ni_{11}As_8$).

La fréquence relative de la maucherite dans les péridotites initialement équilibrées au sein du manteau supérieur souligne l'importance de l'arsenic dans les fluides d'origine mantellique. Les valeurs de l'activité de l'arsenic ont pu être localement aussi élevées que celle du soufre pour former un liquide immiscible riche en As, à l'origine des paragenèses riches en As de haute température. A une température inférieure à 400-450 °C ([17]). La serpentinisation des roches ultrabasiques encaissantes conduit à la remobilisation de S, Fe, Ni et Co inclus dans la paragenèse primaire magmatique. L'assemblage sulfuré varie avec le degré de serpentinisation de : pyrrhotite+pentlandite à pentlandite+heazlewoodite+godlevskite aux stades plus avancés, pentlandite+polydymite (ou violarite), pentlandite+polydymite+millerite et polydymite+millerite.

L'assemblage minéral nickélifère identifié dans les massifs d'Aghbar et de Bou Azzer Est complètement serpentinisés, composé essentiellement de polydymite+millerite+ magnétite pourrait provenir du remplacement lors de la serpentinisation d'une paragenèse minérale primaire formée en plus de l'olivine d'agrégats de pentlandite+pyrrhotite.

D'une manière homogène, les minéralisations sont associées aux roches ultrabasiques incluent i)les minéralisations de nickel disséminées dans les termes de la zone de transition de la série ophiolitique ii) les gisements de chromite podiformes et les PGE associés iii) les minéralisations à or et palladium de Bleida Far-West encaissées par des roches basiques des cumulats iv) les minéralisations filoniennes hydrothermales de cobalt, nickel, arsenic et or de Bou Azzer. La genèse de ces minéralisations est le résultat de plusieurs processus hydrothermaux et tectono-magmatiques superposés.

Des minéralisations magmatiques précoces associées au fractionnement magmatique regroupent les minéralisations primaires de nickel, chrome ([13], [14], [22]) et PGE ([19], [20]).

Des minéralisations hydrothermales antémétamorphiques à sulfures, arséniures et oxydes synchrones de la serpentinisation sous l'influence combinée des fluides hydrothermaux tardifs et des eaux marines probablement chargées d'arsenic lessivé des sédiments avoisinant .

Des phénomènes supergènes intermittents qui concentrent les minéralisations de stichtite et de garniérite.

Une époque métallogénique tardi-panafricaine productrice du cobalt, arsenic, nickel et or en relation avec les phénomènes du doming des non métamorphique.

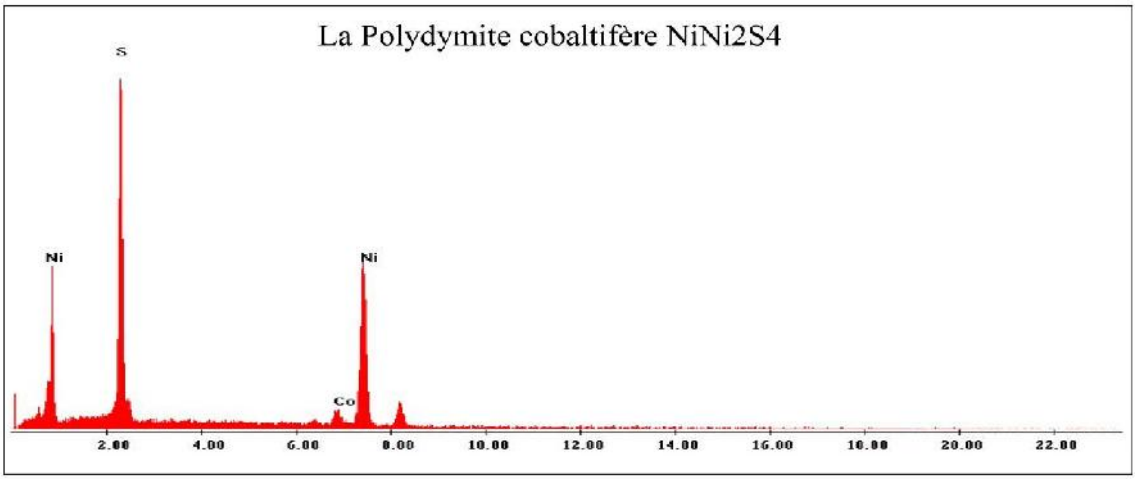

Fig.9. le spectre de la Polydymite cobaltifère NiNi2S4

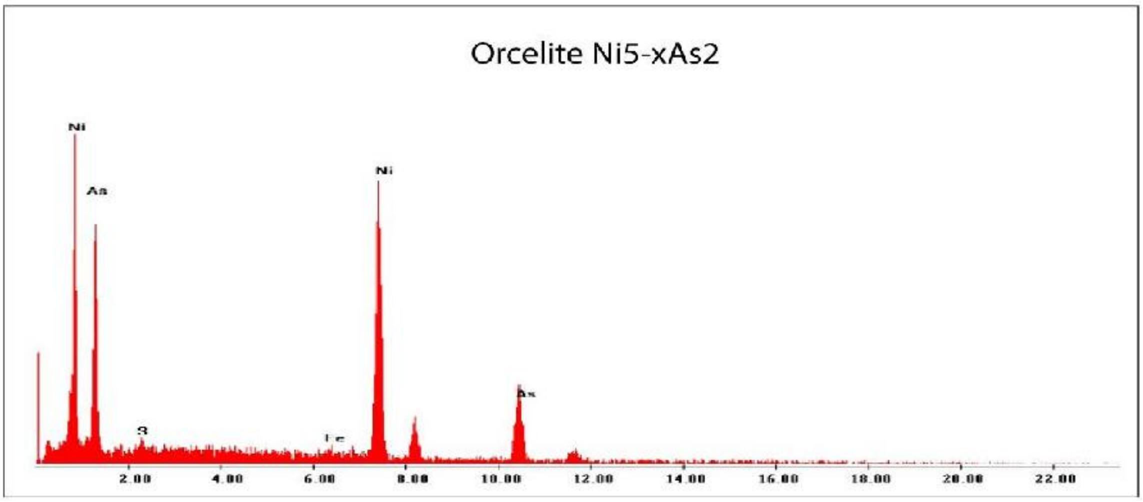

Fig.11. le spectre de l'Orcelite Ni5-xAs2

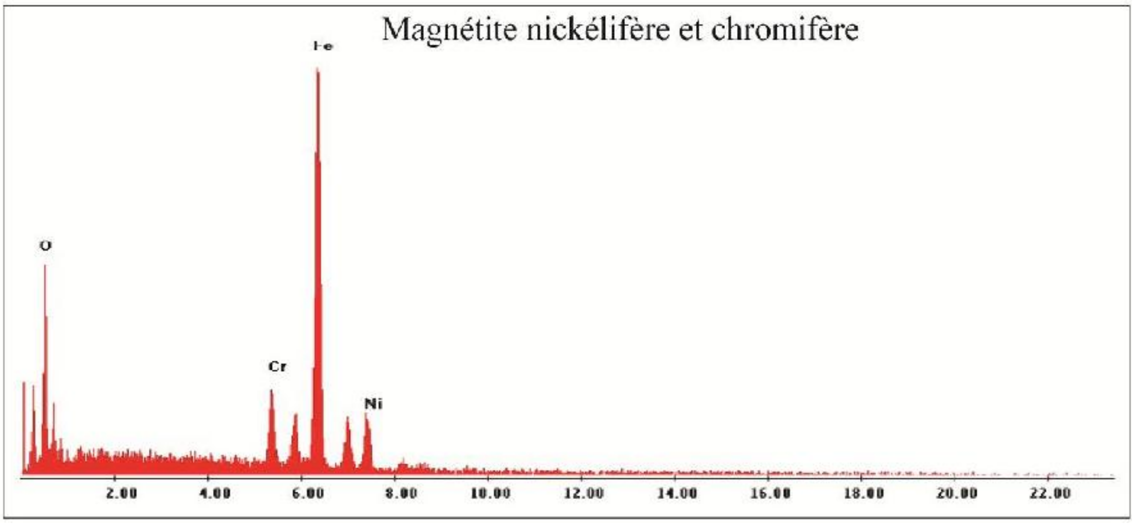

Fig.12. le spectre de la Magnétite nickélifère et chromifère

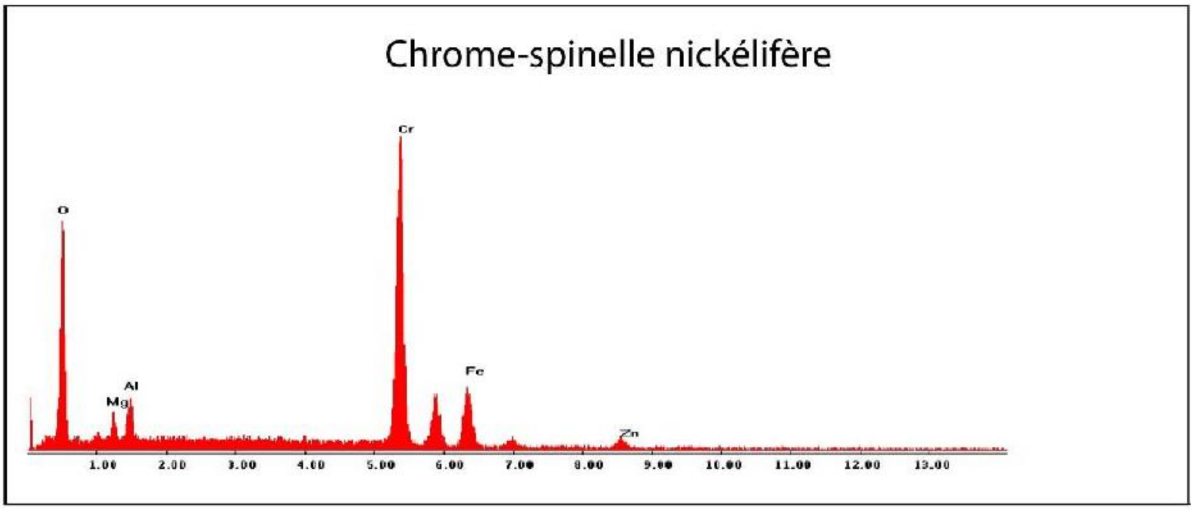

Fig.13. le spectre de Chrome-spinelle nickélifère

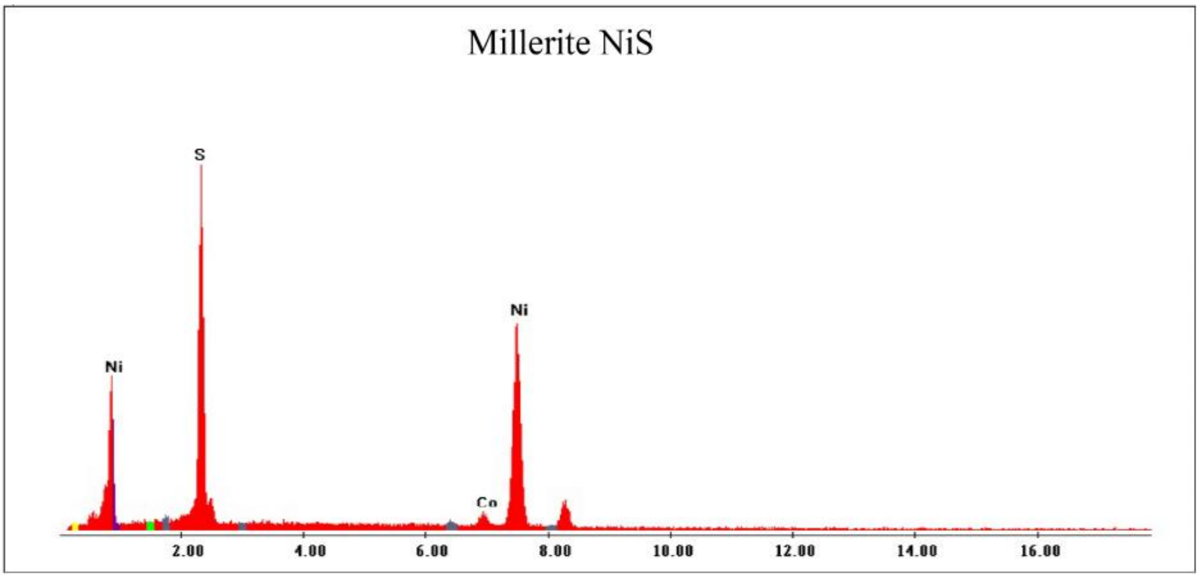

Fig.14. le spectre de la Millerite NiS

Pour la boutonnière de Bou Azzer, le scénario proposé est comme suit (**Fig. 15**) :

Un assemblage primaire d'origine magmatique : (Pyrrhotite, pentlandite et la chromite) (**Fig. 15 : A, B et C**)

La serpentinisation : l'assemblage primaire d'origine magmatique varie suivant le degré de serpentinisation vers un autre assemblage de polydymite, millérite, orcélite et magnétite. (**Fig. 15 : D, E et F)**

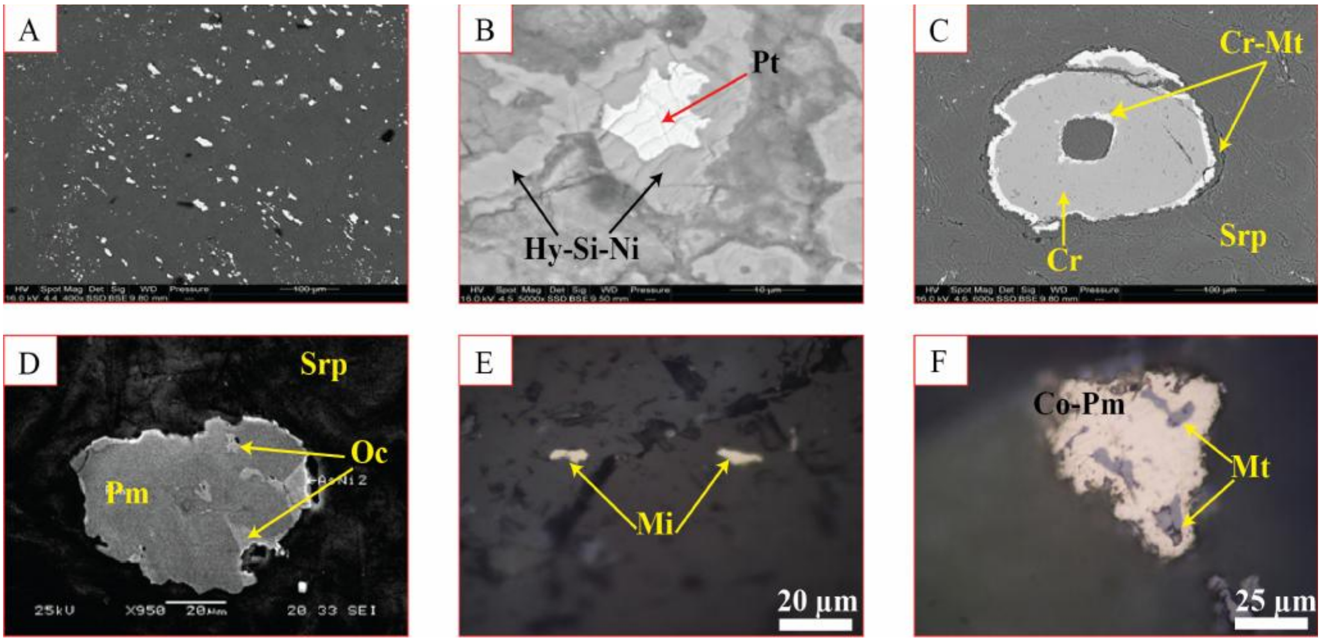

Fig.15. (A, B et C: Assemblage à Pentlandite (41,5 à 40,5 wt% Ni), Chromite (28 à 37 wt% Cr). (D, E et F: Assemblage à Polydmite, millérite, orcellite et magnétite).

6 CONCLUSION ET DISCUSSION

Toutes les hypothèses proposées pour les minéralisations de Bou Azzer placent le phénomène de serpentinisation au cœur des processus de genèse, toutefois avec des divergences majeures. ([21]) a associé le cobalt à la serpentine et considère un événement hydrothermal hercynien dans lequel l'arsenic, le CO_2 et la silice proviendraient d'une origine profonde. ([11]) considère que l'origine du cobalt est dans la serpentinite, la magnétite et certains niveaux riches en sulfures. Il propose un premier dépôt du cobalt sédimentaire dans des chenaux en relation avec la carapace d'Ambed, qui aurait été reconcentré par des phases tectoniques postérieures plus particulièrement à l'Hercynien.

La paragenèse primaire d'origine magmatique est à pentlandite, chromospinelle et magnétite cobaltifère et/ou nickélifère, elle est probablement associée aux sulfures de Fe (pyrrhotite et/ou pyrite) ([13], ([14], [18], [22], [23], [24]). Par ailleurs, l'assemblage minéralogique identifié est composé essentiellement de minéraux secondaires de polydymite cobaltifère, millerite cobaltifère, orcélite et magnétite cobaltifère et nickélifère. Ces phases pourraient provenir du remplacement, lors de la serpentinisation, d'une paragenèse minérale primaire formée, en plus de l'olivine, d'agrégats de pentlandite+pyrrhotite.

La présence de l'orcélite, le seul arséniure de Ni stable pendant la serpentinisation, reflète des conditions de forte activité de Ni et de faible activité de Fe au sein des fluides impliqués dans la serpentinisation. La fréquence relative de la maucherite souligne l'importance de l'arsenic dans les fluides d'origine mantellique. Les valeurs de l'activité de l'arsenic ont pu être localement aussi élevées que celle du soufre pour former un liquide immiscible riche en As, à l'origine des paragenèses riche en As de haute température.

La combinaison d'études structurale, pétrologique, métallogénique, et géochimique dans des massifs nous a permis de confirmer les conclusions avancées par cet auteur, à savoir : Les ultramafites de Bou Azzer, contenaient des minéralisations magmatiques primaires en Ni-Co, dont les témoins sont encore conservés dans les chromites.

Ces minéralisations auraient ensuite subi deux épisodes de serpentinisation au cours desquelles les minéralisations précoces auraient été remobilisées et re-concentrées (i) un premier épisode océanique syn-rifting et (ii) un deuxième épisode continental contemporain de la compression panafricaine.

La mise en place des intrusions de diorites et de diorites quartziques tardi- à post-panafricaines avaient ensuite déclenché des systèmes hydrothermaux qui auraient concentré et/ou enrichi le stock cobaltifère dans les serpentinites. Il parait donc que le stock métal des gisements de Cobalt de Bou Azzer est le résultat d'au moins trois stades d'altération post-minéralisation primaire.

La circulation des fluides favorisée par la forte perméabilité des zones d'intense déformation au sein des serpentinites et des zones de contact entre des formations à lithologies contrastées entre la diorite quartzique et les serpentinites. Néanmoins, la distribution des gisements le long de ce contact et la disparité de la paragenèse minérale entre les différents corps minéralisés restent à expliquer : seraient-elles liées à une zonalité métallogénique, elle-même dictée par les conditions physico-chimiques (P-T-fO_2-fS) des fluides ? Ou bien seraient-elles à mettre en relation avec des micro-hétérogénéités locales au sein de l'encaissant mantellique, ou bien en relation avec la tectonique qui aurait crée des zones pièges ou le stock métal se serait déposé ? Le rôle de la serpentinisation dans l'adoucissement du manteau et son exhumation, est un point clé qui sera étudié en détail, tant du point de vue structural que du point de vue géochimique. En particulier, il est important de préciser à quel stade de l'histoire tectonique l'hydratation du manteau a eu lieu et la nature du (des) fluide(s) impliqué(s) (traçage isotopique à l'aide de O, H, Sr, Nd) L'accent sera mis (i) sur la cartographie des zones d'altération à chacune des trois phases d'altération définies ci-dessus et (ii) sur le calcul des bilans de matière associés à chacune des phases d'altération post-minéralisations primaires. Les éventuels enrichissements et/ou lessivages seront ainsi évalués et la part de chaque phase d'altération dans la mise en place du stock métal final quantifié. Il sera donc possible d'établir un modèle génétique pour cette minéralisation presque unique dans le monde.

Les minéralisations associées aux ophiolites de Bou Azzer traduisent des époques métallogéniques superposées et dans lesquelles le phénomène de serpentinisation a joué un rôle important tant sur le plan physique que chimique. Ces minéralisations incluent i)les minéralisations de nickel disséminées dans les termes de la zone de transition de la série ophiolitique ii) les gisements de chromite podiformes et les PGE associés iii) les minéralisations à or et palladium de Bleida Far-West encaissées par des roches basiques des cumulats iv) les minéralisations filoniennes hydrothermales de cobalt, nickel, arsenic et or de Bou Azzer.

En tenant compte des données récentes ([17], [25]) nous considérons que la genèse des minéralisations de Bou Azzer est le résultat de plusieurs processus hydrothermaux et tectono-magmatiques superposés.

Dans le massif d'Ambed où la serpentinisation des roches ultrabasiques n'est que partielle, une paragenèse primaire d'origine magmatique à pentlandite, chromospinelle et magnétite cobaltifère et/ou nickélifère a été mise en évidence et serait probablement associée aux sulfures de Fe (pyrrhotite et/ou pyrite). En revanche, dans les massifs d'Aghbar et de Bou Azzer Est où la serpentinisation est totale, l'assemblage minéralogique identifié est composé essentiellement de minéraux secondaires de polydymite cobaltifère, millerite cobaltifère, orcélite et magnétite cobaltifère et nickélifère. Ces phases pourraient provenir du remplacement, lors de la serpentinisation, d'une paragenèse minérale primaire formée, en plus de l'olivine, d'agrégats de pentlandite+pyrrhotite.

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Les déformations panafricaines induisent le fonctionnement des accidents majeurs E-W et ENE qui vont servir de drains aux diverses événements hydrothermaux ainsi qu'aux altérations supergènes postérieures. C'est à cette famille qu'appartiennent le filon 7, l'accident majeur ENE de Bou Azzer Est, d'Aghbar et la faille d'Ightem.

Un épisode de redistribution et de reconcentration du nickel et de cobalt sous forme d'arséniures et de sulfures a été décrit par ([17]) mais dont l'âge n'est pas élucidé. L'auteur l'associe à la serpentinisation qui serait aussi responsable de la formation d'une magnétite secondaire enrichie en ces éléments. Il est probable que le gisement à or et palladium de Bleida Farwest récemment découvert soit de type magmatique et associé à cet épisode de rifting.

Après les compressions panafricaines, le domaine de Bou Azzer est soumis à un régime transtensif synchrone du dépôt du Groupe de Ouarzazate ou PIII ([26], [27]) qui conduit à la réactivation des accidents E-W en décrochements sénestres et des accidents NE en failles normales. Un tel contexte extensif a favorisé le développement d'un système de horsts et grabens accompagnés par la remontée de dômes de serpentines, alternant avec des dépressions à dépôts PIII. On peut noter trois dômes principaux, ceux de Bou Offroh, Oumlil et Aït Ahmane. Ce phénomène va se poursuivre postérieurement au dépôt du Groupe de Ouarzazate jusqu'à la base de l'Adoudounien. La montée (doming) des serpentinites forme des dômes ou des lames recoupent les formations de base de la couverture. A la base de celle-ci et en concordance avec les niveaux volcaniques du PIII se développe la carapace d'Ambed qui va jouer le rôle de réceptacle aux minéralisations de type amas (Tamdrost et à Aghbar). Cet épisode est suivi d'une altération des serpentines marquée par une carbonatation intense et une démagnétisation quasi-totale de la surface altérée, allant jouer un rôle important dans la genèse des minéralisations par l'oxydation et le lessivage du cobalt , nickel , arsenic et soufre décrits ci-dessus (ce procédé naturel est aujourd'hui utilisé dans l'industrie de cobalt).

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Knowledge attitude and behaviour concerning pregnancy: Study from a rural village of Bangladesh

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ABSTRACT: "Pregnancy is special, let's make it safe" was the slogan of the 1998 world health day. This worldwide focus on safe motherhood comes as the safe motherhood initiative, launched in 1987, starts into its second decade. According to UNFPA (State of population 2010) 360 mothers per 1000 die of pregnancy in Bangladesh, against 420 in India and 500 in Pakistan due to pregnancy and its related complications .The women are inferior by nature and motherhood, with its domestic role in the family, is their natural place is upheld by strong cultural and mythological and religious beliefs. These beliefs are very strong in Bangladesh. In our society women opinion about pregnancy and child birth is recognized by his family as well as the society .She is not controller of her own body. Despite fertility transition and impressive success of the immunization campaign, the other health indicators are still remaining behind. 67 % of pregnant mothers do not receive antenatal care, 92 % of deliveries take place at home and only 12 % deliveries are attended by trained personnel. This situation cannot allow to be continued. The intervention that make the motherhood safe are known and the resources needed are obtainable .The necessary services are neither sophisticated nor very expensive and reducing maternal mortality is one of the cost effective strategies available in the area of public health. This study was conducted among mothers who had children or were currently pregnant with the objective is to examine the possible association between certain socio-economic, cultural and some other background variables of conception in order to understand more clearly how important these factors are in explaining the observed levels of Reproductive Health status.

KEYWORDS: Knowledge, attitude, behaviour, pregnancy, rural village, Bangladesh.

INTRODUCTION

Around the world, people celebrate the birth of a new baby. Societies expect women to bear children, and being honored for their role as mothers. Pregnancy and childbirth are the special events in women's lives and, indeed, in the lives of their families. This can be a great time of hope and joyful anticipation. It can also be a time of fear sufferings and even death. Although pregnancy is not a disease but a normal physiological process, it is associated with certain risks to health and to survival for the women and the infant she bears. These risks are presents in every society and even every setting. In developed countries they have largely over come because every pregnant woman has the access to especial care during pregnancy and childbirth. But this is not the case of many developing countries like Bangladesh where each pregnancy represents a journey into the unknown from which all too many women never return.

Women, particularly rural women in Bangladesh are generally deprived of different amenities and facilities compared to men. Male domination and women's subordination is distinct feature in our cultural discriminatory attitudes and practices. The sexual and reproductive health for women in Bangladesh is poor than other countries. In Bangladesh 26000 women die in every year due to causes related to pregnancy and childbirth. The risk of maternal mortality is 160 greater than developed countries (http/www. country profile. net). Therefore, maternal mortality represents the end point in a lifetime experience of gender discrimination, neglect and deprivation. Its high rate also represents the failure of the health system for women. Apart from poor and inadequate health care facilities and services, cultural practices (such as “purdah”) lack of health knowledge, almost absence of regular medical check-ups, concealing health problems-all these coupled with Reproductive Health make the women of Bangladesh more vulnerable to health problems. This situation observed primarily due to the existing patriarchal social system that prevails quite strongly in our society. In addition to this modern values and ideas are yet to penetrate among the larger population of the country, particularly rural population (Hossain, 2002:52). In our society women opinion about pregnancy and child birth is recognized by his family as well as the society .She is not controller of her own body. The women are inferior by nature and motherhood, with its domestic role in the family, is their natural place is upheld by strong cultural and mythological and religious beliefs. These beliefs are very strong in Bangladesh

In rural Bangladesh women's perceptions about physiological function is unclear. A clearer understanding of how our women conceive reproductive functions and what is the current level of knowledge and beliefs regarding those could help promotional and educational strategies accordingly. The deep-rooted beliefs, views, perception and attitude of any society is initially relate to the female Reproductive Health in rural areas. Therefore, in this study entitled **"Knowledge and attitude concerning pregnancy: Study from a rural village of Bangladesh”** the status of rural women's perceptions/knowledge and practices on various pregnancy related issues are explored.

OBJECTIVES OF THE STUDY

- To make public the beliefs, attitudes and values of rural people regarding women's reproductive physiology in their cultural background.
- To collect information about beliefs, rituals and practices related to pregnancy.
- To determine the health care seeking behavioral pattern related to pregnancy of rural women.

RESEARCH METHOD

The study topic pregnancy is an ordinary phenomenon in Bangladesh. At last but not at the least; in this study pregnancy was described from real life context. It is part of everyday life of the people of Bangladesh. This indicates that the present study can best be handled by ethnographic method. Ethnography involves observation of the wider context of people lives and interested in the native point of view.

The beliefs about pregnancy and child birth may therefore be examined by analyzing its nature and ingredients in the perspective of cultural changes those are continuously taking place. The component of methodological mixes included participation observation, and survey method. The case study method was also followed for in-depth analysis.

DATA COLLECTION PROCEDURE

In the present study the data was collected through direct Participant Observation with the 100 adult female population of the village those are married and currently pregnant. Participation with them provided information about belief system and their level of knowledge. The Participation Observation proceeded by survey about population household, socio-economic life of women and Reproductive Health situation of the village women by the face-to -face formal interviews. Questionnaires were prepared to collect the general and specific information from the respondent. It has already mentioned that the study was mainly a micro study through an analysis of empirical data obtained from survey by a structured questioner. Besides this, the techniques of collecting data were informal interview and Focus Group Discussion. For ensuring the reliability of information the researcher selected some key informants

DATA ANALYSIS: BELIEFS REGARDING CONCEPTION AND PREGNANCY

Every society has its own traditional beliefs and practices related to health care. Beliefs in supernatural powers, i.e. God, beliefs in holy rituals, salvation, offerings and sacrifices are applied at different stages of life from birth to death. Pregnancy in the case of a woman is the midpoint of life and death. Therefore, there are many such practices; rituals, beliefs and offerings which are meant to protect a mother from influences of evil spirits and supernatural powers. Food taboos are also common during pregnancy in Bangladesh. People have taken pleasure in using traditional beliefs and practices for a long time and got used to it. Thus it can be made easily accept something that has been given by the faith healer to the community. Some practices are effective whereas others may be harmful or ineffective. These beliefs and practices are linked to culture, environment and education. Everybody must have concern for the community's cultural values and beliefs so that they can utilize the harmless practices for effective use as well as eliminate harmful practices.

Present study tries to cover this area by trying to get the Muslim views and attitudes regarding above-mentioned variables in Muslim community. The findings of the present study would be revealing in light of the fact that in the lower socio-economic group of Muslim community leaders wield a lot of influencing power. Keeping the objectives in mind data that collected from married women are analyzed below:

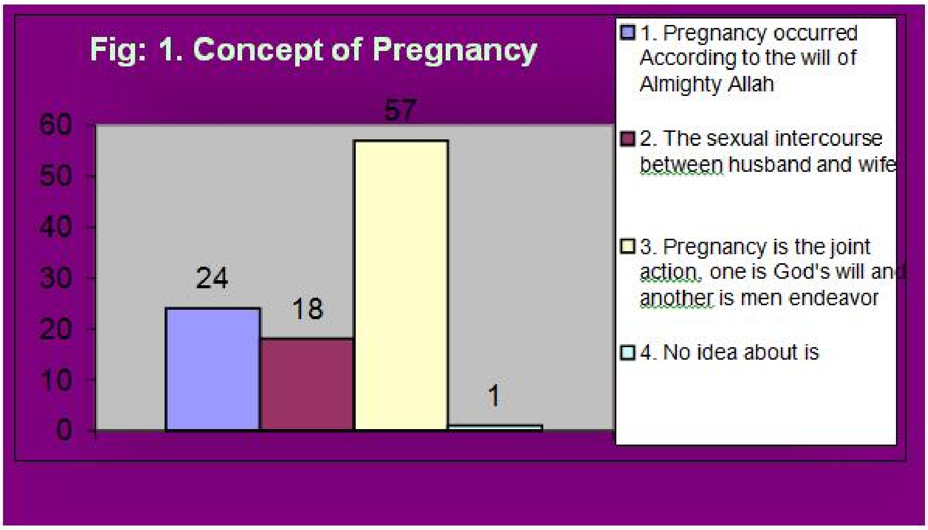


Figure 1: Concept of Pregnancy

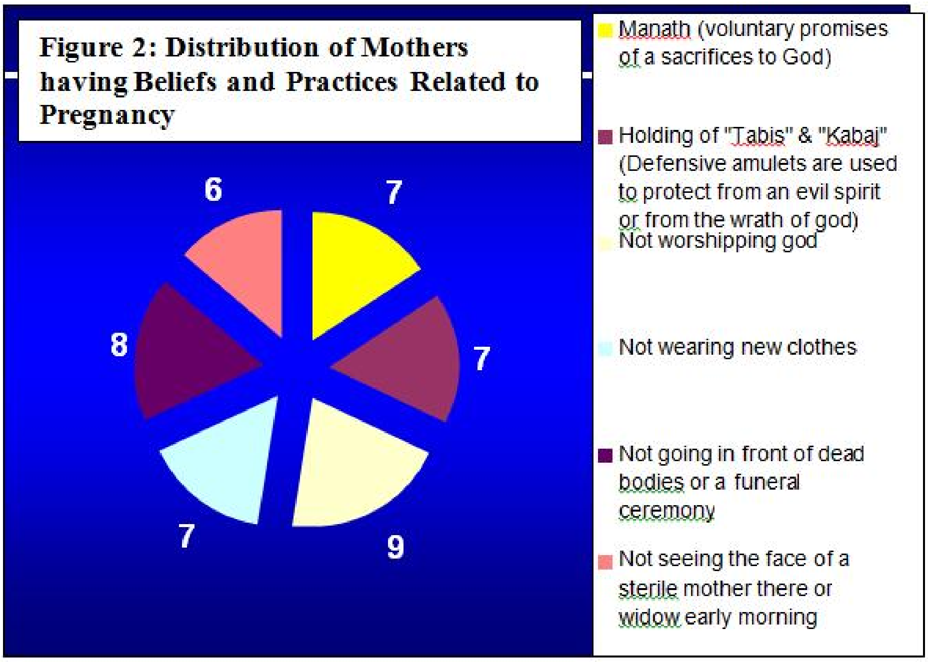
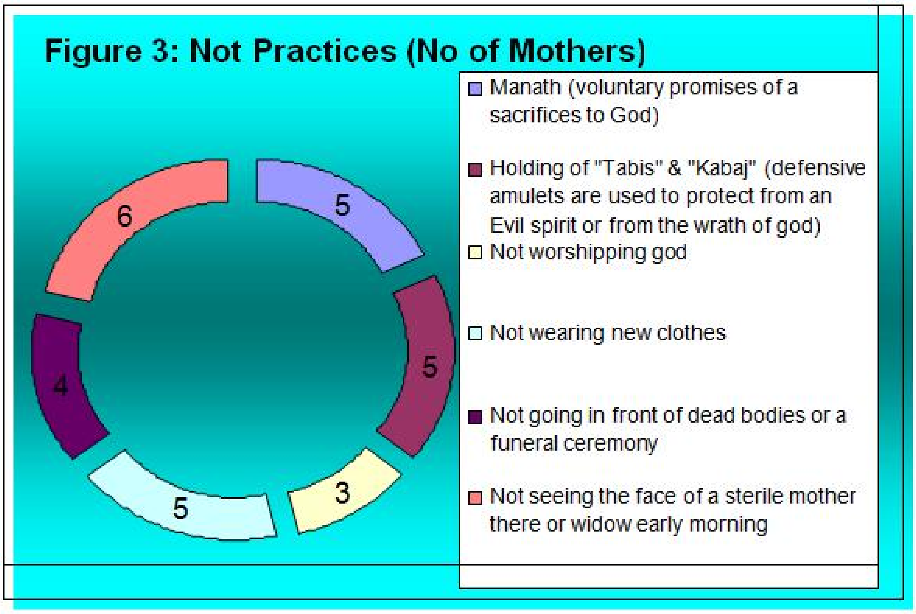


Figure 2: Distribution of Mothers having Beliefs and Practices Related to pregnancy



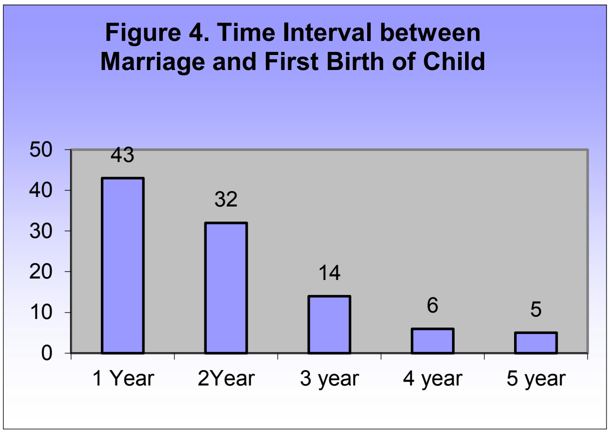


Figure: 4 Time interval between Marriage and the Birth of First Child of the Informants.

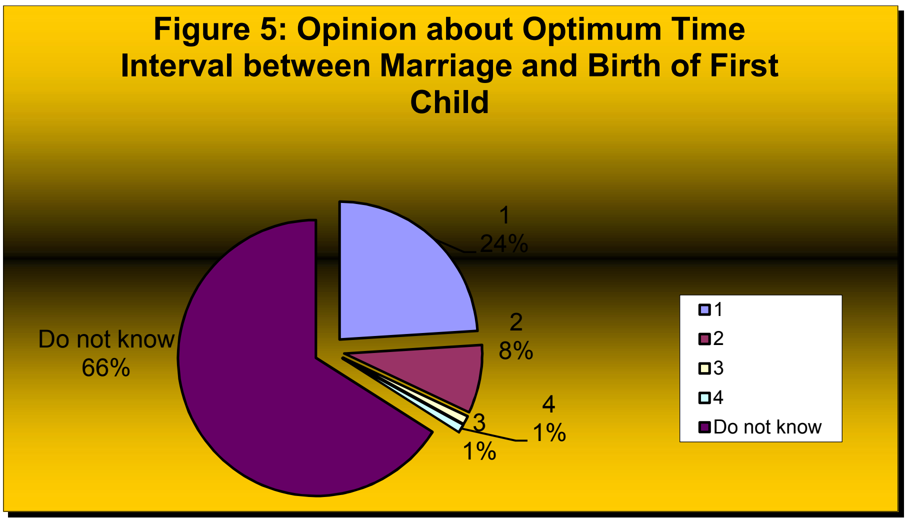


Figure: 5 Opinions about Optimum Time Interval between Marriage and Birth of First Child

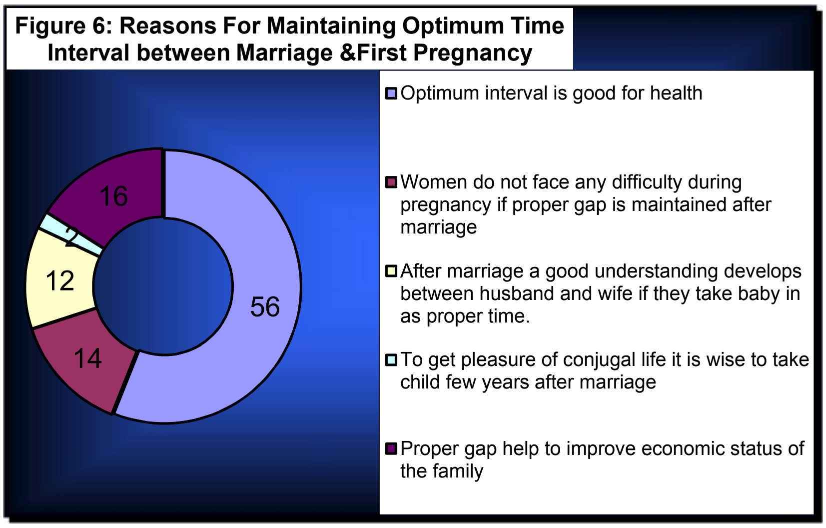


Figure: 6 Reasons for Maintaining Optimum Interval between Marriage and First pregnancy

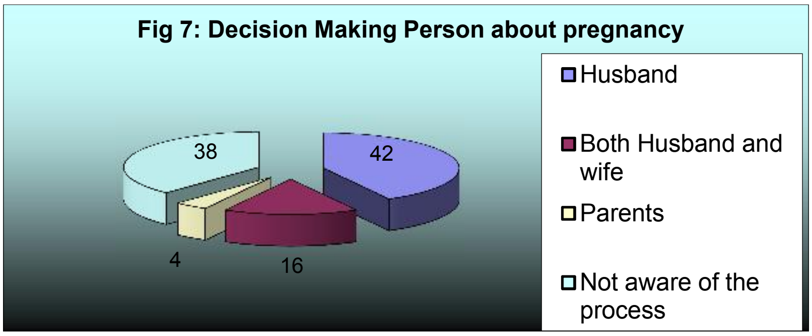


Figure: 7 Decisions Making Process about Pregnancy

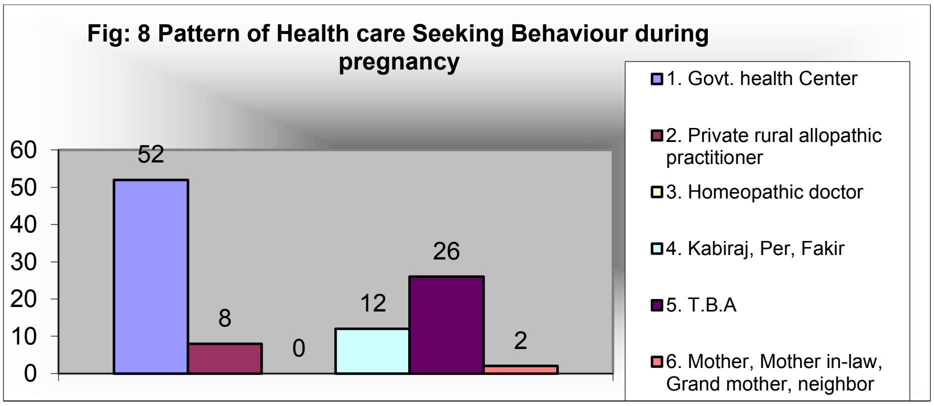


Figure: 8 Pattern of Health Care Seeking Behavior during Pregnancy

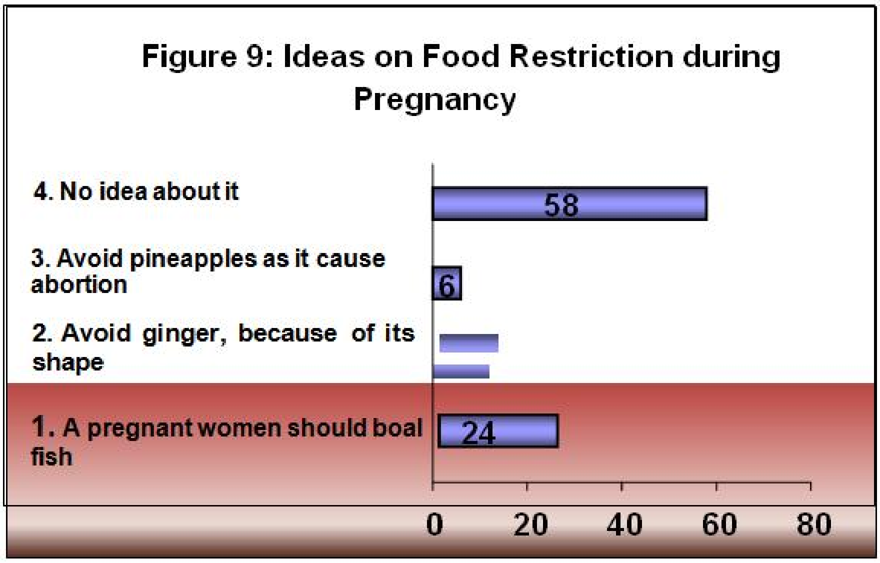


Figure: 9 Knowledge/Beliefs regarding Restrictions on Food Intake during Pregnancy

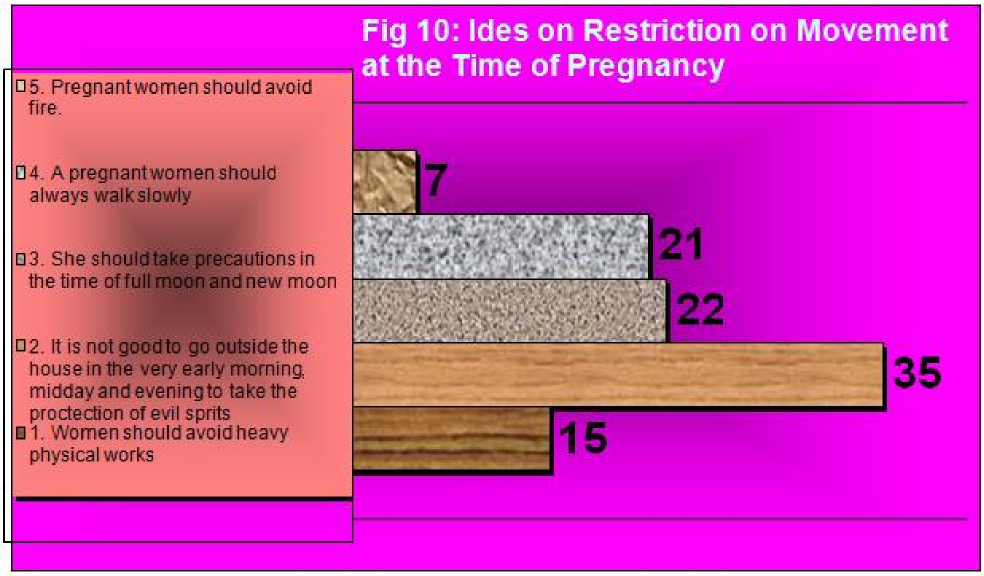


Figure: 10 Ideas on Restriction on Movement and Activities during Pregnancy

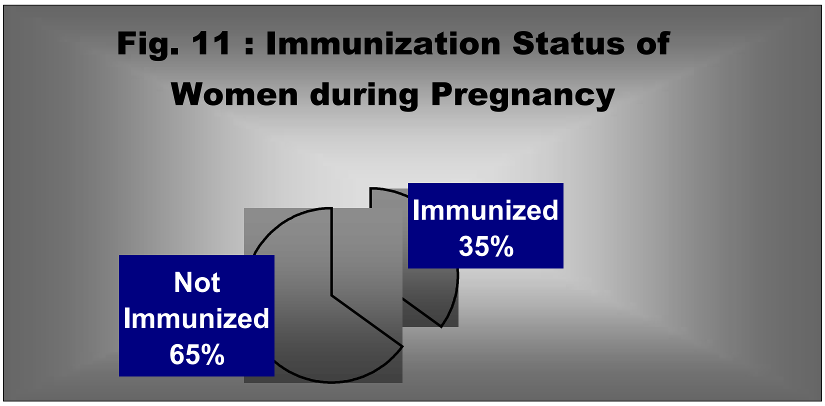


Figure: 11 Immunization Status of Women during Pregnancy

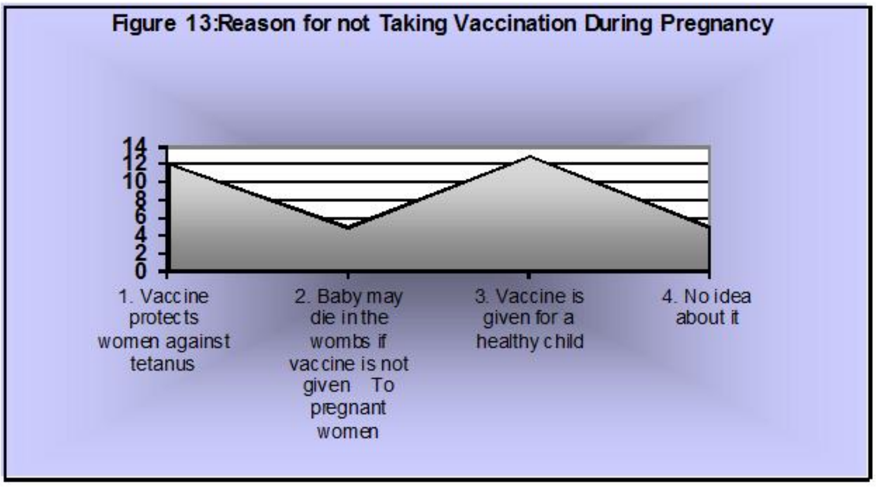


Figure: 13 Reason for taking and not taking Vaccination during Pregnancy

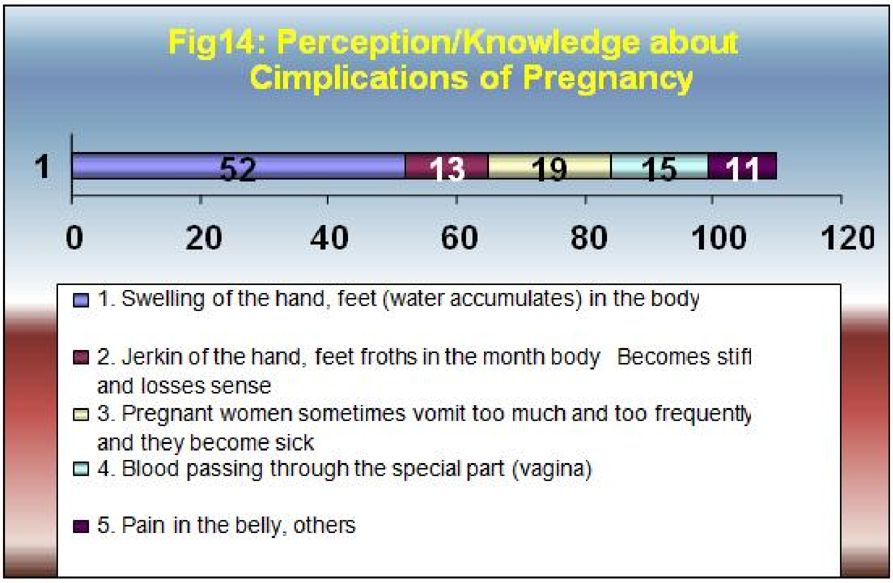


Figure: 14 Complications during Pregnancy

KNOWLEDGE AND PRACTICES REGARDING PREGNANCY

In this country, lack of proper medical attention and hygienic conditions during delivery leads to the risk, complications and infections that cause, death or serious illness for the mother and the newborn or both. Although government health facilities are available down to union level, more than 90% deliveries are conducted at home. The reproductive morbidities diminish women's fertility, productivity and quality of life, as well as the health and survival of the next generation. They also become social outcasts in some cases – turned out of homes and rejected by their husbands and families.

The data found from field study are analyzed below:

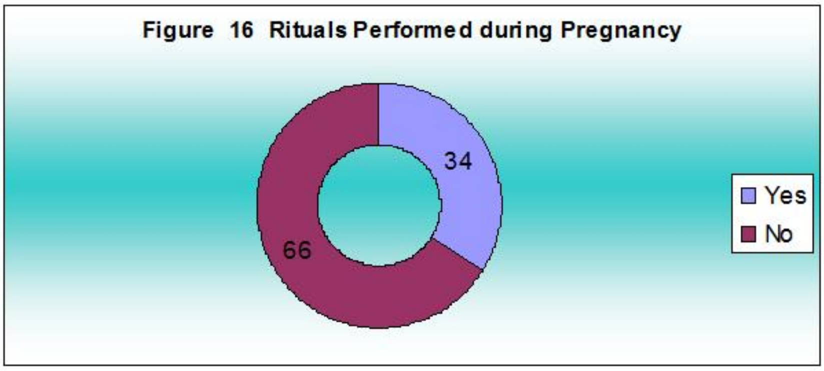
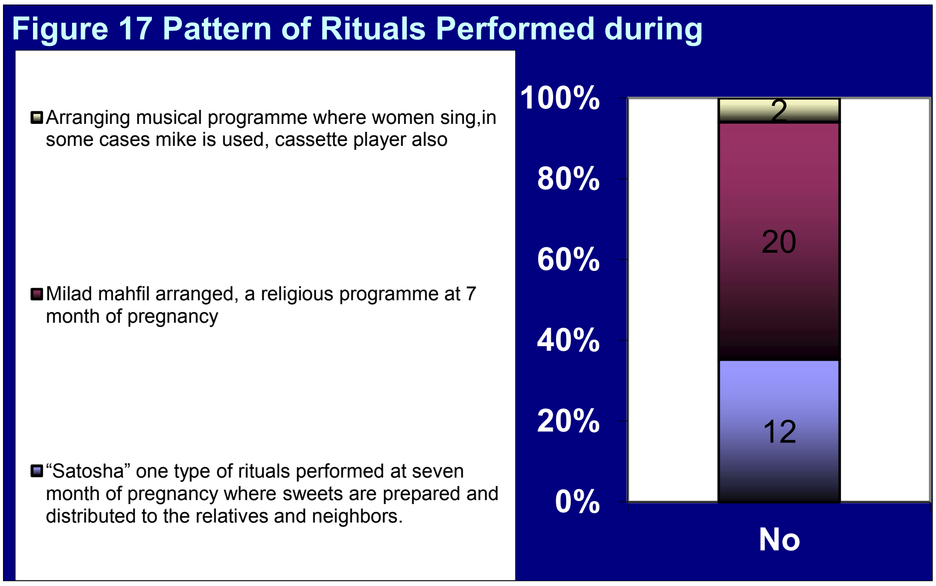


Figure 16: Pattern of Rituals Performed during Pregnancy



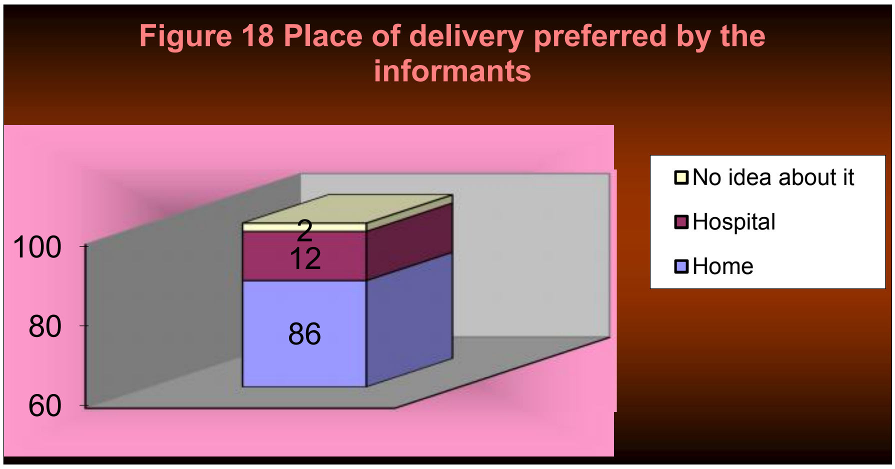


Figure: 18: Place of delivery

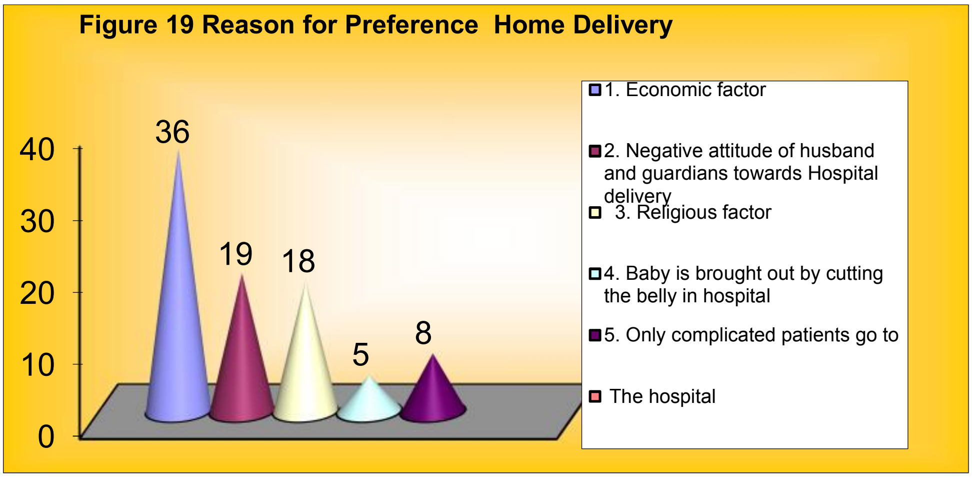


Figure: 19 Reason for Preference of Home Delivery

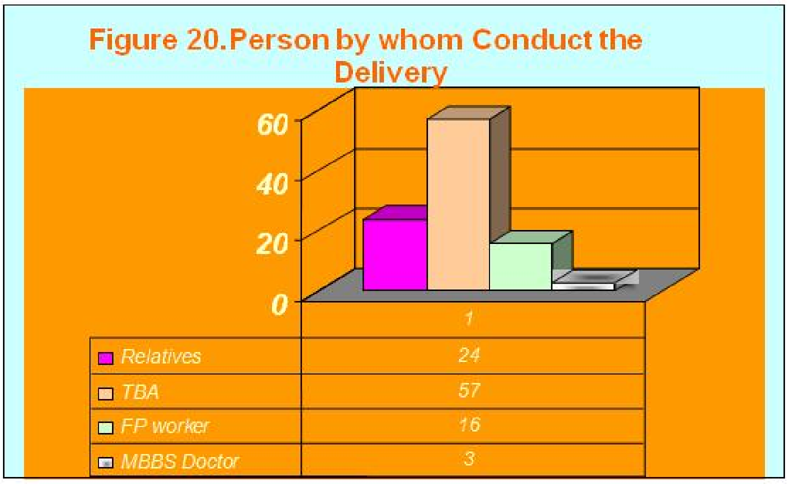


Figure20: Person Attended the Delivery

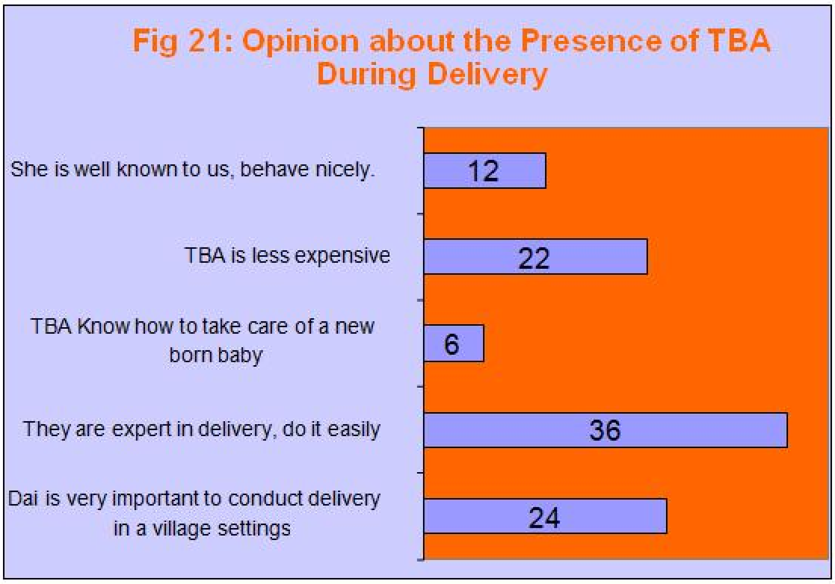


Figure: 21 Opinion about the presence of TBA during Delivery

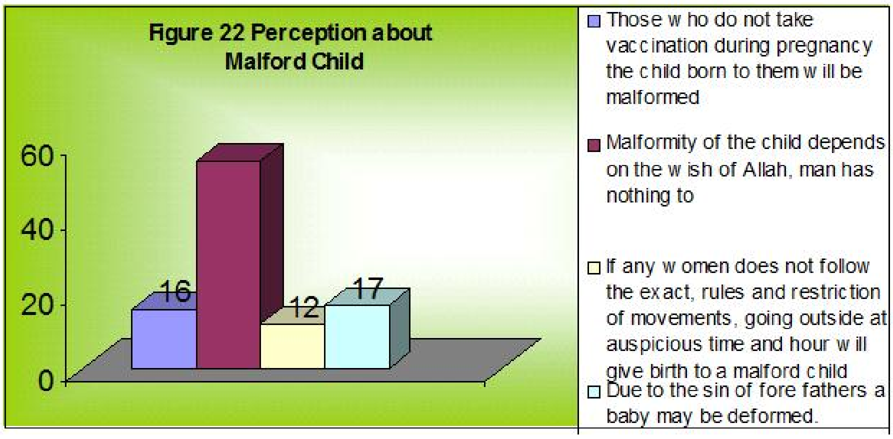


Figure 22: Perception about Malford Child

DISCUSSIONS:

This study was carried out as an attempt to assess the beliefs and rituals concerning pregnancy in the village Badarpur. The findings of this study are:

In the village Badarpur, there is a mixed type of beliefs that pregnancy not only the result of sexual intercourse between husband and wife. It happens when Almighty Allah wishes to give child to those couples. This belief system in study area regarding pregnancy is consistent with the classical analogy that women in the land and man its cultivator's, so that the womb is a field to be planted with male semen.

It was not expected from the informants that they would have good knowledge on the exact mechanism of conception in human reproduction. The beliefs, views regarding pregnancy revealed that conception occurs by the will of God but sexual intercourse plays a vital role in this regard.

Considering the time interval between marriage and birth of 1st child, the people are well experienced and well informed that just after marriage; pregnancy should be avoided for various reasons. The optimum time interval between marriage and birth of first child should be maintained by the newly married couple with the idea of keeping the health of women in a good condition. The mean time interval was 2.50 years in this study area. Most of the informants failed to maintain this interval in married life. Attitude towards delaying the first pregnancy is observed but the practice is un-thinking. So the interval is not an expected level. This type of gap between attitude and practices are observed in other health related issues also.

The study revealed that in majority cases husband take decision prior to pregnancy. There is an increase realization for joint decision about pregnancy, which indicates a good husband-wife communication developed in the study area.

The health care seeking behaviour of rural people depends on the perception of the cause of disease, gender issue, social class, availability of health services in that locality. So during pregnancy, village people prefer to consult with *Dai* (TBA), *Fakir, Kabiraj*. Husband sometimes consult with the *polli chikitsaks* about their wives problem related to pregnancy. But pregnant women rarely get opportunity to consult the male practitioner in this village.

In Badarpur, still there is a strong belief regarding restrictions of food intake and movement during pregnancy. The behavioral pattern regarding restrictions and perceptions of belief systems about human reproduction relates it with the body mechanism to mature.

Regarding immunization it is revealed that .34% was vaccinated during pregnancy. Again majority were not vaccinated. A good number of female were vaccinated but had no idea why they got it.

The reason for not taking vaccines revealed from the study that female informed their refusal to take vaccines was due to fear. This reflects the perception about modern medicines and non-reliability on modern health care facility.

Various types of rituals are observed during pregnancy in a traditional society of Bangladesh. But the study revealed that only a few persons reported that they observed rituals at pregnancy. Majority informants told that they did not perform any rituals, due to constant of economic hardship faced by the family. Majority of the people cannot observe the rituals though they know different rituals to be observed during pregnancy. Those who observed rituals informed that majority of them performed “Satosha”. It also indicates sharing the feelings of the pregnant women by relatives for welcoming the baby.

The study revealed that the risk of pregnancy and complications are known to the informants but they explained in their own way of perceptions. Most of them blamed the evil spirits, not following the restrictions of movements during pregnancy, sin done by the couple or forefather etc.

Home delivery is common in Bangladesh, especially in rural area. In this village majority of the informants pointed out that home delivery requires less amount of money. They also preferred home delivery because they think hospitals are for rich urban people and their husband had a negative attitude towards hospitals delivery.

CONCLUSION

Making motherhood a safer time in women's lives requires commitment at all levels: in the home, in the community, in the clinic, in the country, and at the international level. This is a commitment to reducing inequities, improving women's autonomy, and ensuring that motherhood is a safe, joyful, and rewarding experience. Good quality maternal health care is the single most important intervention to prevent maternal and newborn mortality and morbidity. Maternal health services, including essential obstetric care for complications, must be made available to all women during pregnancy. Families and communities have critical roles to play in ensuring that safe motherhood is achieved. Public education programs, at national and community levels, should focus on the following supportive actions: improving nutrition for girls and women; facilitating women's access to maternal health care during and after pregnancy and delivery; educating women and families to recognize and respond to emergency situations; and ensuring that women get the rest they need during pregnancy and after delivery.

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Test Cases Prioritization using model based test dependencies: A survey

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ABSTRACT: Software Testing is a part of software engineering which helps to identify failure or defect in advance to give quality to the product. Regression testing is an important aspect of testing field in which modified part of the software will be tested to ensure that no new errors will be generated into previously tested code. Regression test suite is typically large so that a method or technique should select for test cases which will give effectiveness to the software and also reduces the overall cost. In this kind of situation test case prioritization technique is used to give the effectiveness to the software. It organizes test cases in an order such that, test case having high priority will be executed first through which effectiveness will be increases. Performance goal of test case prioritization is fault detection; number of faults will be detected quickly during testing process, code coverage and reliability.

KEYWORDS: Regression Testing, Test Case, Test Case Prioritization, APFD (Average Percentage Fault Detection).

1 INTRODUCTION

Software testing is performed to verify that software is build according to the customer specification or requirements. It will increase the quality and efficiency of the software [1]. The overall objective of testing is to find out bug in the software by applying different kind of testing(unit testing, load testing performance testing, regression testing, smoke testing, stress testing, black box testing ,white box testing etc) to uncover the faults as soon as possible to give effectiveness to the software. When software is modified or enhances after fixing some error, Regression Testing reruns the regression testing suite to ensure that new version of software project runs smoothly and correctly [2].

Regression test suite is typically large, for performing testing on test suite various techniques should be applied to reduce the overall cost and time. The various techniques are:-

a) Retest All

b) Test Case Selection

c) Test Case Prioritization

d) Test Case Reduction

e) Hybrid Approach

a) Retest All:- All the test cases in the existing test suite will be executed again. This technique is very expensive and required lot of time for re-execution of test cases [4][11].

b) Test Case Selection:-Instead of re-running the whole test suite a part of test suite will be selected to give the maximum number of faults [4]. It divides the test suite in 3 parts:- (1) Reusable Test Case, (2) Retest able Test Case,(3) Obsolete Test case. The drawback of this technique is that it does not give the effectiveness of the software while using lot of resource and it will permanently remove the test cases from test suite. Sometimes discarded test cases will give maximum no of faults.

c) Test Case Prioritization:- In this technique the test cases will be prioritized to give maximum number of faults[6][7][9]. The main goal of prioritization is to give the effectiveness to the software by detecting faults, by increasing confidence in reliability and also in code coverage property. It has an advantage over selection technique that is does not eliminate the test cases from the test suite permanently. Fault detection rate is high by assigning the priority to the test cases to give the effectiveness of the software by doing maximum code coverage.

d) Test Case Reduction:-The purpose of this technique is to eliminate redundant test cases from the test suite to save the cost of regression testing [8]. It also minimizes the total running time of the remaining test cases. The drawback of reduction technique is that the fault detection effectiveness of test suites can be severely decreased by reduction.

e) Hybrid Approach:-It is combination of test case selection and test case prioritization.

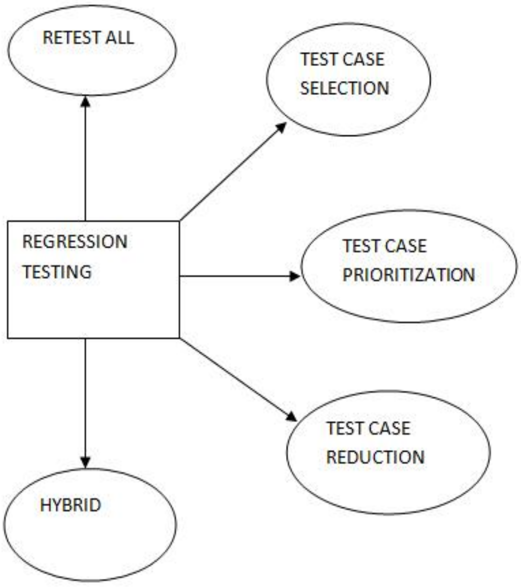

Fig 1: Test Cases Prioritization Techniques

2 LITRATURE REVIEW

Shifa-e-Zehra el al [19] conducted study on prioritization using dependencies. According to them Prioritization technique using dependency structure is very efficient when there exists large coupling. As dependencies can be observed and based on those dependencies test case prioritization is done which lead to the ordering of test cases and the test cases having more dependents will be executed first. With the help of prioritization resource can also be used efficiently. Otherwise, the test cases which are important to execute gets no resources. Dependency can be open or closed different algorithms can be used to detect both kinds of dependencies. Basically, the focus in this paper is on the test case dependencies and further prioritization of test cases according to those discovered dependencies.

Shin Yoo el al [20] has selected the papers that deals with test suite minimisation, test case selection and test case prioritisation. According to them the work on these three is strongly associated to each other. As test suite minimisation checks out for the test plans and wherever the duplicity is present there it decreases the size of test plans which leads to the test suite minimisation. With the reduction the test suites gets removed everlasting. Test case selection process selects the test cases from a typical set of test cases. And Test case prioritisation technique provides the priorities to the different test cases, further these test cases will be run in the order of their priority. The test case with higher priority will run fist and the test case with lowest priority will run at the last.

Swarnendu Biswas el al [21] describes about the test suite management as: Test suits needed to be managed as when the modification are made in the original test suites in order to provide more functionality, some new test cases needed to put in while some of the test cases needed to get out of the suite, this in and out process needs management. Test cases reuse is the process of using again those test cases that have previously been used before the modifications. We can use them again in order to reduce the efforts and money.

Prateeva Mahali el al [22] provides model based optimization and prioritization for the test suites in regression testing. According to their methodology the optimization of test cases is performed using genetic algorithm after that prioritization is performed in order to produce better results and the successful regression testing. They found deduction in cost and time with the current methods. They have taken a case study of a shopping mall which is providing better results as comparison. The system which is under test has been represented with UML 2.0 activity diagram.

Quart-ul-an-farooq el al [23] presented a state based regression testing approach. The tool used for the approach is START which is an eclipse based. START treats the dependencies that exist between the various states. When the modifications will take place the dependencies must be taken care and this can be possible through start. START takes UML 2.1 class diagrams and state machines. For proving the efficiency of the technique a case study has been depicted which is "student enrolment system". It shows the reduction of test suites. START can also be incorporated with other testing tools and it absolutely works fine with them. The main parts of the START are: Parsor, Comparator and test suite analyzer. And it takes inputs in the form of XMI v2.1 format.

3 TEST CASE PRIORITIZATION

Test case prioritization is considered when we need test cases having higher priority to be run earlier than the other test cases present. With this approach defects can be found early. The problem of resource lacking can be resolved as resource can be better utilized. Priorities are not assigned randomly but got assigned according to some principle. And then test cases will run according to their own order of execution. If we will detect the faults former then release of the product will be before on time as well [25]. And we can detect the faults former by prioritizing test cases. The approach can used for this prioritization is discovering the "functional dependencies". Scenarios that will be having more dependencies will produce more faults as well. Techniques can be:

Open dependency structure: it can be described as; one test case should be executed prior to other test case anywhere in the program [26].

Closed dependency structure: it can be described as; one test case should be executed just before the other test case means the other test case must follow the first test case. Need for prioritization of test cases: whenever we have inadequate number of resources then it may happen that the test cases which are not so much required to get run would consume the resources which results in lack of resources for the test cases which are urgently required to run. So to avoid this kind of condition to occur, we can prioritize the test cases. With the help of which we can give high priority to the test cases which are urgently required to run and lower priority to those test cases which are less needed to get run which will lead to better utilization of inadequate resources [26]. Test case prioritization will also decrease the time consumption and will lead to early detection of faults.

4 MODEL BASED TESTING

This is a testing technique based on models means test cases gets generated from the models itself [22]. And the models are based on the requirements and the design of the software system. With model based testing one can find the faults early as the test cases gets generated from the models and models are generated before the actual implementations, which lead to improve the quality of the development, saves times ,efforts etc.UML is used to imprison the various requirements. Models: model is an overall description of the system that how the various components are related to each other [24].

4.1 MODEL BASED TESTING PROCESS

Following are the various steps in modal based Testing [23]:

1. Informal specifications or Requirements are gathered.
2. Model gets generated from those specified requirements.
3. Test suites are generated further which contains :

3.1. Test sequence: The system under test is controlled by it.

3.2. Test oracle: It monitors the growth of the development, after observing.

3.2.1. It provides a PASS or FAIL outcome.

3.2.2. If fail occurs, it shows that the system under test doesn't match with the perception of model.

Fail may occur due to:

a) Incorrect Implementation.
b) Incorrect model creation.
c) Incorrect requirement specification.

5 PROBLEM FORMULATION

Prioritization of test cases is the process of arranging the test cases in a logical manner. It is useful because it helps in better utilization of expensive resources like disk space. Defects can be found earlier. Also it reduces the time required to execution of whole process. Over the past few years many prioritization techniques have been produced. But prioritization using dependencies in model based testing can give better results as comparison. As we know the technique which will be able to detect defects earlier will be more powerful. Testing is very important part of the software development life cycle, so it must be performed as efficiently as one can. Various techniques have been provided by the researchers to make testing effective. As test case optimization, test case selection, test case prioritization is used to reduce the time and increase the rate of fault detection. And model based testing has also been introduced in order to detect defects earlier. Because it is believed that developer will also gets benefit by earlier detection of faults because they can fix them if they will get to know about them earlier which ultimately will reduce the cost, effort and time.

There are various techniques which can be used to prioritize test cases like:

a) History based: In this prioritization of test cases is done by using the prior knowledge.
b) Knowledge based: In this test cases are prioritize by extracting the knowledge from human beings.
c) Model based: In this test cases are prioritize by taking any system model in account.

In this research work, prioritization of test cases using their dependencies in model based testing will be performed. In order to detect the defects and provide information about these defects to the developer earlier. It will also reduce the time as the faults will be detected at early phases.

6 CONCLUSION

Regression testing is done on the test suite by applying one of its techniques that is test case prioritization which gives maximum number of faults and also provides effectiveness to the software. In this paper, problem is formulated to discover the maximum number of defects by prioritizing the test cases using model based dependencies. In future, test cases are prioritized with model based dependencies and efficiency of technique will be evaluated with APFD matrixes

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Use of marine algae in the quality evaluation of the El-Jadida area water mass

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ABSTRACT: Macroalgae are a good element for assessing the ecological quality of coastal waters. As such, this indicator has been included in the strategy for monitoring coastal water masses. In view of results on this parameter during this first campaign determining the diversity and spatio-temporal distribution of marine algae in all stations concerned by the study, we were able to evaluate the health of the study area coast water mass. The algae distribution differs from one station to the other according to the season and according to human factors, to give a water mass at low quality.

KEYWORDS: macroalgae, ecological quality, diversity, water mass.

1 INTRODUCTION

With over 3000 km of coastline, hydrological conditions particularly favorable due to the upwelling existence, sunshine which extends almost the entire year, rocky coasts diversity and still little beat and a rich algal flora which combines very different biogeography groups, Morocco is endowed with great potential in terms of exploitable algal resources. Already present among the largest exporters of seaweed extracts (agar), country harvest essentially *Gelidium sesquipedale* (Turner) Thuret and *G. spinulosum* (C. Agardh) J. Agardh (90 to 95% of production, the remainder consisting of different species *Gracilaria*, *Laminaria* and *Gigartina* ([1]; [2]). In 1991, algae production amounted to around 7,500 tonnes [3] and in 2013 the production of raw algae reached 14388,781 tones [4]. Although raw seaweed is exported from Dakhla (southern Morocco) the main operating area is the El Jadida-Jorf Lasfar riding which provides 80% of exports about 500 tones of agar per year ([2], [5]). Apart from this very limited area, the rest of the Moroccan Atlantic coast conceals considerable potential for production and still virtually unexploited.

Since the early work of [6], the algological contributions made in Morocco was essentially floristic and taxonomic, the most important being those of ([7]; [8]) and ([9]; [10]). Few authors have studied the distribution and species composition in Morocco ([11]; [12]; [13]; [7]; [14]; [15]). However, the production areas development and the new deposits exploitation of depend on the knowledge deepening. We also need to study the water mass quality of the Moroccan Atlantic coast to control our mediation activities related to marine environment.

The implementation of the Water Framework Directive (WFD) involves the application of control points for the assessment of the ecological condition of coastal water masses. The macroalgae are a good item to assess the environmental quality of coastal waters. In this title, this indicator was retained in the monitoring strategy for coastal water masses. The methodology implemented for the subtidal part is based on the work of [16]. It is a simplified application of the protocol used in the framework of the monitoring network REBENT established in Europe and in Spain. This report deals with the application of the DCE protocol for the water mass to the side in four sites on the shoreline Doukkala.

This document presents investigations results carried out in 2013, for the subtidal area. The final goal being to determine the ecological status of studied sites waters mass.

2 METHODOLOGY

2.1 SITES LOCATION

For the field's algae characterization, sites chosen were defined between Oualidia and Azemmour; four sites have been chosen: Oualidia, Mly Abdellah, El-Jadida and Lahdida (figure 1).

Four sites chosen are defined in the bathymetric chart extension of those surveyed on the foreshore. Because of the subtidal area configuration in the various sites studied, rocky discontinuities and sand presence in some sites and pollution, we are limited to some sites only: Oualidia (reference Site), Mly Abdellah, El-Jadida (Sidi Daoui toward the port) and Azemmour (Lahdida ; closest to the Oued Oum R'ibe mouth).

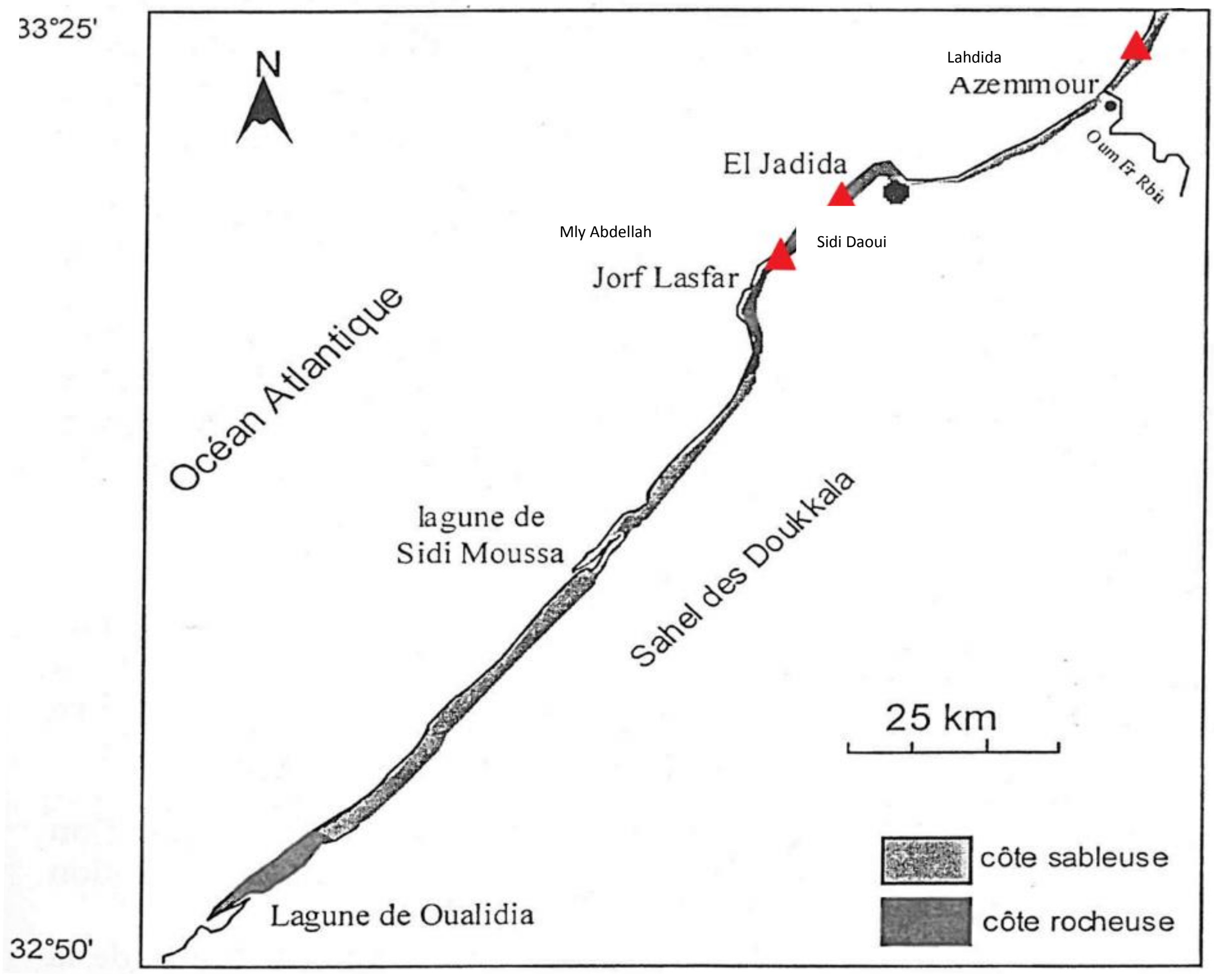

Figure 1: Location of surveyed sites

- Oualidia site has been taken as a reference site thanks to the quality of waters mass qualified for good.
- Mly Abdellah site was concerned by study, because it is characterized by a very important algal diversity and it is near the Complex Morocco Phosphorus which makes it a polluted site.
- Sidi Daoui site until the manifold of the industrial area north of the fishing port was chosen because of the presence of domestic sewage collector from the El-Jadida city, this site also receives wastewater from the slaughterhouse and those of the hospital Mohamed V; therefore is a source of major pollution of marine waters.
- Azemmour site is integrated in this study to assess the effect of Oued Oum Er Rabie mouth.

The dives carried out by site, with an average duration of ½ hr per dive, are carried out by bathymetric level (-3 m, -8 m, -13 m and -20 m) to acquire the data concerning the algal composition. Qualitative and quantitative measures are carried out in situ on quadrates of 1m^2. Quadrates are positioned in a random manner, the more nearly the bathymetry or within the seat belt (while avoiding flaws, steep slopes and sediment). The configuration in gentle slope of the area being surveyed and the limited time per dive limit the acquisition of data including to delimit the extension bathymetric chart of each level.

It is to be noted that the substrate is highly heterogeneous on all studied sites for bathymetric levels concerned. The presence of sand on some sectors will lead to the modification of adirondacks localization.

2.2 INTERVENTION TIMETABLE

Investigations campaigns are scheduled during the first fortnight of mid-March 2013 up to mid-July 2013 in the four sites. The bathymetric levels taken into account can only be explored only in conditions of wave height to less than 1 m up to 1.5 m. On the other hand, for schedules reasons of tides and proximity, outputs part is done at the start of the El-Jadida port followed by the work done to Mly Abdellah and the other two at the outset of Oualidia (Sidi Moussa to Oualidia) and Azemmour (Lahdida at the Oued Oum Er Rabie mouth). Outputs will be on the day, with the possibility of achieving ten dives per site.

2.3 WORK TO ACHIEVE BY BATHYMETRIC LEVEL

2.3.1 IMPLEMENTATION

A boat will be cabin cruiser for investigations achievement. The onboard equipment consists of a GPS kid 78 ® allows a marking from the surface. The sonar specifies the configuration and the site depth. Two divers in scientific immersion realize readings on quadrate and a third ensures the surface security as well as the boat cockpit. As well, the quadrate realization to the depth of preference will be preceded by a discovery stage to define the presence and abundance of structuring species (to apply adequate quadrates number).

The observation protocol DCE (the Water Framework Directive) proposed in this study and the calculation of the quality index for the indicator subtidal macro algae is the one proposed by the Europeans and the Spaniards for assessment of the water mass quality. The station anteriority in terms of subtidal funds rocky studies (Network Reent) constituted a serious asset to accomplish this work. This same observation protocol has been applied by several authors in different countries ([17]; [18]; [19]; [20]; [21], [22]).

We have defined our own monitoring strategy to assign to water masses an ecological status among 5 levels (very good, good, average, bad and very bad). The ecological condition assessment of coastal water masses must be done especially through biological parameters (subtidal macro algae). A relevant habitats selection has been carried out.

The work on each quadrate is to:

- Identify the macro-algae species presented; collect all the algae present on each quadrate;
- Assess the algal coverage percentage in situ by direct visualization; validation a posteriori on photo ;
- Species density the better represented; counting feet when this is possible for the larger species ;
- Specific richness per site calculated on the basis of 10 quadrates randomly selected among set of achieved quadrates.

It is also noted that epiphytic species are not taken into account in inventories qualitative and quantitative on quadrates.

2.3.2 PARAMETERS INVESTIGATED

To assign a quality index to a site, the parameters taken into account are the following:

- Species composition and density defining the grade separation (Fucales (*Fucus spiralis*) and other macroalgae participating in the definition of different seat belts) = structuring species ;
- Specific composition (characteristic species and opportunistic species) ;
- Total specific richness.

2.3.2.1 SPECIES COMPOSITION AND DENSITY DEFINING RANGES

The presence and density of these species are identified at quadrates level positioned in the seat belts of levels 1-2 and level 3, by counting feet. The limit between the horizon to *Fucus spiralis* (seat belt which constitutes the lower limit of level 1) and the horizon to brown algae (*Fucus spiralis*) dense (level 2) does not need to be determined and it is considered a single seat belt to dense *Fucales* in consolidating these two horizons. However, the *Codium adhaerens* presence in the lower limits of the level 2 should be noted. Level 3 is characterized by the appearance of *Bifurcaria tuburculata* and *Dictyota dichotoma* with the red algae diversification.

2.3.2.2 SPECIFIC COMPOSITION

This note is the result of 3 sub-indices:

- Characteristic species: The parameter to integrate in the ecological sites qualification is the presence/absence of substratum characteristic species to brown algae structuring. In each level, it counts the number of characteristic species presented. For each of four ecoregions identified (Oualidia, Mly Abdellah, Sidi Daoui, Azemmour), characteristic species lists have been defined.

-Opportunistic species: These species are recorded in individual number and a note is assigned according to their total density for four stations. For each frame, the opportunistic species are counted and their density is calculated in feet number per m^2.

- Presence of indicator species of good ecological status: For each ecoregion, if one of the indicator species of good ecological status is present, a point is added to the average of the two sub-indices "characteristic species" and "opportunistic species".

- Presence of threatened or endangered species: the presence of these species characterized the coastal waters degradation level of each studied station.

2.3.2.3 TOTAL SPECIFIC RICHNESS

It is determined on 10 quadrates for all floors; superiors and median and lower. The floristic diversity corresponds to the total number of identified taxa within the sampling area corresponding to the level.

2.3.3 PROTOCOL FOR QUALITY INDEX AND EQR CALCULATION

The water masse types identified in this study are subdivided into three supertypes:

- Supertype A: rocky coast little turbide ;
- Supertype B: side sandy-muddy little turbide ;
- Supertype C: rocky coast or sandy-muddy turbid.

2.3.3.1 THE QUALITY INDEX

A rating scale system will allow assigning a note for each of the parameters investigated. Each of these notes will participate in the site quality index calculation.

a. Composition and density of species defining ranges

A different scale is applied according to the supertype belongs the water mass (Table 1).

Table 1: Rating scale (density of species defining the grade separation)

Density of species defining the grade separation (nb ind/m^2)		Note
Supertype A and B	Supertype C	
<10	<15	0
(10 ; 20[	(15 ; 30[	5
(20 ; 35[	(30 ; 45[	10
(35 ; 60[	[45 ; 60[	15
≥60	≥60	20

b. Specific composition

This note is the resultant of 3 sub-indices:

➢ **Characteristic species**

For each level, a count of characteristic species is achieved, which allows you to determine the characteristic species number well represented in each level. The scale (Table 2) allows, in function of the water mass supertype, to assign a note.

Table 2: Rating scale (characteristic species)

	Characteristic Species Number	Note
Supertype A or B	<9	0
	[9-12[	5
	[12-15[	10
	[15-18-[	15
	≥18	20
Supertype C	<5	0
	[5-8[	5
	[8-11[	10
	[11-14[	15
	≥14	20

➢ **Opportunistic species**

In each seat belt, the opportunistic species are counted within quadrates (10 quadrates selected at random). It then calculates their density (in number of feet / m^2). A single scale (Table 3) allows, whatever the level studied, give a score based on the total density of opportunistic species.

Table 3: Rating scale (opportunistic species).

Opportunistic Species Density (nd ind / m2)	Note
≥30	0
(20 ; 30[	5
[12 ; 20[	10
(7; 12[	15
(0 ; 7[	20

➢ **Indicator species of good ecological status**

For each of ecoregions, we evaluated the indicator species presence of good ecological status. If at least one of the indicator species is present on a site, an additional item is added to the average of two sub-indices "characteristic species" and "opportunistic species".

c. Total Specific Richness

In each frame, the algal diversity is measured by listing the species present. This allows to identify the taxa number on a minimum surface for sampling (10 quadrates in levels (1-2) and 10 quadrates in level 3). If for a level, quadrates number made is higher, then a draw random in order to obtain quadrates required number. Depending on the level studied, a notation grid (on 10 points) allows to characterize the site according to the total specific richness measured (Table 4).

Table 4: Rating scale: total specific richness.

	Supertype A	Supertype B or C	Note
Taxa number Identified on 10 quadrates	<15	<20	0
	(15 ; 20[	(20 ; 30[	5
	(20 ; 30[	(30 ; 40[	10
	(30 ; 40[	(40 ; 45[	15
	≥40	≥45	20

d. Site quality index Calculation

The site quality index is obtained by calculating the average (reported on 100 points) of notes obtained.

- Density species note in the defining grade separation (40pts);
- Specific composition note (40pts);
- Specific richness total note (20pts).

$$\mathbf{IQ} = \frac{\textbf{Note average of investigated parameters}}{\mathbf{100}}$$

2.3.3.2 EQR CALCULATION

The EQR or Ecological Quality Ratio is calculated by taking the ratio between a site quality index and the reference site quality index. Oualidia site is considered as a reference site because of its distance from the pollution and of rivers waters and its water mass is classified good.

$$\mathbf{EQR} = \frac{\mathbf{IQsi}}{\mathbf{IQsr}}$$

With: - **IQsi**: Quality Index of each studied station;
- **IQsr**: Quality Index of the reference station.

2.3.3.3 READING GRID

A reading grid allows a function of EQR in site 0 and 1, to characterize the ecological status of the water mass concerned in accordance with the table (5).

Table 5: EQR reading grid

[0 ; 0.25 [	**Very bad**
[0.25 ; 0.45 [	**Bad**
[0 ;45 ; 0.65 [	**Medium**
[0.65 ; 0.85 [	**Good**
[0.85 ; 1]	**Very good**

In cases where several sites are in the same water mass, we calculated the average EQR of these latter to qualify then the water mass.

3 RESULTS

3.1 SPECIES DEFINING RANGES COMPOSITION AND DENSITY

Species to be counted in four stations are presented in table (6).

Table 6: List of species defining ranges

	Upper range	Median range	Lower range
Chlorophycees	- *Ulva spp* - *Enteromorpha spp*	- *Ulva spp* - *Enteromorpha spp* - *Codium adhaerens*	- *Ulva spp* - *Enteromorpha spp* - *Codium tomentosum* - *Codium adhaerens*
Pheophycees	- *Fucus spiralis*	- *Fucus spiralis*	- *Fucus spiralis* - *Bifurcaria tuburculata* - *Dictyota dichotoma*
Rhodophycees	-*Corallina spp* -*Caulacanthus ustulatus*	-*Caulacanthus ustulatus*	-*Caulacanthus ustulatus* - *Gigartina acicularis* - *Gelidium spinulosum* - *Laurencia pinnatifida* - *Corralina elongata* - *Gelidium sesquipedale* - *Halopithys incurvus*

3.2 SPECIFIC COMPOSITION

- <u>Characteristic species</u>

The characteristic species presence is regarded as a testimony of a good ecological status of the middle (table 7). As well, the more their number is high and more the number of points allocated is large.

Table 7: Characteristic species list of four stations studied

	Oualidia	Mly Abdellah	El-Jadida (Sidi Daoui toward the port)	Azemmour
Chlorophycees	*-Ulva spp* *-Enteromorpha spp* *-Codium tomentosum* *-Bryopsis balbisiana* *-Chaetomorpha linum*	*-Ulva spp* *-Enteromorpha spp* *-Codium adhaerens* *-Codium tomentosum* *-Ulva lactuca* *-Blidingia marginata*	*-Ulva rigida* *-Ulva lactuca* *-Chaetomorpha aerea* *-Blidingia marginata* *-Halicystis parvula*	*-Ulva spp* *-Enteromorpha spp* *-Bryopsis pennata* *-Cladophora pellucida*
Rhodophycees	*-Corallina spp* *-Caulacanthus ustulatus* *-Callophyllis laciniata* *-Gelidium spp* *-Chondracanthus acicularis* *-Ustulatus acicularis* *-Laurencia pinnatifida* *-Phyllophora crispa* *-Polysiphonia complanata* *-Nitophyllum punctatum* *-Pterosiphonia complanata* *-Pterosiphonia pennata* *-Rhodophyllis divaricata* *-Calliblepharis ciliata* *-Porphyra umbilicalis* *-Lithophyllum decussatum*	*-Caulacanthus ustulatus* *-Gigartina acicularis* *-Gigartina pistillata* *-Gelidium spinulosum* *-Laurencia pinnatifida* *-Corralina elongata* *-Gelidium sesquipedale* *-Halopithys incurvus* *-Corallina officinalis* *-Gelidium sesquipedale* *-Gymnogongrus griffithsia* *-Calliblepharis ciliate* *-Calliblepharis jubata* *-Mesophyllum lichenoides* *-Nitophyllum punctatum* *- Phyllophora crispa* *-Plocamium cartilagineum* *- Jania rubens* *-Pterosiphonia complanata* *-Pterosiphonia pennata*	*-Corallina elongata* *-Grateloupia lanceola* *-Lithophyllum incrustans* *-Caulacanthus ustulatus* *-Chondracanthus teedei* *-Mastocarpus stellatus* *-Chondrea cappilaris* *-Jania rubens* *-Lithophyllum lichenoides* *-Pterosiphonia complanata* *-Gelidium sesquipedale* *-Gracilaria multipartita* *-Titanoderma pustulatum*	*-Caulacanthus ustulatus* *-Gelidium sesquipedale* *-Gracilaria multipartita* *-Lithophyllum byssoides* *-Corallina officinalis* *-Palmaria palmata* *-Heterosiphonia plumosa*
Pheophycees	*-Fucus spiralis* *-Bifurcaria Bifurcata* *-Taonia atomaria* *-Dictyopteris polypodioides* *-Petalonia fascia* *-Sphacelaria radicans* *-Cystoseira humilis* *-Cystoseira tamariscifolia* *- Cystoseira nodicaulis* *-Sargassum acinarium* *-Sphacelaria brachygonia*	*-Fucus spiralis* *-Bifurcaria Bifurcata* *-Dictyota dichotoma* *-Cystoseira baccata* *-Cystoseira humilis* *-Cystoseira tamariscifolia* *-Halopteris scoparia* *-Dictyopteris polypodioides*	*-Fucus spiralis* *-Halopteris scoparia* *-Sphacelaria radicans* *-Pilinia rimosa* *-Laminaria ochroleuca* *-Dictyota spiralis* *-Cystoseira humilis* *-Taonia atomaria* *-Elachista flaccida*	*-Fucus spiralis* *-Petalonia fascia* *-Halopteris filicina* *-Laminaria ochroleuca* *-Culteria adspersa*

-<u>Opportunistic Species</u>

They are considered as an environmental degradation indicator in link with a human activity effect. When their number and density increase, point number assigned decreased (Table 8).

Table 8: Opportunistic species list

Taxonomic group	species
Chlorophycees	- *Ulva lactuca* - *Ulva rigida* - *Ulva fasciata* - *Enteromorpha intestinalis* - *Enteromorpha prolifera* - *Chaetomorpha aera* - *Chaetomorpha linum*
Pheophycees	-*Scytosiphon lomentaria* -*Laminaria ochroleuca* -*Sacchoriza bulbosa*
Rhodophycees	-*Gelidium latifolium* -*Hypnea musciformis* -*Caulacanthus ustulatus* -*Griffithsia opuntioides* -*Antithamnion cruciatum* -*Centroceras clavulatum*

- <u>Presence of good ecological status indicator species</u>

These species are: Laminaria digitata, Padina pavonica and Gelidium corneum.

- <u>Presence of threatened or endangered species</u>

The presence of these species shows a high level of marine environment degradation (Table 9).

Table 9: List of threatened or endangered species (Riadi and all, 1998)

Taxonomic group	Species	Gravity of threat	Types of threats
Chlorophycees	-*Ulva fasciata* -*Bryopsis plumosa* -*Bryopsis balbisiana*	*** *** ***	-Waste Water household and industrial. -Strong urbanization. -Adulterated naval.
Pheophycees	-*Halopteris scoparia* -*Halopteris filicina* -*Padina pavonica*	*** *** ***	Urban Pollution and industrial.
	-*Laminaria ochroleuca* -*Sacchoriza bulbosa*	*** ***	Surface Contamination of coastal and marine waters.
Rhodophycees	-*Gelidium sesquipedale* -*Gelidium spinulosum* -*Gelidium latifolium* -*Gelidium pulchellum* -*Gelidium crinale* -*Gelidium pusillum*	*** *** *** *** *** ***	-Intense grubbing. -Biological rest period non respected. -Pollution.
	-*Gracilaria multipartita* -*Gracilaria cervicomis* -*Gigartina pistillata*	*** *** ***	-Urban pollution and industrial.

3.3 Total Specific Richness

Species richness of each station is constituted by all species defined by the study conducted by Hanif N. et al [23] in the same study area.

3.4 FINAL NOTATIONS AND SITES QUALIFICATION

The quality index (QI) is the result of 4 studied parameters. This IQ is divided by reference index for the final rating EQR calculation (Table 11).

Table 11: Classification grid of surveyed sites

Sites	IQ	Reference (Oualidia)	EQR	Qualification
Mly Abdellah	38	72	0.52	Medium
El-Jadida	21	72	0.29	Bad
Azemmour	49	72	0.68	good
Water mass	36	72	0.49	Medium

The EQR means for all of sites belonging to the water mass of Oualidia to Azemmour coast is of 0.49; which allows characterizing this parameter in quality "Medium".

4 DISCUSSION

The DCE protocol application (Water Framework Directive) for the quality monitoring of the littoral Doukkala water mass shows that it is described as bad. This comprehensive qualification could be explained, in part at least, by fact that coastal water mass is subject to a regular desalinated water related to the presence of a dense hydrographic network and of a significant rainfall. The main vector of freshwater and turbide at sea is Oum Er R'bie River in the water mass north; it drains the waters of its urbanized watershed. Because of the coastal currentology, and the littoral drift directed toward the south, the turbidity covers in flood periods a large portion of the water mass.

The water turbidity is linked to the suspended matter contribution, eutrophisation, and the sediment suspension. Turbidity can have various origins such as weather conditions (rainfall, storms), the amenities coastlines, the phytoplanktonic blooms and the rivers pollution...

The foreshore morphology (reef flat width and roughness), the substrate nature (sand or rock), the sediment presence and hydrodynamic instability influence largely the vegetation composition and structure [24]. For all communities studied, seasonal variations are closely related to environmental conditions and the dominant species life cycle. According to the evolution of algal phytocenoses model proposed by Ballesteros i Sagarra [25], we can distinguish two phases during the year, a "diversification phase" marked by a relatively balanced organization stand (maximum Equitability and diversity) then a "production phase" corresponding to the optimal development or dominant species (minimum Equitability and diversity). For *Fucus spiralis* belt, the first phase takes place in winter-spring and the second in summer-autumn. For Florideophycee communities, evolution is reversed with an organization period in summer-autumn and a production phase at the beginning of year [24]. For *G. sesquipedale*; from April to September growth is active, the weight gain is first due to the increase of the total number of branching and also to the frond elongation. From September seaweed is degraded of its fronds suite, either to the liberation of reproductive cells or to the natural fronds fragmentation by waves. Indeed, during this period, the fronds number harvested with grounding is important [26]. The same result was reported by [27] in *G. sesquipedale* populations in south of France, and by Mouradi A., and al., [28] in Mehdia site. *G. multipartita* species has low growth in winter and active growth in spring-summer and lightweight in autumn, similar results concerning growth periods were obtained by [29]. From September to October fronds become fragmented and disappear and in winter the individuals are in disc form [30].

Similar annual variations were observed on the Spanish Atlantic coast ([31]; [32]). In Morocco, this cyclical evolution can be affected by various environmental agents (storms, sand encroachment, and abrasion by the rollers, high desiccation, and mussel exploitation by man) which, by destroying stand, allow installation of transitional opportunistic ephemerophycees (Ulvophyceae).

This water mass is subject to a strong anthropogenic pressure and local communities have mobilized to improve the water quality with particularly significant remediation work to optimize the wastewater treatment. The entire set of physico-chemical changes of coastal waters have an influence on algal blooms communities that develop there.

The macroalgae and in particular some *Laminaria* are sensitive to the water temperature. A coastal waters warming could strongly influence *Laminaria* distribution (who could disappear from some sites) and the ecological status defines by the macroalgae indicator would be degraded.

The use of water mass quality index proved to be an effective tool for assessing the rocky ecological quality of coastal communities, based on the analysis of assemblages of macroalgae [33].

Algal diversity is largely influenced by variation of environmental parameters and pollution. Among environmental factors governing macrophyte distribution, temperature and day length are suggested to be the most relevant at a worldwide geographical scale [34]. Abiotic factors such as depth (light), salinity, substratum, nutrients, water motion, sedimentation and pollution affect the structure and distribution of algal communities at a local scale ([35]; [36]; [37]; [38]; [39]; [40]; [41]).

Macrophyte communities found at unpolluted sites in the study area are characterized by the presence of a perennial canopy of *Gelidium sesquipedale* or *Cystoseira baccata* growing over a basal layer of *Pterosiphonia complanata*, *Rhodymenia pseudopalmata* and *Corallina officinalis* [42]. Seasonally, an epiphytic layer of *Dictyota dichotoma* and *Plocamium cartilagineum* is developed preferentially on *G. sesquipedale*. When pollutants are introduced into the waters, the first vegetation response is the degradation of the perennial canopy, with *C. baccata* appearing to be more sensitive to pollution than *G. sesquipedale*. The development of certain species more tolerant to pollution such as *P. complanata* or *Codium decorticatum* is encouraged by the absence of the canopy, and they become the dominant species of the community. The decline of large perennial algae under the effect of pollution is the first sign of degradation ([43]; [44]; [45]; [46]; [47]).

In the study area, the large perennials *Cystoseira baccata* and *Gelidium sesquipedale* are partially replaced by the large annual *Codium decorticatum*. This fact has been reported by several authors ([48]; [47]) who have pointed out the replacement of *Cystoseira spp.* by species of *Codium* in polluted areas, whose development is encouraged by nutrient enrichment of the waters.

5 CONCLUSION

This first investigations campaign has allowed collecting information to calculate an environment quality index. However, some settings could not be defined and would require additional investigations to clarify the information collected and lead to an algae fields characterization as it is in the field.

The main difficulty which has arisen in this work relates to the fact that the species distribution and their densities are of benefit function of sites configuration and more particularly of the exposure to dominant swells. Thus, it would be desirable to test on the ground the protocol used by a high number of quadrates by extension of sampling area.

To optimize the quality index calculation, obtaining bathymetric limits levels (levels 1, 2 and 3) is required. It would also be interesting to define the depth that characterized beginning of each level. The collection of this information passes through new exploration which some more profound.

In conclusion, this first analysis of the intertidal and subtidal Phytobenthos for a Moroccan Atlantic coast portion in Doukkala coast still submerged by pollution can be an important point for monitoring water quality in the region. Finally, in terms of algal resources, it provides new information on various agarophytes (*Gelidium spp*. and *Gracilaria Multipartita*) and carraghénophytes (*Gigartina spp*. *Grateloupia spp*., *Mastocarpus stellatus* And *Gymnogongrus spp*.) potentially exploitable in Morocco.

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La réserve forestière Dékpa d'Agbaou, un exemple de conservation de la diversité végétale sur les sites miniers de la Côte d'Ivoire

[Forest reserve of Dékpa Agbaou, an example of plant diversity conservation on mine sites in Côte d'Ivoire]

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ABSTRACT: After an Environmental and Social Impact Assessment of operating the Agbaou gold mine work, the company ENDEAVOUR MINING agreed to create a refuge area for biodiversity, its gold site. The present study was conducted to assess the plant diversity of this site, and its value for the conservation of flora. Floristic inventories were made in plots of 200 m2 where the presence / absence of all plant species were noted. Circumferences of tree species with dbh ≥ 5 cm were measured. The particular status species have been identified. Diversity indices were calculated as well as the importance values for tree species. The inventory has identified 358 species of which 31 are among those classified as rare, threatened or having different levels of endemism. These are species such as Cola lorougnonis and Drypetes singroboensis considered by national botanists as missing ivorian flora. The most important tree species are Celtis zenkeri, Pterygota macrocarpa, Mansonia altissima, Ricinodendron heudelotii, Ceiba pentandra and Nesogordonia papaverifera. All these timber species are very popular in the area because overexploitation. Shannon index varies from 1.3 to 3.57 showing a variation in level of plots degradation. The example of the Forest reserve Dékpa rates to be repeated on all mine sites in Côte d'Ivoire because usually, the mining companies are accused for "devour" biodiversity.

KEYWORDS: rare species; Community reserve, ecological compensation; mining.

RESUME: Après une étude d'impact environnemental et social (EIES) des travaux d'exploitation de la mine d'or d'Agbaou, la société ENDEAVOUR MINING a accepté de créer une zone refuge pour la biodiversité, sur son site aurifère. La présente étude a été menée pour évaluer la diversité végétale de ce site, et sa valeur pour la conservation de la flore. Des inventaires floristiques ont été réalisés dans des parcelles de 200 m^2 où la présence / absence de toutes les espèces végétales a été notée. Les circonférences des individus d'espèces arborescentes ayant un dbh ≥ 5 cm, ont été mesurées. Les espèces à statut particulier ont été identifiées. Des indices de diversité ont été calculés ainsi que les valeurs d'importance pour des espèces d'arbres. L'inventaire a permis de recenser 358 espèces dont 31 figurent parmi celles classées rares, menacées ou ayant différents niveau d'endémisme. Ce sont des espèces telles que *Cola lorougnonis* et *Drypetes singroboensis* considérées par des botanistes nationaux comme disparues de la flore ivoirienne. Les espèces arborescentes les plus importantes sont *Celtis zenkeri*, *Pterygota macrocarpa*, *Mansonia altissima, Ricinodendron heudelotii, Ceiba pentandra et Nesogordonia papaverifera,* toutes des espèces de bois d'œuvre très recherchées dans la zone du fait de leur surexploitation. L'indice de Shannon varie de 1,3 à 3,57 montrant une variation de niveau de dégradation des parcelles. L'exemple de la « *Réserve forestière Dékpa* » mérite d'être répété sur l'ensemble des sites miniers de la Côte d'Ivoire car habituellement, les sociétés d'exploitation minière sont accusées de « dévorer » la biodiversité.

MOTS-CLEFS: espèces rares; réserve communautaire, compensation écologique; exploitation minière.

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1 INTRODUCTION

Confrontée ces dernières années à la baisse des prix des matières premières agricoles sur le marché mondial, aux perturbations climatiques, à l'érosion des sols et aussi à la rareté des surfaces forestières cultivables, la Côte d'Ivoire a entrepris d'accroître l'exploitation de ses ressources minières. Ainsi, plusieurs gisements d'or à travers le pays ont fait l'objet de permis d'exploration et/ou d'exploitation. Toutes les zones écologiques du pays sont concernées [1].

Habituellement, les sociétés d'exploitation minière sont accusées de « dévorer » la biodiversité se trouvant sur tout leur périmètre d'exploitation. Pour une gestion durable de ses ressources naturelles, l'Etat de Côte d'Ivoire a depuis 1996, instauré l'obligation de réalisation des Etudes d'Impact Environnemental et Social (EIES) avant tout activité d'exploitation de ses gisements miniers. Ces EIES s'étendent à tout projet d'aménagement, de construction d'infrastructure ou tout ouvrage notamment industriel, agricole ou commercial dont l'activité peut être génératrice de pollution, de nuisance ou de dégradation de l'environnement [2]. L'objectif est d'évaluer les effets de ces activités sur l'environnement et de proposer toute mesure ou action en vue de faire disparaître, réduire ou atténuer les effets néfastes pour l'environnement.

Pour prendre en compte les dimensions environnementale, écologique et humaines, ces EIES sont réalisées par une équipe pluridisciplinaire composée d'experts dans les domaines de gestion environnementale, climatologie, hydrologie, hydrogéologie, flore, faune, socio-économie, agronomie, occupation des sols, etc. A l'issue de ces études, des recommandations sont validées par la commission interministérielle au cours de la séance de validation du rapport de l'EIES par l'Agence Nationale De l'Environnement (ANDE).

La zone refuge Dékpa d'Agbaou, objet de cette étude s'inscrit dans la dynamique de réalisation des EIES sur des sites miniers et surtout la prise en compte des recommandations des experts. En effet, l'idée de la création de cette zone refuge est née du fait que, lors de la réalisation de l'EIES relative au tracé de la ligne électrique 90 Kv, pour relier le site d'exploitation de la mine d'or d'Agbaou, l'équipe chargée du volet Flore et Végétation, a observé sur l'emprise du trajet, la présence d'un bloc forestier jouissant d'un état de conservation relativement bon [3]. Ce genre de fragment forestier étant rare dans la zone et particulièrement sur le site d'exploitation, l'équipe a recommandé lors de la séance de validation du rapport complet de l'étude, à la société, sa conservation comme mesure pour compenser la perte ou la dégradation de la biodiversité; ce qu'elle a accepté sur le site aurifère.

Dans le cadre de la création de la zone refuge, plusieurs activités ont été définies dans un projet d'aménagement et de réhabilitation. Parmi ces activités, se trouve la réalisation d'un inventaire floristique complet permettant d'évaluer non seulement le potentiel floristique, mais surtout, sa valeur pour la conservation de la biodiversité végétale. C'est cet inventaire qui a fait l'objet de cette étude.

Le présent manuscrit présente l'expérience de l'évaluation faite sur la diversité des espèces de plantes, dans la zone refuge Dékpa. Il démontre l'exemple de la conservation de la biodiversité et présente les leçons tirées de cette expérience.

2 MÉTHODES D'ÉTUDE

2.1 SITE D'ÉTUDE

La localité d'Agbaou se situe au Centre-ouest de la Côte d'Ivoire, dans le Département de Divo (Figure 1). Le bloc forestier qui a fait l'objet de cette étude couvrait, en 1998, une surface de 136,5 ha. En 2013, la superficie restante est de 12,9 ha. Cette superficie restante relativement bien conservée, se divisait en deux petits blocs contigus de 7,28 et 4,91 ha chacun [4]. Actuellement, seulement 8,05 ha de ce bloc forestier constituent la zone refuge Dékpa (Figure 1). L'on y rencontre une portion de forêt bien conservée et des compartiments dégradés, constitués de champs de vivriers et de jachères. Pour la conservation du bloc forestier, des réunions ont été organisées entre la société d'exploitation et les communautés villageoises des 5 villages les plus proches de la zone refuge (Agbaou, Daako, Zego, Zaroko et Douaville). Ces rencontres ont permis d'obtenir l'approbation et l'adhésion des Responsables coutumiers de ces villages. Des activités de reboisement ont eu lieu dans les compartiments dégradés de la réserve.

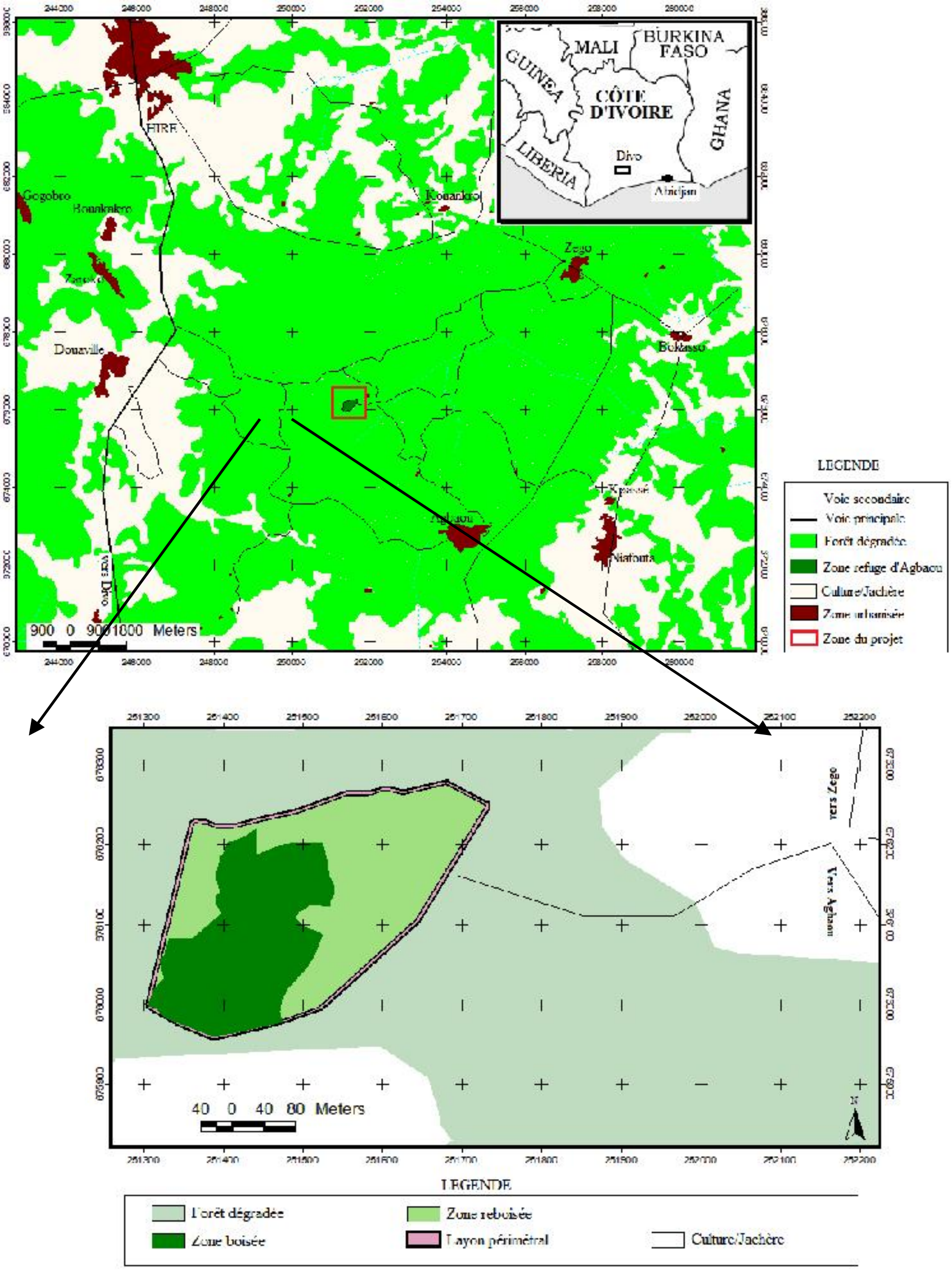

Figure 1 : Localisation de la zone refuge Dékpa en Côte d'Ivoire

2.2 Récolte des données

Des inventaires botaniques ont été réalisés dans tous les compartiments de la zone refuge à travers deux standards méthodologiques complémentaires : méthodes de relevé de surface et itinérante. Le relevé de surface a consisté à délimiter des parcelles de 10 m x 20 m (200 m^2). La taille relativement réduite de ces parcelles a eu pour avantage, de les mettre en place dans tous les types de biotope (forêt, jachère, plantation de cacaoyer, culture vivrière). A l'intérieur de ces surfaces, toutes les espèces de plantes sont identifiées. Les circonférences des espèces arborescentes qui ont des diamètres à hauteur de poitrine (dbh) d'au moins 5 cm, ont été mesurées. Au total 35 parcelles ont été ainsi inventoriées. Les coordonnées géographiques de toutes les parcelles ont été enregistrées au GPS pour une géolocalisation des espèces à statut particulier.

La méthode itinérante a permis de prendre en compte, toutes les autres espèces non rencontrée dans les parcelles. Ces espèces sont notées pour compléter la liste floristique de la zone refuge. Parmi, elles, les coordonnées de celles présentant un statut particulier de conservation, ont été enregistrées.

2.3 ANALYSE DES DONNÉES

Les nombres d'espèces, de genres et de familles ont été d'abord déterminés, de même que les types morphologiques (arbre ou arbuste, liane et herbe) et les types chorologiques (GC, GC-SZ et SZ), en se référant à [5], [6]. Les types chorologiques GC et SZ désignent respectivement les régions phytogéographiques Guinio-Congolaise et Soudano-Zambézienne. Ainsi, une espèce dont le type chorologique est GC-SZ, appartient à la fois à ces deux niveaux chorologiques. Ces paramètres ont permis d'avoir une idée globale de la richesse et de la composition floristique de la zone refuge.

La diversité des espèces a été évaluée à travers des indices de diversité (H') de Shannon [7] et d'équitabilité (E) de Piélou [8]. Ces deux indices ont été calculés selon les formules mathématiques suivantes :

$$H' = - \Sigma (ni/N) \ln (ni/N)$$

Dans cette formule, **H'** est l'indice de Shannon, **ni** le nombre d'individus d'une espèce **i** et **N** le nombre total d'individus de toutes les espèces.

$$E = H' / \ln S$$

Où **E** est l'indice d'équitabilité de Piélou et **S** le nombre total d'espèces de la zone refuge.

Pour les espèces arborescentes ayant un dbh minimum de 5 cm, les valeurs relatives de la densité, la fréquence (occurrence) et la dominance ont été calculées. La somme de ces trois valeurs relatives appelée l'Indice de Valeur d'Importance (IVI), décrit par [9], a permis de mettre en évidence l'importance des espèces arborescentes dans la zone refuge.

La valeur pour la conservation des espèces de plante a été déterminée à travers la diversité qualitative. Elle a consisté en un dénombrement d'espèces à statut particulier. Il s'est agit d'identifier les espèces endémiques ivoiriennes (GCi), des forêts de Haute Guinée (HG), ou du bloc forestier ouest-africain (GCW), sur la base des listes d'espèces préétablies par [5], [6], [10]. A ces espèces endémiques, a été ajoutée la liste des espèces rares ou menacées d'extinction de la flore ivoirienne selon l'UICN [11].

Les coordonnées de toutes ces espèces ont permis d'obtenir une cartographie de la distribution de leurs individus matures dans la zone refuge.

3 RÉSULTATS ET DISCUSSION

3.1 RICHESSE, COMPOSITION ET DIVERSITÉ DES ESPÈCES VÉGÉTALES

Dans la zone refuge, au total 358 espèces végétales de toutes les tailles et de toutes les formes ont été inventoriées. Ces espèces se répartissent entre 186 genres et 62 familles. En considérant uniquement les relevés de 200 m^2, la moyenne est de 28,56 ± 6,7 espèces. Celles des niveaux taxonomiques supérieurs sont de 14,03 ± 4,2 genres et 4,94 ± 2,3 familles.

La zone la moindre perturbée renferme 330 espèces. Les champs nouvellement abandonnés et les jachères ne renferment que 142 espèces ; ce qui démontre que plus de la moitié des espèces présentes dans la forêt conservée n'arrivent pas à trouver des conditions idéales pour l'établissement de leur niche écologique dans les compartiments dégradés. Pour [12], dans la zone forestière semi-décidue de la Côte d'Ivoire, dont fait partie le site de cette étude, l'établissement de la majorité des espèces forestières, dans les jachères, ne peut être effectif qu'après 40 ans. Dans la zone refuge Dékpa, il y'a des activités de reboisement en cours dans les compartiments dégradés ; ce qui accéléra sans doute, la reconstitution de la végétation pour une résilience avant 40 ans.

La valeur totale de l'indice de Shannon est de 3,58. Cette valeur varie considérablement d'une parcelle à une autre (Tableau 1). En effet, la valeur maximale par 200 m^2 est de 3,57. La valeur minimale est de 1,27. L'indice d'équitabilité de Piélou varie de 0,66 à 0,9 pour une moyenne de 0,78. Ces écarts de variation des indices de diversité d'une parcelle à une autre, sont liés à leur état de dégradation proportionnel aux effets des perturbations dues aux activités humaines sont encore persistants.

D'autres signes de cette perturbation peuvent être démontrés à travers cette étude. En effet, parmi toutes les espèces inventoriées, les arbres sont les plus nombreux avec 50,27 % des espèces. Ils sont suivis des lianes avec 29,14 % des espèces ; les espèces herbacées étant les moins nombreuses (Tableau 1). La proportion assez élevée des espèces lianescentes traduit la dégradation importante de cette zone refuge.

La majorité des espèces inventoriées sont inféodées à la zone phytogéographique Guinéo-Congolaise (GC). Ces espèces représentent 71,82 % de l'ensemble. Celles inféodées à la fois à la zone phytogéographique Guinéo-Congolaise (GC) et la zone Soudano-Zambézienne, représentent quant à elles, 17,41 % des espèces. Les espèces qui se rencontrent naturellement et uniquement dans la région Soudano-Zambézienne, sont les moins nombreuses (Tableau 1), les conditions climatiques ne leur étant pas favorables. En effet, les précipitations annuelles des dix dernières années, varient dans l'espace de Divo, de 922,80 à 1175,30 mm [13]; ce qui est plutôt favorable aux espèces de forêt denses semi-décidues [14].

3.2 VALEUR D'IMPORTANCE DES ESPÈCES ARBORESCENTES

En considérant uniquement des individus d'espèces arborescentes ayant au moins un dbh de 5 cm, c'est *Celtis zenkeri* qui est la plus fréquente avec 8,18 % des occurrences de toutes les espèces. Ce sont également les individus de cette espèce qui ont les plus gros diamètres (Tableau 2). L'espèce la plus abondante est *Pterygota macrocarpa* avec 12,18 % des individus de toutes les espèces.

Tableau 1 : Récapitulatif de la richesse et de la composition floristiques de la zone refuge

	Paramètres floristiques	Total	Moyennes / 200 m^2
Richesse	Nombre d'espèces	358	28,56 ± 6,7
	Nombre de genres	186	14,03 ± 4,2
	Nombre de familles	62	4,94 ± 2,3
Diversité	Shannon	3,58	2,42 ± 1,15
	Equitabilité	0,87	0,78 ± 0,12
Morphologie	Arbres et arbustes (%)	50,27	
	Lianes (%)	29,14	
	Herbes (%)	20,59	
Chorologie	Espèces GC (%)	71,82	
	Espèces GC-SZ (%)	17,41	
	Espèces SZ (%)	10,77	

Tableau 2: Liste des 10 espèces les plus importantes de la zone refuge

Espèces	Occurrences (%)	Abondances (%)	Dominances (%)	Importances (IVI)
Celtis zenkeri	8,18	8,49	15,70	32,36
Pterygota macrocarpa	6,92	12,18	5,54	24,64
Mansonia altissima	6,92	8,86	7,74	23,51
Ricinodendron heudelotii	5,03	3,69	11,08	19,80
Ceiba pentandra	5,03	4,06	8,12	17,21
Nesogordonia papaverifera	5,66	4,43	3,85	13,94
Hymenostegia afzelii	3,77	5,17	1,34	10,28
Cola lorougnonis	2,52	6,27	0,31	9,10
Bussea occidentalis	3,14	2,58	2,78	8,51

L'importance de *Celtis zenkeri* dans la zone refuge n'a rien d'étonnant. En effet, depuis longtemps, la végétation de la région toute entière, a été caractérisée de forêt semi-décidue à *Celtis* spp. et *Triplochiton scleroxylon* [15]. La deuxième espèce caractéristique, *Triplochiton scleroxylon*, est également présente dans la zone refuge étudiée. Cependant, les proportions occupées par les tiges de cette espèce, sont moins importantes ; ce qui peut être lié à une exploitation intense des individus matures, étant donné qu'elle fait partie des espèces de bois d'œuvre de première catégorie en Côte d'Ivoire [16].

En combinant les valeurs relatives d'occurrence, d'abondance et de dominance, *Celtis zenkeri* et *Pterygota macrocarpa* sont suivies dans l'ordre décroissant des importances par *Mansonia altissima, Ricinodendron heudelotii, Ceiba pentandra, Nesogordonia papaverifera, Hymenostegia afzelii, cola lorougnonis* et *Bussea occidentalis* (Tableau 2). Hors mis les deux dernières espèces de cette liste, toutes les autres sont connues comme des espèces de bois d'œuvre. L'exploitation des semences, des fruits ou du bois de certaines comme *Mansonia alissima*, *Nesogordonia papaverifera* et *Triplochiton scleroxylon* est interdite en Côte d'ivoire depuis 1965. Elles peuvent constituer le cortège des espèces emblématiques ou de clé de voûte de la zone refuge. Ces espèces sont caractéristiques de la stabilité de la zone refuge. La croissance de leur peuplement indiquera que le milieu est stable.

3.3 ESPÈCES À STATUT PARTICULIER ET LEUR DISTRIBUTION DANS LA ZONE REFUGE

Au total 31 espèces à statut particulier ont été recensées lors des inventaires (Figure 2 et Tableau 3). Ces espèces sont représentées par 55 tiges matures, soit une moyenne de 1,8 tige par espèce. Environs 52 % de ces espèces ne sont présentés que par un seul individu mature. Des interventions récurrentes des populations riveraines, à la recherche de bois de chauffe ou pour la chasse et la cueillette dans la zone refuge, pourraient être endommageables pour ces espèces dont l'unique individu peut être coupé lors ces activités.

Dans le compartiment dégradé de la zone refuge, ont été inventoriées 14 de ces espèces à statut particulier (Figure 2). Dans ce compartiment, seules *Pterygota*

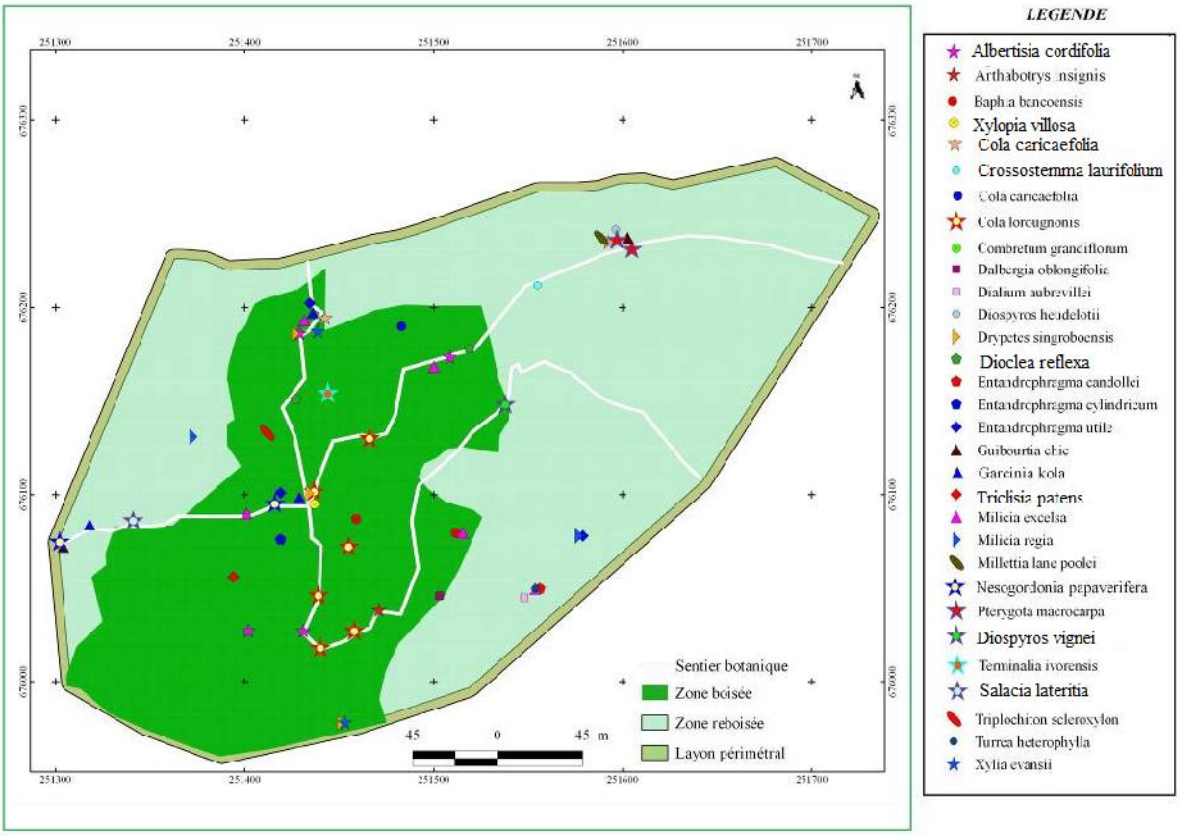

Figure 2 : Distribution des espèces à statut particulier dans la zone refuge

Tableau 3 : Espèces à statut particulier présentant au moins un individu mature dans la zone refuge : GCi = espèce endémique à la flore ivoirienne ; GCW = espèce endémique aux blocs de forêts ouest-africains ; HG = espèce endémique aux forêts de Haute Guinée ; Vu = espèce classée dans la catégorie vulnérable de l'UICN ; EN = espèce classée dans la catégorie danger d'extinction de l'UICN ; LR = espèce classée dans la catégorie risque faible de l'UICN

Espèces	Statuts	Nombre de tiges matures
Albertisia cordifolia	GCi	5
Arthabotrys insignis	HG	1
Baphia bancoensis	GCi	2
Cola caricaefolia	GCW	2
Cola lorougnonis	HG, EN	6
Combretum grandiflorum	GCW	1
Crossostemma laurifolium	GCW, HG	1
Dalbergia oblongifolia	GCW	1
Dialium aubrevillei	GCW	2
Dioclea reflexa	GCW	1
Diospyros heudelotii	GCW, HG	1
Diospyros vignei	GCW	1
Drypetes singroboensis	GCi, Vu	2
Entandrophragma candollei	Vu	1
Entandrophragma cylindricum	Vu	2
Entandrophragma utile	Vu	2
Garcinia kola	Vu	3
Guibourtia ehie	Vu	1
Milicia excelsa	LR	4
Milicia regia	HG, Vu	2
Millettia lane-poolei	GCW, HG	1
Nesogordonia papaverifera	Vu	3
Pterygota macrocarpa	Vu	2
Salacia lateritia	HG	1
Terminalia ivorensis	Vu	1
Triclisia patens	GCW, HG	1
Triplochiton scleroxylon	LR	1
Turrea heterophylla	HG	1
Xylia evansii	GCW, HG	2
Xylopia villosa	HG	1

macrocarpa et *Milicia regia* sont représentées chacune par deux individus matures, les autres espèces étant représentées par un seul individu. Aussi, ces deux espèces ne se rencontrent pas dans la partie la plus conservée. La présence de *Milicia regia* connue sous le nom commun de « Iroko », peut être liée à sa conservation habituelle dans les agrosystèmes par des indigènes qui l'adorent ou l'exploitent pour la qualité de son bois, dans plusieurs localités de la Côte d'Ivoire. Ce genre d'espèces est qualifié d'arbre sacré auquel un adepte peut être lié pour sa vie entière [17].

Dans le compartiment le mieux conservé, 27 des espèces à statut particulier, soit 87 % ont été inventoriées. Douze (12) de ces espèces sont aussi présentes dans la partie dégradée. Les espèces représentées par plus d'individus matures sont *Cola lorougnonis* (6 tiges), *Albertisia cordifolia* (5 tiges) et *Milicia excelsa* (4 tiges). Aucune de ces espèces ne se rencontrent dans le compartiment dégradé. Cette absence démontre que les activités anthropiques dont la résultante est la conversion de la forêt en jachère, après les cultures agricoles, semblent avoir des effets plus sévères sur la majorité des espèces à statut particulier. Cette observation peut être confirmée par [18] et [19] selon qui ces espèces sont les plus sensibles aux perturbations causées par l'homme. L'on comprend donc pourquoi d'après [4], les agrosystèmes de la zone d'étude sont pauvres en espèce présentant une forte valeur pour la conservation de la biodiversité.

Parmi les 31 espèces, 13 soit 41,9 %, figurent sur la liste rouge de l'Union Internationale pour la Conservation de la Nature [11]. Seule *Cola lorougnonis* est dans la catégorie en « danger » de disparition de la flore ivoirienne. Cette espèce figure également parmi celles qui sont endémiques aux forêts de Haute Guinée (HG) d'après la liste de [10]. En se référant à [5], [6], en Côte d'Ivoire, cette espèce n'a été signalées jusque là que dans les forêts de la Région de Divo entre les fleuves Bandama et N'zi, dont fait partie la zone de cette étude, dans les années 1960 à 1980. Aussi pour cet auteur, l'espèce serait en voie de disparition de la flore ivoirienne. Trois (3) autres sont endémiques à la flore ivoirienne. Il s'agit de *Albertisia cordifolia, Baphia bancoensis* et *Drypetes singroboensis* d'après les listes préétablies par [5], [6] et [10]. Parmi ces espèces, *Drypetes singroboensis* figure également sur la liste rouge de l'UICN [11] dans la catégorie vulnérable.

Celles qui sont endémiques aux blocs forestiers ouest-africain (GCW) sont au nombre de 11 espèces. La majorité des ces espèces (10) sont également sur la liste des espèces endémiques aux forêts de Haute Guinée; ces deux régions phytogéographiques chevauchant au niveau de l'Afrique de l'Ouest.

En se référant au six (6) critères reconnues par la Forest Stewardship Council (FSC) permettant de définir la valeur pour la conservation de la biodiversité d'une forêt [20], les résultats de cette étude, démontrent que ce bloc forestier, désormais protégé et bien délimité pour éviter tout empiètement de sa modeste superficie, riche en espèces vulnérables, en danger ou menacées d'extinction, ainsi qu'en espèces endémiques, est un écosystème rare, menacé ou en voie de disparition dans la localité d'Agbaou. Ce genre d'écosystème, s'il reste sans mesure de protection, sont vulnérable à la déforestation au profit des activités agricoles ou à la fragmentation forestière [21]. Pour [4], *Cola lorougnonis* et *Drypetes singroboensis* témoignent part leur présence dans la zone refuge Dékpa, de la particularité des conditions environnementales, difficilement réalisable dans les autres zones forestières ivoiriennes et même dans les jachères de la localité d'Agbaou.

4 Conclusion et perspectives

La présente étude a permis de montrer l'engouement des populations riveraines et de la société ENDEAVOUR MINING à la protection de la zone refuge Dékpa, un fragment de forêt riche en espèces à statut particulier et ou à valeur commerciale, en particulier *Cola lorougnonis*, *Drypetes singroboensis*, *Triplochiton scleroxylon, Nesogordonia papaverifera* et *Pterygota macrocarpa*. Ces espèces emblématiques ou clé de voûte de la zone refuge, constituent des éléments essentiels pour la conservation de la biodiversité, mesure compensatoire planifiée au préalable et répondant aux impacts de l'exploitation minière.

L'étude démontre qu'il est primordial, lorsqu'il est impossible de réduire ou d'éviter des impacts néfastes des travaux ou des projets d'aménagement, de construction d'infrastructure ou tout ouvrage notamment industriel, agricole ou commercial, de prendre des mesures pour assurer une compensation écologique.

L'aménagement de la zone refuge Dékpa connait des progrès considérables surtout au plan communautaire et scientifique. L'évaluation de la diversité faunistique, en particulier l'Avifaune et les Mammifères, devra faire partie des priorités des gestionnaires dans les prochaines étapes du processus de classement. Sur le plan floristique, il s'agira aussi de l'évaluation des importants services écosystémiques (soutien, régulation, approvisionnement et socioculturel) et de la poursuite des activités de reboisement.

L'exemple de la zone refuge Dékpa mérite d'être répété sur l'ensemble des sites miniers de la Côte d'Ivoire ainsi qu'au-delà de ces frontières*.* Toutes les zones écologiques sont certes concernées mais, principalement les zones les plus sensibles à l'érosion et à la dégradation des sols; c'est-à-dire les régions savanicoles et sahéliennes qui constituent par leur fragilité, les portes d'entrée au désert.

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PERFORMANCE AND EMISSION CHARACTERISTICS OF A VARIABLE COMPRESSION RATIO (VCR) SI ENGINE

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ABSTRACT: The compression ratio displays a dominant role in the performance of reciprocating I.C engine. All the methods to increase the power output bring along with them a host of various other problems. For instance, increasing engine speed imposes dynamic load factors and increased wear thereby reducing reliability and life. High turbo-charging results in very high peak pressures and also higher thermal loads. One method of solving high-pressure problem encountered when the specific output is increased is to reduce the compression ratio at full load but at the same time keep it sufficiently high for good starting and part load condition. Thus a fixed compression ratio engine cannot meet the requirements of high specific output and hence felt is the need for a variable compression ratio engine. The effect of compression ratio on brake thermal efficiency, CO & NOX are analyzed using Greaves MK20 SI Engine (2.28kW). The engine has a fixed compression ratio of 4.8, but the cylinder head has been modified to operate at compression ratios 3.6 to 7.4 in this project work. This engine has been used to investigate the effect of different fuels operating at three compression ratios of 4.0, 4.8 and 6.0.

KEYWORDS: Greaves MK20, Compression ratio, Fuel Efficiency, Emission Characteristics, Thermal Efficiency.

1 INTRODUCTION

The concept of a variable compression ratio engine has been the goal of designers since the inception of internal combustion engines. Over the past several decades, numerous designs for varying the compression ratio have been proposed. Most of them were either impractical or too complicated to evaluate on an engine though a few of them were tried experimentally and adapted in limited production. The reason for exploring this technology is used to meet the different situation on road use and maximize the fuel economy. For example, at low engine speed, the speed of car usually low and air intake is inefficient. The engine have to increase its compression ratio so that the power output is higher due to high pressure produced from combustion process, also air and fuel used will be less compare to low compression ratio to get more power. At high engine speed and vehicle speed, the engine has to work harder to get more power. But the combustion chamber will get hotter at the same time, the fuel may burn itself and cause knocking while the compression ratio is too high at the combustion process, so that engine gets hurt. In order to prevent this, lower compression ratio is required to lower the temperature of combustion chamber. To satisfy both conditions, we have to use variable compression ratio engine. The VCR and small engine displacement are used to achieve high energy-conversion efficiency at low power levels. High efficiency at low power levels is important for achieving high vehicle mileage because automobile engines operate at low power levels most of the time. The VCR is also used to prevent knock at high power levels (with a low compression ratio) and to improve efficiency at low power levels (with a high compression ratio). The spark-ignition port-fuel-injected VCR engine operates efficiently and cleanly on gasoline and a range of alternative fuels. All else being equal, an internal combustion engine with a high compression ratio makes more efficient use of the energy in the fuel, and also produces more power, than one with a lower compression ratio. However, at high engine loads, that high compression causes knock, ping and other forms of power-robbing untimed ignition. The advantages of variable compression ratio are well documented and understood in the automotive industry. Yet there are no such engines on the market today. The reason for this is that most VCR concepts do not provide a reliable sealing between piston and cylinder liner. In order to contain the high pressure of an internal combustion, the entire sealing surface of the cylinder liners must continuously be swept. Otherwise the sealing will not be properly lubricated, resulting in abnormal wear, and the ring might be sticking to the liner, resulting in engine breakdown.

2 Design Of Variable Compression Ratio Engine

2.1 Selection Of Engine

- A side valve engine is selected as it is easy to vary the compression ratio
- If the normal compression ratio is less, the clearance volume will be large and it will have space for modifications like introduction of an auxiliary chamber.
- Service and other facilities for the purchased engine should be available immediately.
- If the engine operates with two fuels, the effect of fuels can also be investigated.

With all the above in mind, the Greaves MK-20 engine with the following specifications is chosen.

- MAKE = Greaves Engine (MK-20)
- TYPE = Side valve
- POWER = 2.2 kW
- SPEED = 3000 rpm
- BORE = 68 mm
- STROKE = 50 mm
- DISPLACEMENT = 192 cc
- COMPRESSION RATIO = 4.8
- FUELS PROPOSED = Petrol, Kerosene

2.2 Design Of New Cylinder Head For Variable Operation Of Compression Ratio

The swept volume of the engine is kept constant at 192cc and the Compression ratio is varied by varying the clearance volume by the introduction of an auxiliary chamber. As this will only reduce the compression ratio, the new cylinder head is redesigned to have a lower clearance volume of 30cc and then the clearance volume is increased by adding extra volume in the auxiliary chamber. The plunger is raised by means of a square thread 3mm pitch with a nut fixed and the lift can be measured by rotating the wheel provided on the square thread. Table 1 shows the relationship between the rotation of the wheel, lift of the plunger, the clearance volume and the compression ratio. The compression ration can be varied from 7.4 at the lowest position of the plunger to 3.6 at the highest position.

Table 1. Relationship Between Rotation Of Wheels and Lift Of The Plunger

CR	**3.6**	**4.0**	**4.4**	**4.8**	**5.2**	**5.6**	**6.0**	**7.4**
Clearance Volume	73.846	64	56-47	50.53	45.71	41.739	38.4	30
Additional value added	43.846	34	26.47	20.53	15.71	11.739	8.4	0
Lift of the plunger(mm)	22.33	17.32	13.48	10.45	7.99	5.98	4.279	0
Rotation of the wheel (degrees)	2679.6	2078.28	1618.17	1253.88	953.7	727.63	513	0

Calculation of lift and angle of rotation of the wheel for a compression ratio of 4.8 is shown below:

Clearance at C.R 7.4 = Vs/r-1 = 192/6.4 = 30 cc.

Clearance at CR 4.8 = Vs/M = 192/3.8= 50.5 cc.

Change in clearance volume = 50.5 - 30 = 20.5 cc

Diameter of plunger = 50 mm.

Area of plunger = $\pi/4\ (5.0^2) = 19.64\ cm^2$.

Lift = 20.5/19.64 =1.043 cm.

Pitch = 3 mm

Rotations required = 1.0437;   0.3 revolutions = 3.48 revolutions

Rotations required in degree = 3.47 * 360 = 1253 degrees.

2.3 DESIGN OF CYLINDER HEAD THICKNESS

Ultimate tensile strength of IP131	=	173 N/mm^2
Yield Strength of IP131	=	86.5 N/mm^2
Maximum Pressure in the cylinder	=	25 Bar
Area of the cylinder head	=	6600 mm^2
Force acting on the cylinder head	=	16.5 kN

2.4 DESIGN OF FINS

The fins are designed for the maximum power output of 2.2 kW. From the fuel consumption test, the following measurements are made.

Time for 10 cc flow of fuel	= 20 seconds
Exhaust temperature	= 500 °C
Room temperature	= 30 °C
Air Fuel Ratio	= 10: 1
Surface temperature of the cylinder head ts	= 710 °C

The dimensions of the Cylinder fins on the annular surface of the cylinder are:

Type of cylinder fins	= annular
Number of fins	= 7
Inner radius	= 34 mm
Length of fins	= 23.5 mm
Thickness	= 3 mm

From the data book,

CoefficientoftherrnalconductivityforIP131 (LM13) = 204W/mK.

Convective heat transfer coefficient at a velocity of 5m/s = 100 W/m^2K

1. Heat Input

Qi = mf * Cv =1.584 * 43500 / 3600= 19.14 kJ/s

2. Brake output = 2.2 KW = 2.2 kJ/s

3. Heat Lost through annular fins

From the heat and mass transfer data book (C.P.Kothandaraman, 2012) and

Heat Transfer (J.P.Holman 2003, 3rd Reprint),

Efficiency of fins = 90%

Heat transfer through seven fins Q = η * h * As * (tex – tr) * 7

= 0.9 * 100 * 14608 * (10 - 6) * (1000 - 30) * 7

= 8.89 kJ/ s

4. Heat Carried away by exhaust gases:

Q3 = mex * C pex * (tex - tr)

= {1.584 * 11 * 1.05 * (500 - 40)} / (3600)

= 2.34 kJ/S

5. Heat lost due to Radiation

Assumed to be 20% of heat input,

Q4 = Q1 * 0.2

= 19.14 * 0.2

= 3.83 kJ/s.

6. Heat loss through cylinder head fins

Q5 = Q1 - (Q2 + Q3 + Q4)

= 19.14 - (2.2 + 2.34 + 3.83 + 8.89)

= 1.88 kJ/s.

There are seven rectangular annular fins of 7 mm thickness of length 25 mm and breadth 35 mm.

Therefore perimeter P = 2 * (35 + 7) = 84 mm.

Cross sectional area = 35 * 7 = 245 mm^2

m = {(h'p) / (k *A)}(1/2)

= {(100 * 84 * 10-3) / (205 * 2.45 * 10 - 6)}(1/2)

= 12. 93

Total Heat transfer	= 7 * (hpkA) 1/2 * tanh ml * (ts - tr)
Therefore Qtotal	= 1.4 kJ/s.
The required heat transfer	= 1.88 kJ/s.

This implies that more fins have to be provided. Due to the constraints arising from the provision for bolts, spark plugs and the piezo electric pick up this could not be done. Hence it is suggested that the length of the fins can be increased from 25 to 35 mm to meet the requirement of cooling. But this was not possible too. So the forced cooling technique to increase heat transfer has been adopted using a blower.

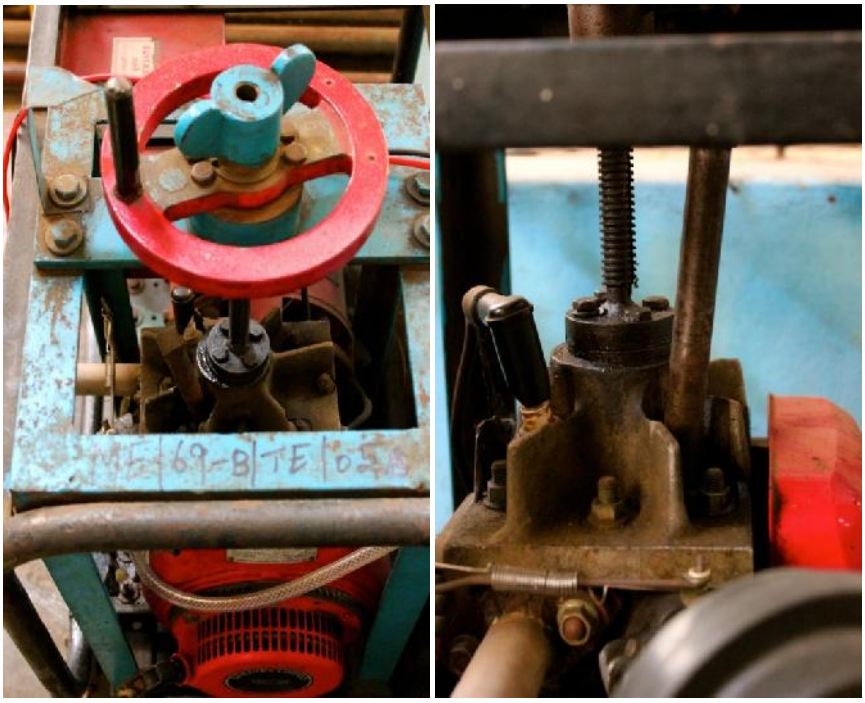

Fig. 1. Lead Screw Mechanism

Fig. 2. Exhaust Setup for Gas-Pickup

3 EXPERIMENTAL INVESTIGATIONS

The tests are conducted with four fuels:

- Petrol
- Kerosene.
- 5% Ethanol blend with Petrol
- 10% Ethanol blend with Petrol

For each fuel, the test procedure is as follows:

  - The rise for the desired compression ratio is set.

- The fuels and the recommended jet are selected.
- Starting from no load, the engine is loaded in steps till full load is attained with the speed being maintained constant at 3000rpm.
- For each load the following measurements are made
- Time for 10cc of fuel consumption
- The voltmeter and ammeter readings
- The exhaust gas temperature
- Exhaust gas analysis using CRYPTON five gas analyzer shown in figure 2 & 3. Exhaust gas analyzer consists of a probe provided with a long polymer cable connected to the analyzer consist of a probe provided with a long polymer cable connected to the analyzer by means of a filter. Exhaust gas analyzer measures NOX and UBHC in ppm and CO, CO_2 and O_2 in percentage by volume. It also measures the a/f ratio and the equivalent ratio. Software is provided with the facility of recording data over a period of a time 1min to 3min the time interval between two readings can also be changed. The data can be stored and printed.
- The experiment is repeated for different compression ratios.
- The readings are tabulated in tables 2 to 13 for petrol, kerosene and gasohol fuels.

Fig. 3. Experimental Setup

Formula used for performing calculations:

- Brake power = V * I/ηg Watts
  where ηg is the efficiency of generator.
- T.F.O 10/tf * (ρf/1000) * 3600 Kg/hr.
  where tf stands for 10cc of fuel consumptions,
  ρf stands for density of fuel in gm/cc.
- Brake thermal efficiency
  ηBT = [(Bp*3600*100) / (T.F.C*CV*1000)]%
  Where CV is calorific value of fuel in kJ/Kg.

Table 2. Test Results For Petrol, C.R=4.0, N=3000rpm

S.No	V (volt)	I (A)	η_g (%)	BP (Watt)	T_f (S)	η_{BT} (%)	Emissions				
							NO_X ppm	UBHC ppm	CO %vol	CO_2 %vol	O_2 % vol
1	230	0	0	0	40	0	101	322	3.76	12	1.03
2	230	1	0.41	560.9	36	6.29	111	336	4.43	12.2	0.54
3	230	2	0.54	851.8	31	8.22	106	343	6.3	11.3	0.4
4	230	3	0.63	1095.2	26	8.87	98	580	9.12	9	0.35
5	230	4	0.68	1352.9	19	9.07	95	746	11.34	7.9	0.22
6	230	5	0.73	1575.3	17	9.37	88	821	12.02	7.1	0.16
7	230	6	0.78	1769.2	15	9.83	86	1154	12.57	6.4	0.14
8	230	7	0.81	1987.7	13	10.66	79	1340	13.24	5.8	0.11

Table 3. Test Results For Kerosene, C.R=4.0, N=3000rpm

S.No	V (volt)	I (A)	η_g (%)	BP (Watt)	T_f (S)	η_{BT} (%)	Emissions				
							NO_X ppm	UBHC ppm	CO %vol	CO_2 %vol	O_2 % vol
1	230	0	0	0	42	0	96	302	4.03	12.2	0.28
2	230	1	0.41	560.9	37	5.88	116	331	6.88	11	0.19
3	230	2	0.54	851.8	31	7.19	99	293	8.69	9.7	0.13
4	230	3	0.63	1095.2	27	7.97	97	387	9.31	9.2	0.09
5	230	4	0.68	1352.9	23	8.93	88	609	12.09	8.6	0.06
6	230	5	0.73	1575.3	21	9.23	85	811	14.22	7.8	0.05
7	230	6	0.78	1769.2	18	9.81	81	1266	15.48	6.4	0.03
8	230	7	0.81	1987.7	15	11.02	76	1464	16.33	5.7	0.02

Table 4. Test Results For 5% Ethanol Blend, C.R=4.0, N=3000rpm

S.No	V (volt)	I (A)	ηg (%)	BP (Watt)	Tf (S)	ηBT (%)	Emissions				
							NO_X ppm	UBHC ppm	CO %vol	CO_2 %vol	O_2 % vol
1	230	0	0	0	38	0	117	302	3.19	13.2	0.31
2	230	1	0.41	560.9	34	6.04	98	394	6.75	11.1	0.26
3	230	2	0.54	851.8	28	7.55	126	563	8.52	10.3	0.32
4	230	3	0.63	1095.2	23	7.97	119	877	9.75	9.3	0.21
5	230	4	0.68	1352.9	18	8.74	104	971	10.36	8.8	0.17
6	230	5	0.73	1575.3	16	8.96	112	1078	11.48	7.9	0.1
7	230	6	0.78	1769.2	14	10.04	119	1274	11.98	7.2	0.07
8	230	7	0.81	1987.7	11	11.12	125	1460	12.36	6.6	0.06

Table 5. Test Results For 10% Ethanol Blend, C.R=4.0, N=3000rpm

S.No	V (volt)	I (A)	η_g (%)	BP (Watt)	T_f (S)	η_{BT} (%)	Emissions				
							NO_X ppm	UBHC ppm	CO %vol	CO_2 %vol	O_2 % vol
1	230	0	0	0	36	0	142	339	5.1	13.2	0.31
2	230	1	0.41	560.9	30	5.42	129	423	7.12	11.1	0.23
3	230	2	0.54	851.8	26	7.13	116	590	8.33	10.3	0.36
4	230	3	0.63	1095.2	21	7.4	111	664	10.26	9.3	0.21
5	230	4	0.68	1352.9	17	8.39	104	791	11.2	8.1	0.12
6	230	5	0.73	1575.3	15	8.54	97	880	11.69	6.3	0.07
7	230	6	0.78	1769.2	12	9.68	88	1279	11.83	5.9	0.04
8	230	7	0.81	1987.7	9	10.86	83	1411	12.44	5.5	0.03

Table 6. Test Results For Petrol, C.R=4.8, N=3000rpm

S.No	V (volt)	I (A)	η_g (%)	BP (Watt)	T_f (S)	η_{BT} (%)	Emissions				
							NO_X ppm	UBHC ppm	CO %vol	CO_2 %vol	O_2 % vol
1	230	0	0	0	47	0	83	388	2.51	13.5	0.35
2	230	1	0.41	560.9	41	7.28	91	412	4.52	12.1	0.28
3	230	2	0.54	851.8	34	8.15	108	581	6.78	9.8	0.17
4	230	3	0.63	1095.2	28	9.71	116	707	8.1	10.2	0.09
5	230	4	0.68	1352.9	23	10.29	129	892	9.37	9.4	0.12
6	230	5	0.73	1575.3	18	10.8	132	1004	12.19	7.7	0.1
7	230	6	0.78	1769.2	11	11.06	121	1176	12.79	6.5	0.08
8	230	7	0.81	1987.7	7	11.39	110	1367	13.55	5.8	0.07

Table 7. Test Results For Kerosene, C.R=4.8, N=3000rpm

S.No	V (volt)	I (A)	η_g (%)	BP (Watt)	T_f (S)	η_{BT} (%)	Emissions				
							NO_X ppm	UBHC ppm	CO %vol	CO_2 %vol	O_2 % vol
1	230	0	0	0	48	0	93	298	1.47	14.2	0.66
2	230	1	0.41	560.9	42	7.34	113	464	5.57	10.8	0.19
3	230	2	0.54	851.8	34	9.02	122	561	7.46	11	0.15
4	230	3	0.63	1095.2	29	9.89	138	683	9.12	9.4	0.16
5	230	4	0.68	1352.9	20	10.55	119	740	11.42	8.1	0.12
6	230	5	0.73	1575.3	17	10.71	111	984	12.59	7.3	0.07
7	230	6	0.78	1769.2	13	10.93	103	1401	12.99	6.7	0.04
8	230	7	0.81	1987.7	10	11.21	96	1126	13.36	6.1	0.01

Table 8. Test Results For 5% Ethanol Blend, C.R=4.8, N=3000rpm

S.No	V (volt)	I (A)	η_g (%)	BP (Watt)	T_f (S)	η_{BT} (%)	Emissions				
							NO_X ppm	UBHC ppm	CO %vol	CO_2 %vol	O_2 % vol
1	230	0	0	0	44	0	95	391	3.51	13	0.72
2	230	1	0.41	560.9	38	6.2	111	489	6.69	10.5	0.53
3	230	2	0.54	851.8	30	7.44	120	601	7.6	10.4	0.24
4	230	3	0.63	1095.2	26	8.29	133	643	8.41	10	0.12
5	230	4	0.68	1352.9	22	9.32	141	802	12.53	7.4	0.09
6	230	5	0.73	1575.3	18	10.32	113	988	13.61	6.5	0.06
7	230	6	0.78	1769.2	15	10.87	104	1216	13.98	6.1	0.05
8	230	7	0.81	1987.7	11	11.29	99	1437	14.35	5.8	0.03

Table 9. Test Results For 10% Ethanol Blend, C.R=4.8, N=3000rpm

S.No	V (volt)	I (A)	η_g (%)	BP (Watt)	T_f (S)	η_{BT} (%)	Emissions				
							NO_X ppm	UBHC ppm	CO %vol	CO_2 %vol	O_2 % vol
1	230	0	0	0	39	0	107	473	4.63	12.2	0.62
2	230	1	0.41	560.9	32	5.78	115	553	6.2	10.4	0.4
3	230	2	0.54	851.8	27	7.4	124	691	7.97	10.3	0.22
4	230	3	0.63	1095.2	24	8.46	139	838	8.24	10.1	0.11
5	230	4	0.68	1352.9	20	8.87	143	960	11.96	7.9	0.09
6	230	5	0.73	1575.3	16	9.11	121	1009	12.06	8	0.06
7	230	6	0.78	1769.2	13	9.86	117	1157	12.45	7.6	0.03
8	230	7	0.81	1987.7	10	10.77	111	1381	12.92	7.1	0.02

Table 10. Test Results For Petrol, C.R=6.0, N=3000rpm

S.No	V (volt)	I (A)	η_g (%)	BP (Watt)	T_f (S)	η_{BT} (%)	Emissions				
							NO_X ppm	UBHC ppm	CO %vol	CO_2 %vol	O_2 % vol
1	230	0	0	0	40	0	126	472	5.3	12	0.27
2	230	1	0.41	560.9	30	5.51	90	321	6.75	11.1	0.26
3	230	2	0.54	851.8	25	6.97	107	603	8.33	9.2	0.3
4	230	3	0.63	1095.2	21	7.53	121	574	8.67	9.9	0.09
5	230	4	0.68	1352.9	18	7.97	113	882	9.99	9	0.11
6	230	5	0.73	1575.3	15	8.69	104	1076	11.51	8.1	0.12
7	230	6	0.78	1769.2	13	9.54	96	1242	12.03	7.9	0.1
8	230	7	0.81	1987.7	12	10.83	93	1459	12.66	7.3	0.08

Table 11. Test Results For Kerosene, C.R=6.0, N=3000rpm

S.No	V (volt)	I (A)	η_g (%)	BP (Watt)	T_f (S)	η_{BT} (%)	Emissions				
							NO_X ppm	UBHC ppm	CO %vol	CO_2 %vol	O_2 % vol
1	230	0	0	0	53	0	92	391	0.91	13.3	1.99
2	230	1	0.41	560.9	42	7.46	100	466	2.82	13	0.9
3	230	2	0.54	851.8	31	8.36	109	619	3.2	13.5	0.39
4	230	3	0.63	1095.2	25	8.67	124	681	7.79	10.2	0.25
5	230	4	0.68	1352.9	23	10.29	131	833	9.29	9.4	0.2
6	230	5	0.73	1575.3	19	10.64	122	1002	13.03	7.1	0.14
7	230	6	0.78	1769.2	17	10.97	101	1160	14.11	6.6	0.11
8	230	7	0.81	1987.7	15	11.27	90	1316	15.95	5.9	0.08

Table 12. Test Results For 5% Ethanol Blend, C.R=6.0, N=3000rpm

S.No	V (volt)	I (A)	η_g (%)	BP (Watt)	T_f (S)	η_{BT} (%)	Emissions				
							NO_X ppm	UBHC ppm	CO %vol	CO_2 %vol	O_2 % vol
1	230	0	0	0	48	0	99	370	3.01	12.2	1.26
2	230	1	0.41	560.9	44	7.18	103	436	5.9	10.9	0.86
3	230	2	0.54	851.8	38	9.42	109	570	7.16	10.1	0.39
4	230	3	0.63	1095.2	35	9.78	121	703	8.22	9.01	0.25
5	230	4	0.68	1352.9	27	10.04	125	791	11.1	8.45	0.24
6	230	5	0.73	1575.3	19	10.65	113	859	12.22	7.9	0.11
7	230	6	0.78	1769.2	17	10.97	107	1032	12.79	7.3	0.08
8	230	7	0.81	1987.7	14	11.23	99	1366	13.46	6.1	0.03

Table 13. Test Results For 10% Ethanol Blend, C.R=6.0, N=3000rpm

S.No	V (volt)	I (A)	η_g (%)	BP (Watt)	T_f (S)	η_{BT} (%)	Emissions				
							NO_X ppm	UBHC ppm	CO %vol	CO_2 %vol	O_2 % vol
1	230	0	0	0	48	0	103	422	1.19	13.8	1.14
2	230	1	0.41	560.9	35	7.46	112	583	2.06	13.6	0.8
3	230	2	0.54	851.8	30	8.36	119	704	7.32	10.7	0.24
4	230	3	0.63	1095.2	24	8.67	127	870	8.32	9.9	0.15
5	230	4	0.68	1352.9	22	9.54	133	1086	9.09	9.4	0.17
6	230	5	0.73	1575.3	16	10.29	125	1209	11.36	8.7	0.15
7	230	6	0.78	1769.2	15	10.64	113	1361	12.94	8.1	0.11
8	230	7	0.81	1987.7	12	11.07	103	1517	13.81	7.3	0.06

4 Results And Discussion

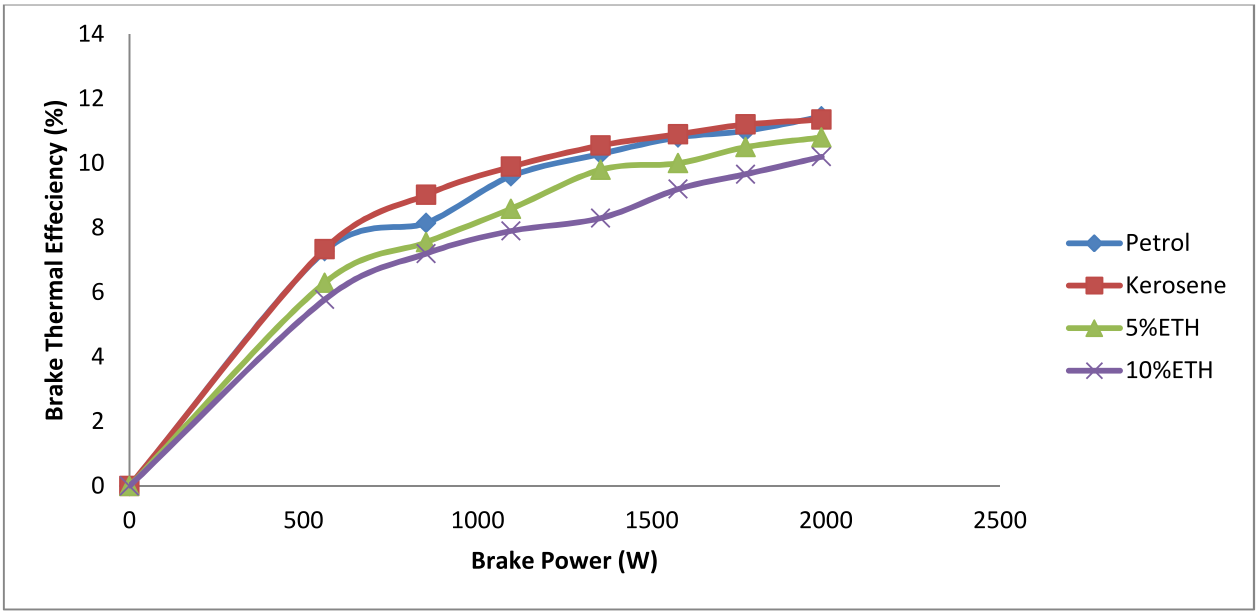

Fig. 4. Brake Thermal Efficiency vs. Brake Power at CR = 4.8

- Figure 4 shows the variation in brake thermal efficiency with load for various fuels at compression ratio of 4.8.
- It is observed from the figure, the brake thermal efficiency is highest for gasoline for all loads.
- It is expected because gasoline has the highest calorific value. Kerosene fuel shows better results compared to gasohol (gasoline-Ethanol) blends, because of lower latent heat of vaporization.

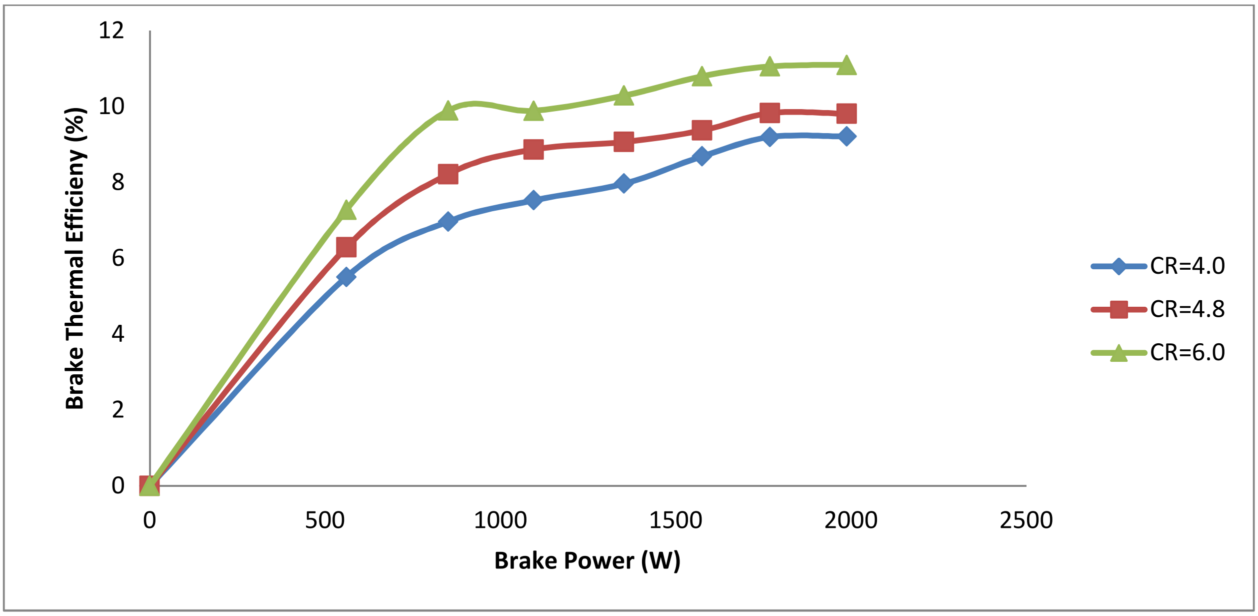

Fig. 5. Brake Thermal Efficiency vs. Brake Power for Petrol

- Figure 5 shows variation of brake thermal efficiency for petrol at different compression ratios.
- It is seen that brake thermal efficiency is high at high compression ratios at all loads.
- This is due the fact that the temperature is high before the beginning of combustion which results in better vaporization and mixing.

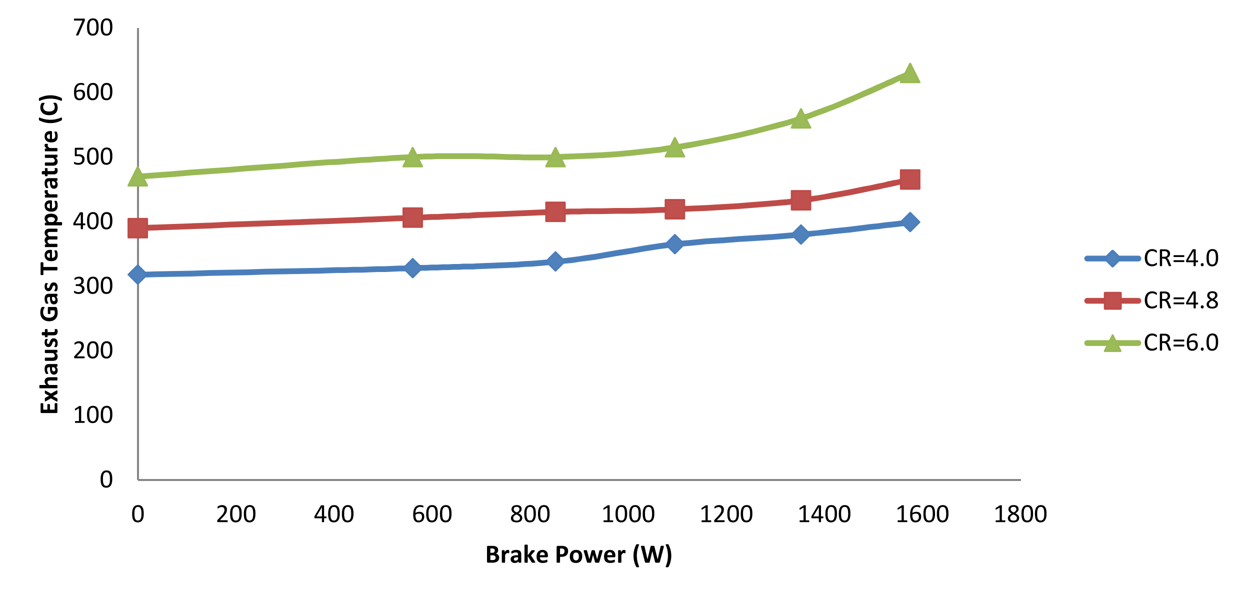

Fig. 6. Exhaust Gas Temperature vs. Brake Power for Petrol

- Figure 6 shows the variation of exhaust gas temperature with brake power at various compression ratios.
- The exhaust gas temperature increases with load and also with compression ratio.
- It is seen that the exhaust temperature is very high (500-600°C) at higher compression ratio (6.0) and hence heat carried away by the exhaust gases is high.
- This is one of the reasons for the lower brake thermal efficiency for this engine.

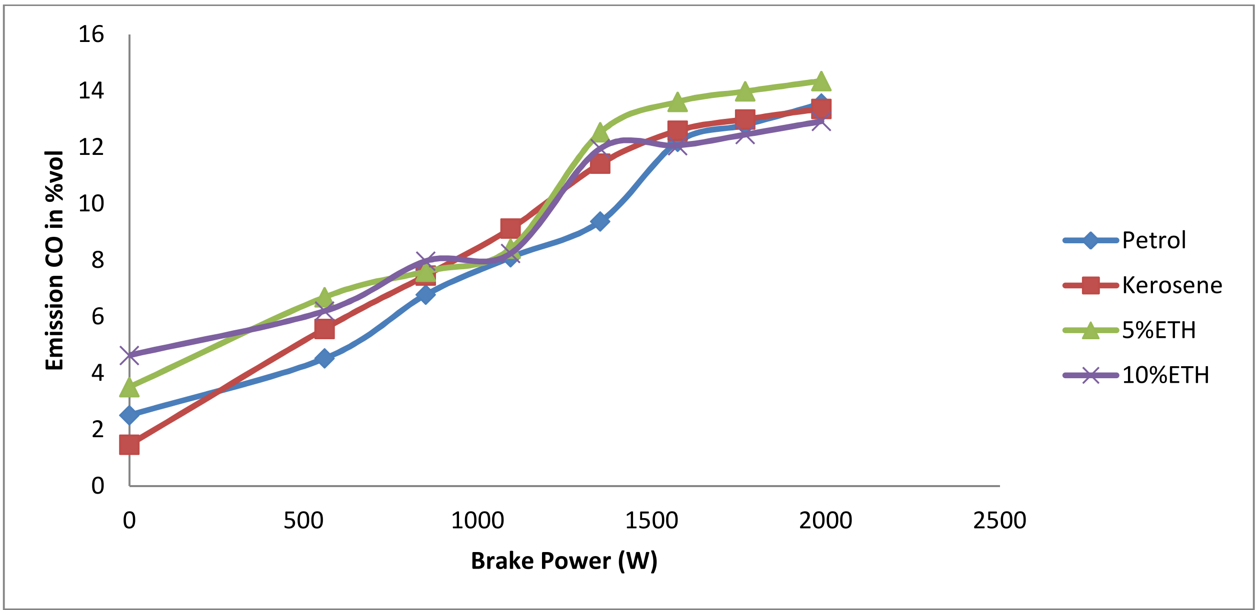

Fig. 7. Emission Characteristics of CO at CR = 4.8

- Figure 7 shows the variation of CO for different fuels at compression ratio 4.8.
- It is observed from the above graph, the level of CO increases with increase in loads for all fuels but no definite trend could be seen between different fuels.
- As shown in the graph, the CO emission gradually increases as brake power increases, for petrol.
- Whereas for ethanol blend, the CO emissions increases at a higher rate compared to other fuels.

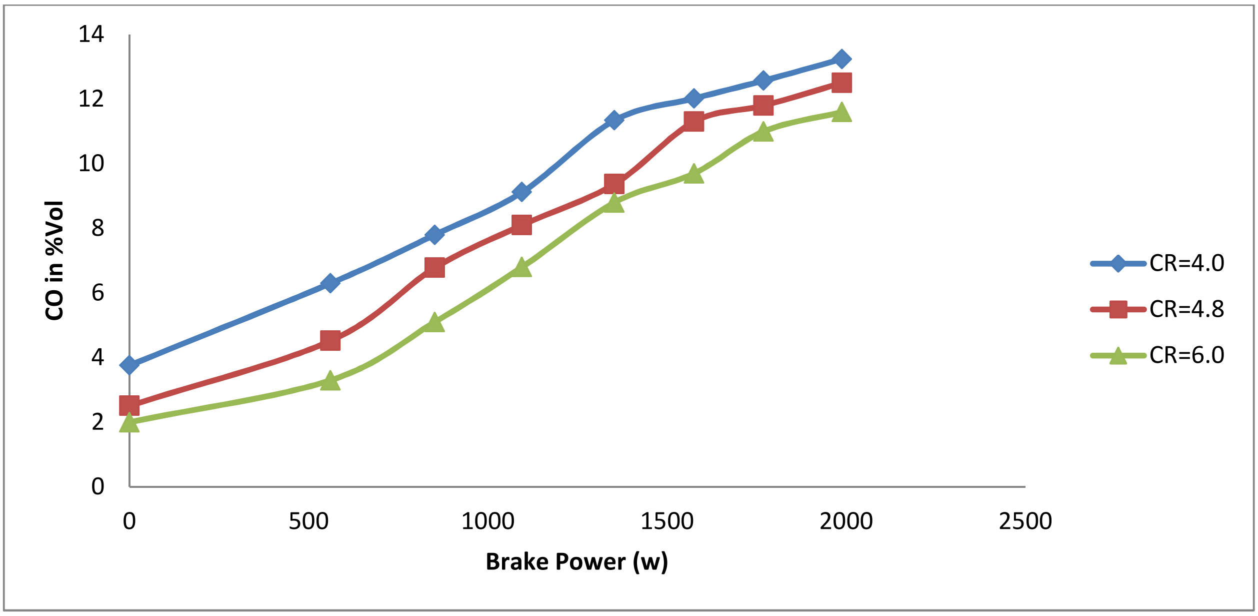

Fig. 8. Emission Characteristics of CO at various CR for Petrol

- Figures 8 show the variation of CO at different compression ratios for petrol.
- It is seen that the level of CO increases with load. As the compression ratio increases, the level of CO decreases, which shows that the combustion is better at higher compression ratios.

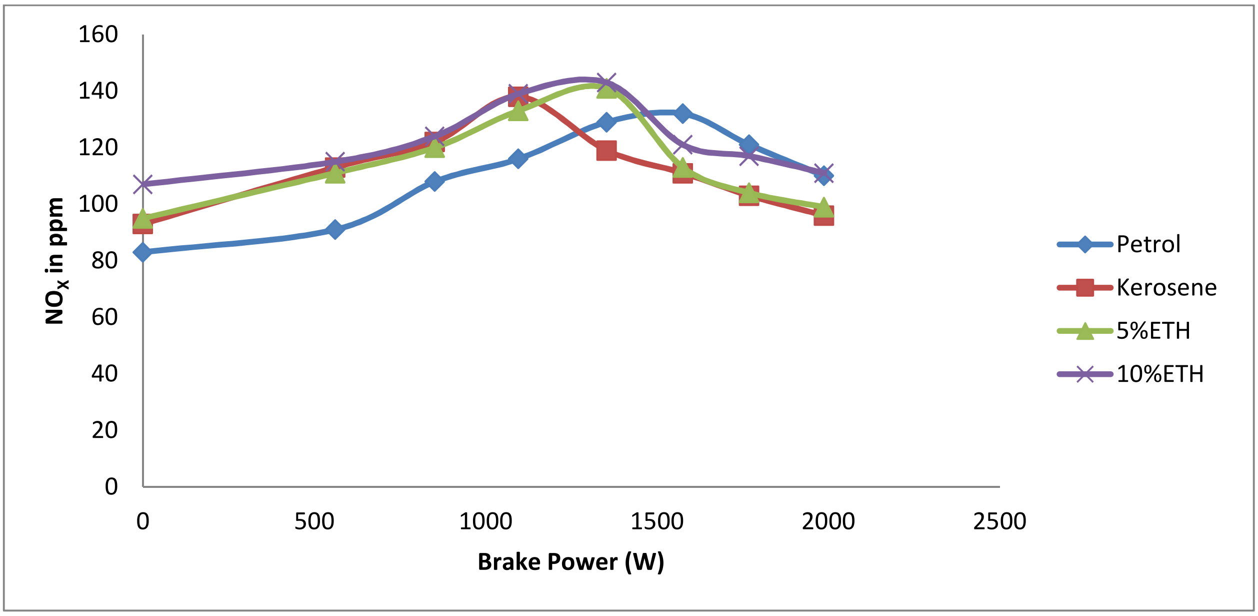

Fig. 9. Emission Characteristics of NO_X at CR = 4.8

- The figure 9 shows the NOx increases with load, reaches peak at nearly 50% full load (900-1000 W).
- After reaching the peak value (50% load) it gradually decreases commonly for all fuels.

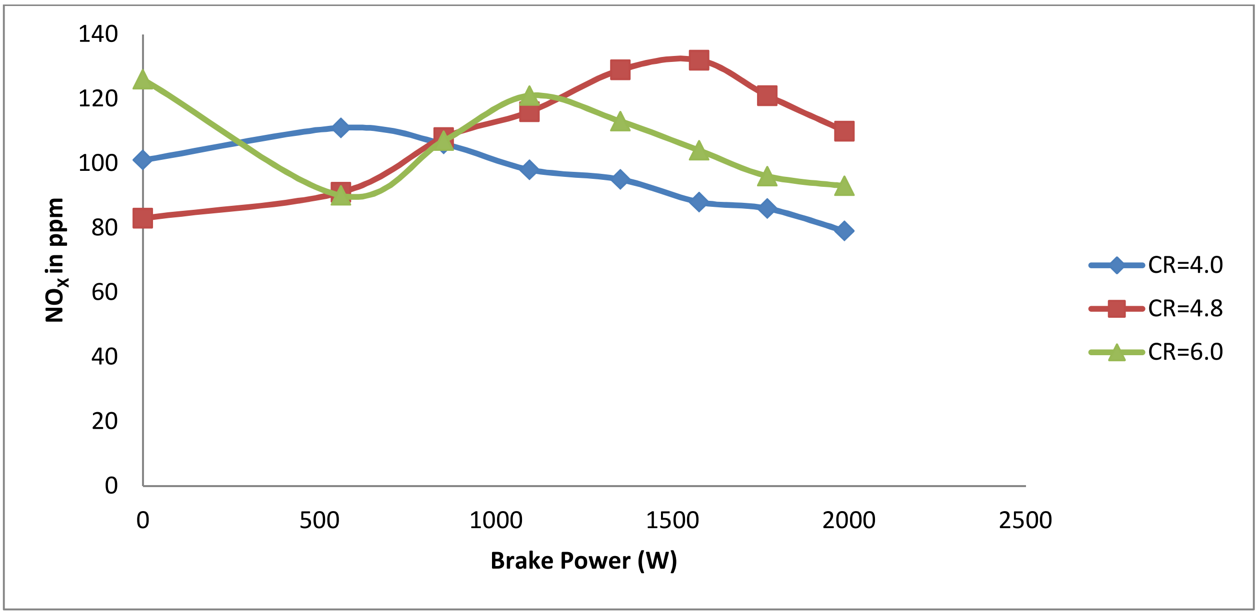

Fig. 10. Emission Characteristics of NO_X at various CR for Petrol

- Figure 10 shows the variations of NOx at with various compression ratios for petrol.
- It is observed that NOx increases as the load increases, reaches a maximum value and then decreases with further increase in load.
- At any load, NOx is high for the higher compression ratio.
- This is natural as high temperatures are expected with high compression ratios.

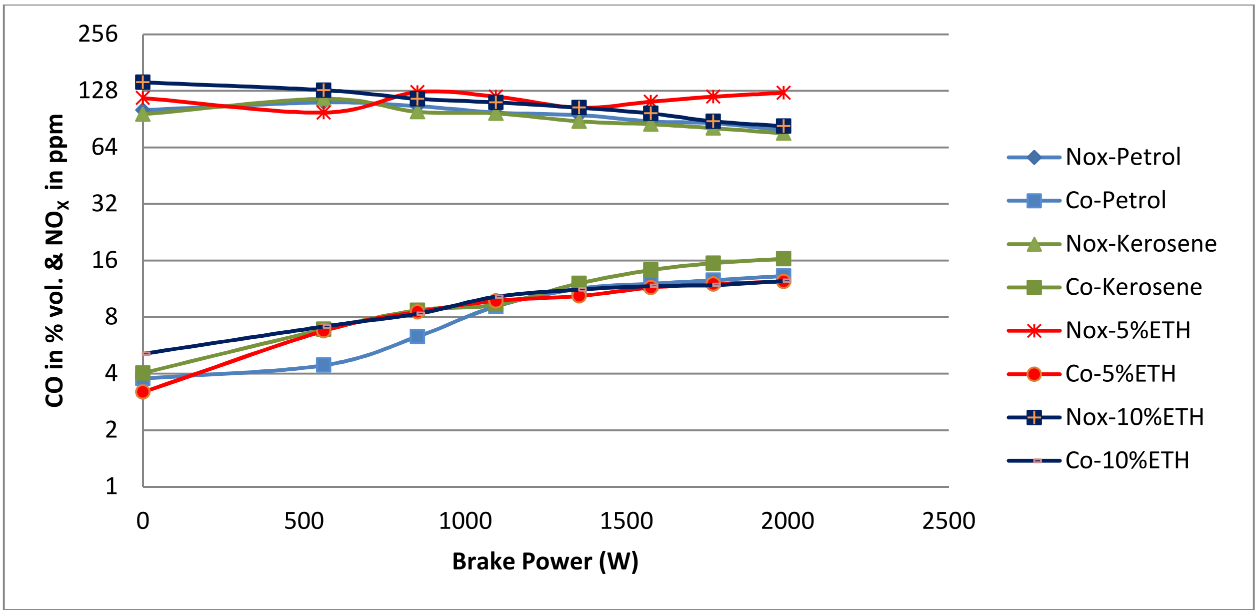

Fig. 11. Comparison of CO with NO_X at CR = 4.0

- Figure 11 shows the variation of NOx and CO with load for compression ratio 4.0 for various fuels used.
- The trend is same as in the case of compression ratio 4.0 except the peak NOx is higher in the case of compression ratios of 4.8 and 6.0.

5 CONCLUSION

- A variable compression ratio SI engine is fabricated with the compression ratio capable of being varied from 3.6 to 7.4.
- The tests were conducted using four fuels namely Petrol,
- Kerosene, 5% Ethanol blend, 10% Ethanol blend for compression ratios varying from 4.0 to 6.0.
- From the experiments conducted on the VCR SI engine fabricated, it is observed that the performance of the engine matches with the original engine.
- The maximum brake thermal efficiency of the engine is found to be abnormally low (around 11%).
- For Petrol, the compression ratio of 4.8 is found to be optimum from the point of view of emissions and efficiency.
- For Kerosene also, the optimum compression ratio is found to be 4.8.
- For Gasohol also, the optimum compression ratio is found to be 4.8

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The Future of Laboratory Work Lab-On-Chip Device: An Overview

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ABSTRACT: The technology of carrying out laboratory operations using scaled down Lab-On-a-Chip (LOC) device is really appealing. The whole laboratory being reduced into a small chip. The time taken to analyze a reaction can be reduced through volume reduction of the reagents used; the distinctive behavior of liquids at the nano scale allows increased control of molecular interactions and concentrations. The cost of reagents and the chemical waste amounts can also be very much reduced through the use of this technology. The LOCs also provide for the analysis of samples at the point of need instead of a centralized laboratory. The main aim of this research is to review about a newly device known as the Lab-on-chip device. This research was carried out to study and well understand all the aspects of this device, including its history, advantages, disadvantages, where it is applied and the challenges. It is evident that with the development of Lab on Chip devices, everything becomes better and easier. Even though the technology is at its initial stages of development, it proves to be very efficient. This clearly shows how much more will be achieved with continual development in this field.

KEYWORDS: Lab On Chip; LOC; Microfluidics; Laboratory; Technology.

PURPOSE

The main aim of this research is to review about a newly device known as the Lab-on-chip device. This research was carried out to study and well understand all the aspects of this device, including its history, advantages, disadvantages, where it is applied and the challenges.

METHODOLOGY

This research was carried out on books as well as articles so as to gather the information that will help in the discussion of relevant matters and also to obtain the required information in the study research.

FINDINGS

The major findings were the information on the history of Lab on chip devices and how they were improved with time. Also, the advantages of the devices e.g. efficiency and cost effectiveness and why it is of real importance. The disadvantages were also found and some of the areas where this technology has been applied.

Research limitations

It was not possible to observe and learn how to operate and work with the devices themselves. Most of the evidence given is based on the available literature and articles on the device.

Practical implications

The practical implication in this study is how the devices can be improved in a way that they become cost effective in manufacture and increasing its availability to medical centers and research institutions.

Originality

The originality is brought about by the need of the medical services to be improved e.g. increasing the ability to detect protein signatures of a disease or infection on blood samples and body fluids before the symptoms arise, for early intervention.

1 Introduction

A lab on chip (LOC) device is a device which can be able to integrate miniaturized laboratory functions on a single microprocessor chip using minute fluid volumes in quantities of up to less than picolitres and nanolitres[1]. The LOCs are categorized as a subclass of micro-electro mechanical systems[2] and are able to combine miniaturized sensing system, a suit of fabrication techniques used by the semiconductor industries like material deposition, surface patterning, electrical property modification and material removal, and control concepts of fluid flow from microfluidics[3-5].

1.1 History

The Lab on Chip technology was first brought forth by Michael Widner at Ciba-Geigy (now Novartis) in the 1980s and it was described theoretically in 1990 [6]. An extensive work was published in 1992 on the same[7]. Additional development was carried out as a new field of discovery—microfluidics—was established in the 1990s[8]. Microfluidics is an interdisciplinary field that deals with of extremely small, minute volumes of fluids, their behavior and control, and the designing of the systems which use these minute volumes [9]. Besides being commonly found in ink-jet printers, major microfluidics applications have been encountered in biotechnology research[10]. As a matter of fact, some experts regard this field as a biotechnology branch[11]. In some ways, Microfluidics counterparts nanotechnology where the fluid behavior at the micro scale can vary substantially from the fluid behavior at the macro scale[12]. Phenomena like surface tension, fluid resistance and heat conduction start becoming important, and matters like evaporation, threat posed by air bubble presence and absence of turbulent flow, are very critical to system design [13].

Initially, much of the stimulus for continued development of LOCs originated from the Human Genome Project, a project coordinated by DOE and National Institutes of Health (NIH) for 13 years, which began in 1990 and ended in 2003[14]. As at now, much of the push for the continued development of LOCs originates from the craving for point-of-care medical diagnostics, be it on a space craft, in the doctor's office, or other remote location. Moreover, development research is compelled by the growing need for miniaturization, to reduce the expenses and the environmental research impacts (green analytical chemistry)[15, 16]. The LOC technology, already significant, is still viewed to be in its initial stages. Research in the LOC technology still continues in many fields[17].

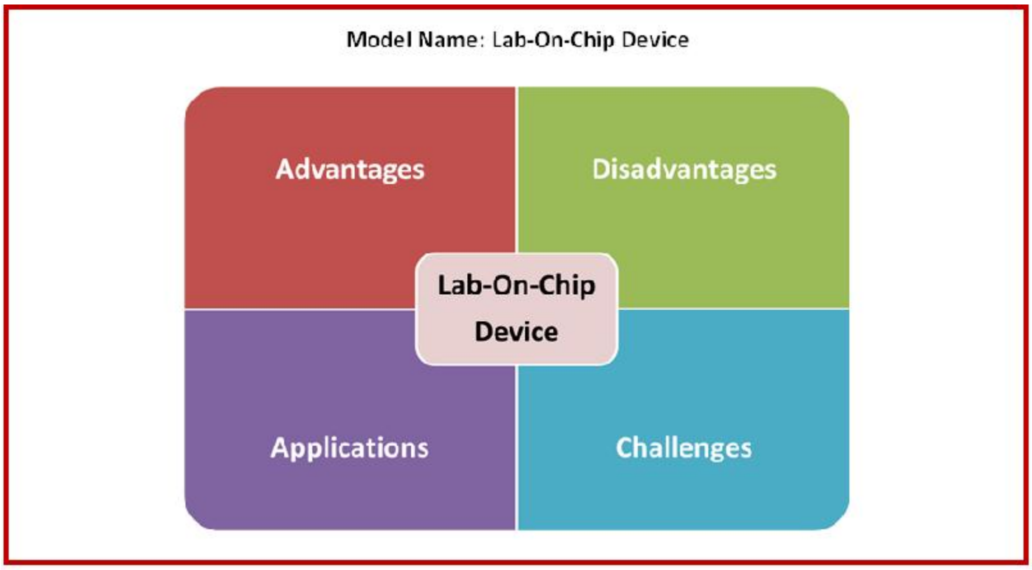

Fig. 1. The Lab-On-Chip Device and its four aspects

1.2 Advantages

They enable fast analysis of fluid samples. This is simply because, the diffusion distances are short, there is very fast heating because of the small volumes, the small volumes also increase the surface area to volume ratio. All these factors fasten the analysis process of the fluid samples[18]. The lab on chips also lead to cost effectiveness in the purchase of reagents. This is because the LOCs have miniaturized laboratory functions to usage of small amounts of fluids in the order of picolitres and nanolitres[19]. This reduces the amounts of reagents required for the laboratory operations. It is also easy to collect required samples since they are not required in large quantities. Multiplexing can also be done with this device. Very many analyses can be analyzed simultaneously and still obtain very accurate results. Because of this, a series of tests can be done on the same device at the same time[20].The device is also highly sensitive and can detect toxins and impurities.[21].The device is portable and very easy to use since it is automated and with a simple touch screen interface.

1.3 Disadvantages

LOC devices are very effective in areas that are developed technologically and industrially. The developing and the under developed areas may not benefit much from this technology. The other disadvantage is that this technology is not fully developed. It is still in its initial development stages and may not be effective in every aspect or diverse in various fields.

1.4 Applications

The LOC devices are used in the health care for diagnostics. They detect protein signatures of infections and diseases in body fluids. Through this, early interventions can be done and prevent diseases before the symptoms start showing up[22]. EPA is funding an environmental LOC project with the objectives of creating a novel, nanomaterial-based submersible microfluidic device, for exploiting distinctive properties of carbon nanotubes and metal nanoparticles for continuously, rapidly, and economically monitoring various categories of priority pollutants [23]. This project is also seeking to understand the relationship between the chemical and physical properties of the nanomaterials and the behavior observed[24, 25]. The addressed challenge is helping to transform the LOC model to a good and effective environmental monitoring system. It involves examination of nanotube and nanoparticle materials for the detection processes and separation respectively[26].

NIH is supporting the development of point detection disposable LOC which has built-in mercury precursor electrodes for detecting heavy metals[27, 28]. In the fabrication materials field, investigation of LOCs that are constructed using soft lithography techniques, and not silicon microchip fabrication processes, is done [29]. Soft lithography is a substitute to silicon-based micromachining which uses replica molding of nontraditional elastomeric materials in fabrication of stamps and microfluidic channels. As an addition to the soft lithography approach, multilayer soft lithography, which are used to fabricate multiple layers from soft materials, is used to come up with active microfluidic systems containing switching valves, on/off valves, and pumps entirely out of elastomer[30]. The tenderness of these materials makes the device areas be reduced by over two orders of magnitude in comparison with silicon-based devices.[31]

The LOC technology is also applied in the field of medicine, in the rapid, automated, point of care system (RapiDx) which was developed by Sandia National Laboratories. The Sandia National Laboratories was trying to find possibilities of developing point-of-care analyses of health and disease status that is rapid. The LOC devices were used to detect protein signatures of diseases, exposure to toxic substances or infections in body fluids like blood and saliva. This would help in early intervention before the symptoms start appearing. The RapiDx was a miniaturized device which used nanoliters of samples to measure protein signatures. Using this technology, it was easy to take only a drop of blood or saliva at the point of care for analysis and drawing tubes of blood were no longer needed [9][14].

1.5 Challenges

The different climates of different parts of the world are a challenge to this technology and therefore, the chips should be designed in a way that the reagents are kept safe so as to remain effective for a long period of time. Other parts of the world are not advanced in terms of the health care and this may bring in a reason to improve the ease of use so that it may be beneficial also to people living in such areas. Materials of use and the techniques of coming up with them and maintenance should be considered so that they don't lead to high prices in obtaining and maintaining the chips so as to make them accessible.

2 Conclusion

It is evident that with the development of Lab on Chip devices, everything becomes better and easier. Even though the technology is at its initial stages of development, it proves to be very efficient. This clearly shows how much more will be achieved with continual development in this field. Through LOCs, it is easier to carry out medical tests easier and faster and prevent some diseases before they become serious. Laboratory functions involving solutions are made easier, efficient and fast to carry out at minimal reagent costs and still obtain very accurate results within a very short period of time[32]. With much development in the LOC technology, the field of science and technology will experience a great revolution brought about by the LOC devices. A lot of researches will be easy and efficient, and experiments carried out on small chips instead of labs. It will cost less to venture into research in the field of science and technology. With experiments being able to be carried out on small chips rather than big labs, and in quantities of less than a picoliter, it's easy and less costly. With their accuracy too, the LOCs will improve the research in science to obtaining accurate results and increase precision.

From this research, it was realized that the LOC devices are still in the development process and not much has been exploited in the technology. This therefore implies that with much development and improvements, the world will be made a better place by this technology.

Authors' Profiles

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THE PRODUCTION OF FUEL-GRADE BIOETHANOL FROM CASSAVA STARCH: A CONCEPTUAL PROCESS DESIGN

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ABSTRACT: This project proposes a conceptual process design for the production of bioethanol to produce an alternative fuel that can supplement the gasoline products at a very reasonable price and produces less carbon dioxide emissions which is mandated under section 5 of RA 9367, the Biofuels Law of 2006 which states that all gasoline products will have 10 percent blend bioethanol by 2011. Due to high demand, the project proposes a process design of 10,000 metric tons bioethanol per year using fed-batch fermentation process with *Saccharomyces cerevisiae* CBS 8066 as microorganism. The plant produces 99.80%(w/w) anhydrous alcohol based on the current ASTM specification and operates continuously with an annual production time of 7,200 hours. In order to optimize the overall process, a novel separation technique is considered in this study with respect to process design and economics by integrating pervaporation and ultrafiltration system. For dehydration and recovery of ethanol, hybrid distillation-pervaporation consists of a distillation column and an externally connected pervaporation module is used to overcome the azeotropic composition from the liquid mixtures of water and ethanol. The result is an integrated system of continuously producing bioethanol in purity up to 99.8%(w/w).

KEYWORDS: Biofuels, fermentation, ethanol yield, biomass, *Saccharomyces cerevisiae*.

INTRODUCTION

The Consultative Group on International Agricultural Research (CGIAR) envisions that by 2020 roots and tubers will be integrated into emerging markets through the efficient and environmentally sound production of a diverse range of high-quality, competitive food, feed, and industrial products. Like, for instance, the production of bioethanol from root crops which has been used as one of the fuel options for internal combustion engines.

Bioethanol has been promoted as a solution for a variety of complex problems related to energy and the environment. Compared to fossil fuels, bioethanol has the advantages of being renewable, providing cleaner burning and producing no green-house gases [Altintas *et al*., 2001].

The real debut of bioethanol was in early 1970's when Brazil started the ethanol program to produce ethanol as fuel additive to decrease the amount of petroleum they imported. Since then, Brazil is the major fuel bioethanol producer in the world with current ethanol production capacity of 14 million cubic meter per annum. Throughout the world, there have been many nations incorporating ethanol into the fuel market [Efe *et. al*., 2005].

The current worldwide interest in bioethanol production is not only due to economical reasons but the exhaustion of the fossil fuel and the increasing greenhouse effect due to the high carbon dioxide emissions which urged the nations to search for alternative fuels that can supplement with gasoline products and compatible with petroleum in price.

The Organization for Economic Co-operation and Development (OECD) and UN FAO food agency, projected that global ethanol production, would double between 2007-2017 reaching 125 billion liters. It is expected to grow rapidly over the next decade, mainly with exports from Brazil to the US and EU. As a result, it increases the global demand for ethanol that would be able to sufficiently address the world's growing energy requirements.

Moreover, the Philippine's Biofuels Act of section 5 RA 9367, states that all liquid fuels for motors and engines shall contain locally-sourced biofuels components. The law mandates that all gasoline products will have 10 percent blend bioethanol by 2011 and the marketed fuel-grade ethanol shall meet all industry standards, including specifications for E-grade denatured fuel ethanol.

Today, the Green Future Innovations Inc. (GFII) will build a P6-billion bioethanol plant in Isabela that will produce 54 million liters and generate 19 megawatts annually starting 2012 and contributes to the domestic supply of green energy pursuant to the Biofuels and Renewable Energy Laws.

The GFI's annual production shall be displacing 54 million liters of imported fossil fuel and with world crude prices averaging $ 81 per barrel in which, the foreign exchange savings is estimated at $ 27.5 million per year. Apart from the economic benefits of the project, GFII iterates the socio-economic impact to the farmers and creates more than 15,000 Filipinos will be employed by this project.

DESIGN OBJECTIVE AND REQUIREMENTS

This project aims to design a large-scale process of bioethanol with annual production of 10,000 MT in order to contribute the current global demand of ethanol at 14.5 million tons per annum [Dominy, 2003].

Thus, specific requirements are considered for the design procedure in order to obtain an effective and efficient production plant. These requirements include: the process concepts chosen, mode of operation, the operating conditions, the raw materials used and others. Likewise, it is important that the process design should incorporate features to meet current ASTM standards.

CONCEPTUAL FRAMEWORK

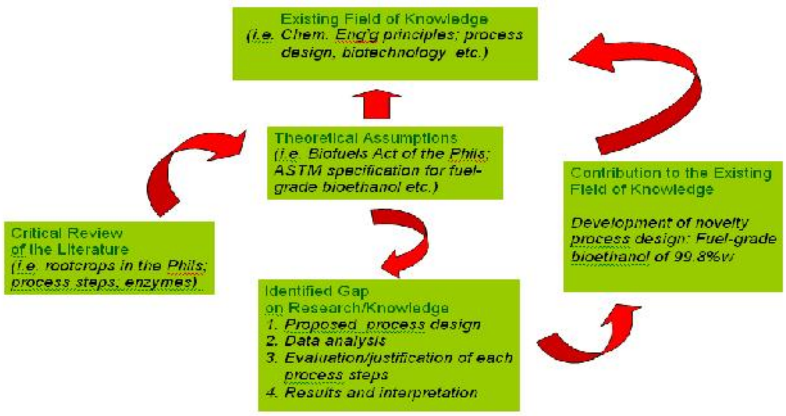


Fig. 1.1 A conceptual framework in production of a fuel-grade bioethanol from cassava starch

METHODOLOGY

In order to attain the objectives of the study, the following shall be utilized as strategies in which necessary data and relevant information will be obtained.

a. A critical review of literatures on the cassava as rootcrops and various designs processes in production of bioethanol.
b. Prepare a conceptual process design based on the proposed project.
c. Present technical and financial studies for the completion of the pilot-scale bioethanol plant.
d. Submit a technical paper to the review committee and apply to the different funding institutions for the realization of this project

Different ethanol grades are available in the market depending on its application. The current ASTM specification for water in fuel ethanol is a maximum of 1.0% (1.3 wt%). Other countries and governments have established lower allowed concentrations of water. But, the European Union standard is 0.3 wt% (standard EN 15376).

Due to the demand, the ethanol production from cassava starch must undergo several processes which include the pre-treatment process, fermentation process and downstream processing in order to meet the required ASTM specifications. This chapter provides us discussion on the different process options. Figure 1.2 depicts the overview for the process steps involved.

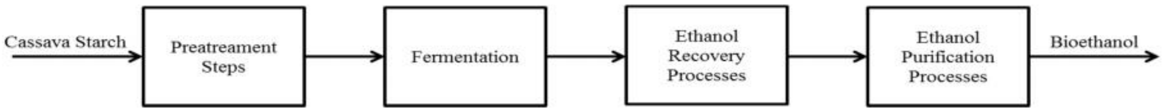


Figure. 1.2 Overview of Process Steps in Bioethanol Production

Process options are evaluated carefully using the criteria for choice. The selection of the process is done based on points system from the most important (5) to the least important (1) criteria as described below.

Table 1.1 Process Option Criteria

Criteria	General Description	Points
Product yield and purity	High product yields that contain less amounts of impurities	5
Economics	Less production cost and products at competitive prices	4
Impact on Environment	Have minimal outputs of by-products and wastes	3
Ease of Operation	Must not be hazardous and operate within safe conditions	2
Process conditions	Must be up-to-date and employ a relatively advanced process	1

Feed Preparation. Cassava starch is used as feedstock in the production of ethanol. From the Bureau of Agricultural Research [2009], the moisture content of the cassava is reduced to 14% by drying at a temperature of 60^0C and is carried out 24 hours per day before readily be available for the fermentation process.

Hydrolysis. The cassava starch undergoes enzymatic hydrolysis to convert starch into glucose. Prior to enzymatic treatment, the starch slurry undergoes gelatinization in a jet cooker. Gelatinization conditions are set at pH of 6.5 and a temperature of 105^0C for 5 minutes. The product of gelatinization is a viscous starch paste. The resulting gelatinized starch undergoes the firs enzymatic step known as liquefaction or dextrinization. The liquefaction process involves the contact of the gelatinized starch with *A-amylase* at a temperature of 95^0C for 2 hours. In this process, the viscosity of the mixture abruptly decreases due to the disruption of the granular structure of the starch into shorter dextrins. The liquefied cassava starch is then subjected to a subsequent saccharification step with the employment of *amyloglucosidase* in order to convert the dextrins into glucose. The saccharification step is done at a pH of 4.5 and a temperature of 60^0C for another 25 hours [Pandey *et al*., 2006, van der Maarel *et al*., 2002].

Yeast Preparation. Ethanol fermentations are carried out with the baker's yeast strain *Saccharomyces cerevisiae* CBS 8066. The yeast is kept on slants of GPY-(glucose/peptone/yeast extract) agar. The inocula for the fermentations are prepared in a shake flask with a medium of 10 kg/m^3 glucose and 10 kg/m^3 yeast extract paste. The fermentation media contained 150-300 kg/m^3 glucose, 7.5 kg/m^3 yeast extract paste, 5 kg/m^3 NH_4CL, 1.0 kg/m^3 KH_2PO_4, 0.25 kg/m^3 $MgSO_4.7H_2O$ and 0.20 kg/m^3 $CaCl_2.2H_2O$ in demineralized water. The solution containing glucose and $CaCl_2.2H_2O$ and the solution containing the rest of the ingredients are sterilized apart at 110^0C [Groot *et al*., 1993]

Fermentation. Fed-batch fermentation is used in this process. A feedstock containing 6% (w/w) fermentable sugar, 2 g/L of yeast and a nutrient solution is continually fed into the fermenter [IATA and McGill University, 2009]. The nutrient solution is composed of $(NH_4)_2SO_4$, 3 g/L KH_2PO_4, and 0.5 g/L $MgSO_4.7H_2O$. The fermentation is done in aerobic conditions with an optimum pH value of 4 to 5, the temperature of 30^0C to 35^0C and the fermentation period take about 3 days. Without yeast, fermentation could require more than 10 days.

In all fermentations the pH was controlled at pH 5.0, by adding 4 N NaOH. The antifoam agent polypropylene glycol was added at regular intervals to the broth (average flow rate about 0.1 ml/h). Air was sparged into the broth at a rate of 0.1 m^3/m^3/min based on total fermentation volume. The temperature of the condenser, where carbon dioxide leaves the system, was kept constant at 4^0C [Groot *et al*., 1993].

During the fermentation, sugar is converted to ethanol with 0.98 of the theoretical yield which corresponds to 0.46-0.50 g ethanol / g sugar. The remaining substrate is utilized by the microorganisms for maintenance, cell growth and production of by-products such as acetic acid, higher alcohols and acetaldehyde. The continuous feed is started after initial glucose has been utilized during the rapid growth phase. The rate of addition of glucose is determined by the need to prevent autolysis, and by the oxygen demand rate.

The fermentation liquid is mixed with turbine impellers. Some air is sparged in the broth to supply a trace amount of oxygen to support growth of yeast. The operating variables for the fed-batch process are given in Table 1.2.

Table 1.2 Fed-batch operating variables [Jackson, 1990]

Volume	150-200 m^3
Power input	3-4 kW/m^3
Air flowrate	0.5-1.0 (v/v)min
Pressure	0.3-0.7 atm
Temperature	22.22-32.22^{0}C
pH	4.0-5.0
Fermentation time	72 hours

The fermentation is carried out in vessels to maintain a continuous operation and to prevent requirement of extra storage tanks for broth and recycle biomass. The biomass is recycled to maintain high cell concentrations in the fermenters.

The fermenter should be of steel with sloping bottoms and closed taps. They are provided with vets to conduct away the carbon dioxide, and frequently with cooling coils to regulate and limit fermenting temperatures. The fermenter is inoculated with three to four percent of yeast mash and the fermentation is carried out in 72 hours (3 days duration) during which time the temperature rises from approximately 73^{0}F to 90^{0}F (22.22-32.22^{0}C) because the reaction is exothermic.

Downstream Processing. For high ethanol productivity, an ultrafiltration module is coupled to the fermenter for cell retention. The broth is recirculated over the ultrafiltration module and part of the liquid permeates through the membrane, as result of a pressure difference over the membrane. A bleed is used to prevent an undesirable build-up of yeast cells. The ultrafiltration is carried out with a 0.1 m^2 hydrophilic hollow fiber membrane module (X-Flow, Hengelo, The Netherlands) [Groot *et al*., 1993].

A novel separation technique is used by pervaporation, in which an ethanol/water mixture is recovered from the broth by evaporation via a selective membrane. For this design, an integrated ethanol production process with biomass retention by an ultrafiltration and in situ ethanol recovery by pervaporation. The mass transfer in pervaporation membranes is based on the solution-diffusion mechanism. A homogenous, nonporous membrane is used through which the compound diffuses only when it dissolves to a certain extent in the membrane. At the downstream side of the membrane, the compound is evaporated in a vacuum and the vapor is trapped in a condenser. The components of a liquid mixture can be separated based on their difference is solubility and diffusivity in the membrane. Microorganism, proteins, salts and the like are rejected by the membrane while volatile byproducts in the fermentations such as the higher alcohols and ester will also be recovered.

Pervaporation is carried out with nitrogen gas as the sweep gas. The gas is circulated by a compressor (15 l gas/min), and the vapors are condensed using a condenser at 0^{0}C and a cold trap at -60^{0}C. Plate and frame modules (5 liters/m^2-h at 30^{0}C, SEMPAS, Horb, FRG) are used, since these modules will be less sensitive to fouling by particulate matter in the broth and ease for cleaning than hollow fiber modules. The sterilization of the plate-and-frame module is disinfected by circulating a 70 wt.% mixture of ethanol in water at about 55^{0}C for 5 h and flushing with 10 L of sterile water [Groot *et al*., 1993].

A hybrid process for integrating distillation with pervaporation is used to produce 95 wt% ethanol from a feed of 50 wt% ethanol. The feed is sent to a distillation column operating at near ambient pressure, where a bottoms product of nearly pure water and an ethanol-rich distillate of 95 wt% are produced. The distillate purity is limited because of the 95.6 wt% ethanol in water azeotrope. The distillate is sent a pervaporation step where permeate of 20 wt% alcohol and a retentate of 99.8 wt% ethanol is produced. The permeate vapor is condense under vacuum and recycled to the distillation column. It requires a total condenser after the distillation tower and a liquid pump to increase the pressure of the column top stream.

The stillage of the distillation process will be processed to concentrate and recover suspended materials or dissolved materials as by-products. While the pervaporator has membrane-based process in which a liquid feed stream from the distillation is brought into contact with one side of a non-porous or molecularly porous membrane [Fleming and Slater, 2007].

RESULTS AND DISCUSSION

The input-output diagram for the production of 10,000 metric tons of ethanol per year using the fed-batch production scheme is shown in Figure 1.3. The quantities of each component are evaluated such that the total input is equal to the total output. The t/h is referred to as ton/ hour.

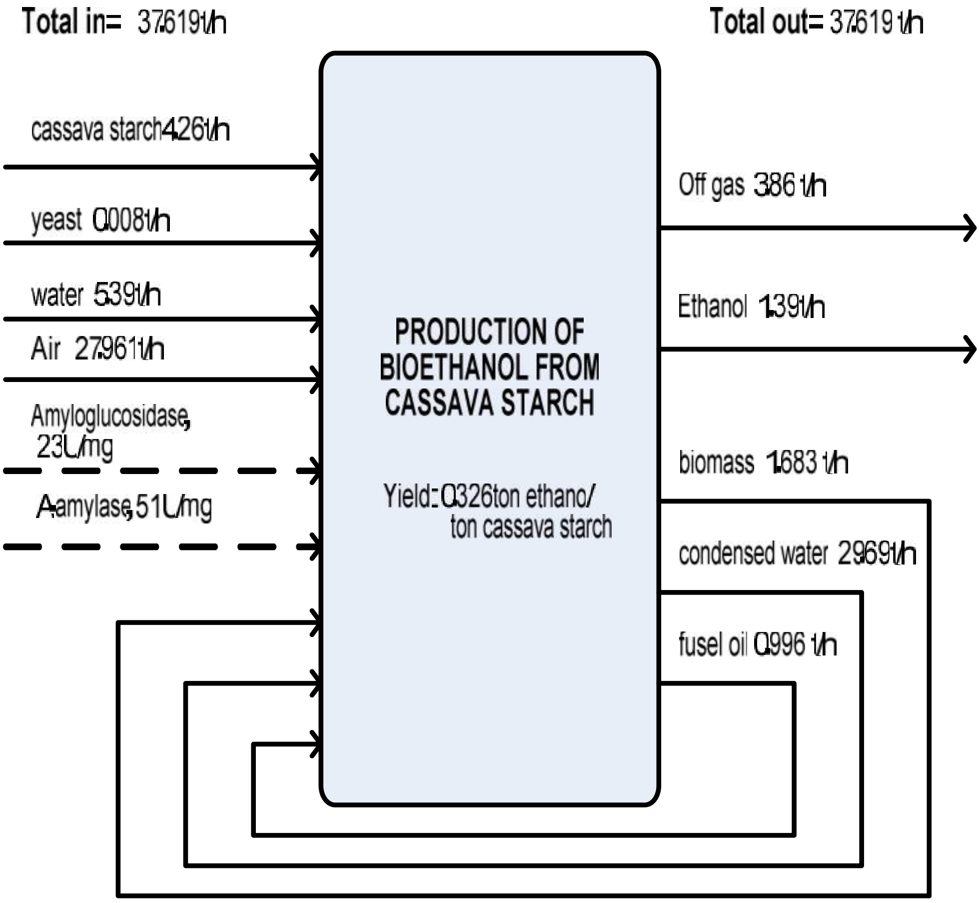


Fig. 1.3 Input-Output diagram for Bioethanol Production from Cassava Starch

BLOCK SCHEME DIAGRAM

** values in parenthesis refer to production in ton per annum*

The composition and the amounts of the components, process conditions, phases, yields and conversions are incorporated in all major streams of the process. The details of the mass balance calculation are given in the Appendixes.

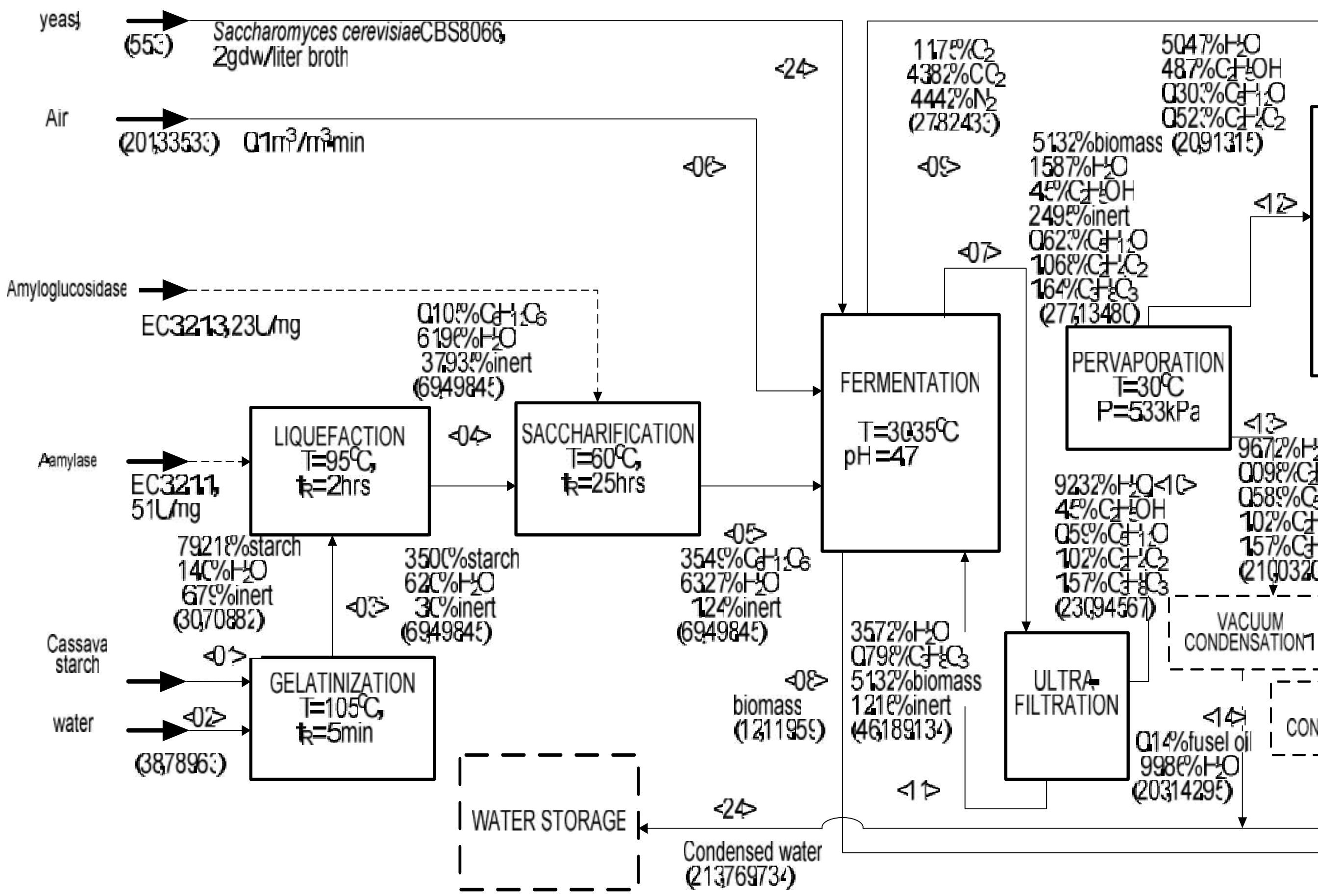
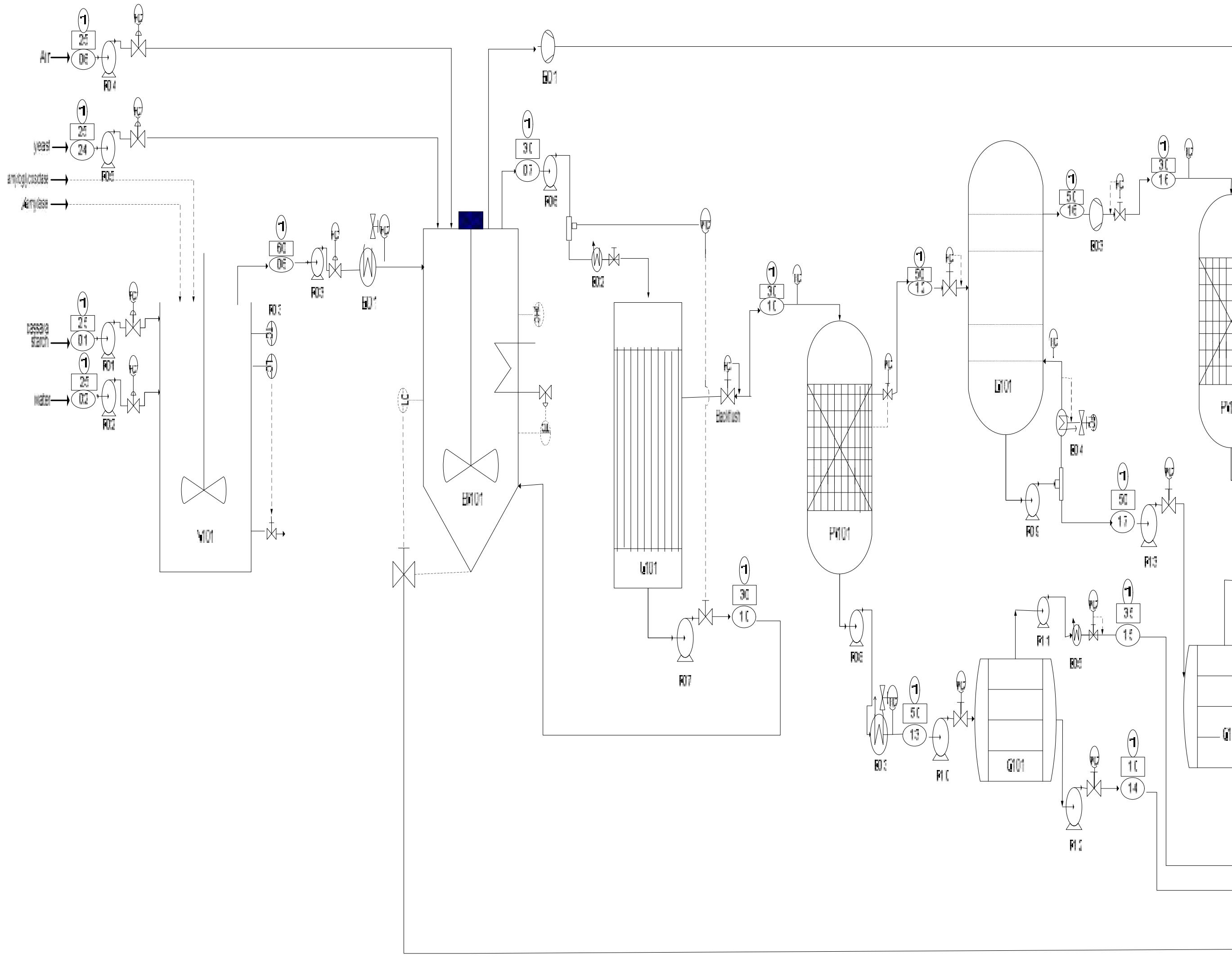


Fig. 1.4 Simplified block scheme diagram of ethanol production with a basis of 10,000 t/a ethano



PROCESS EQUIPMENT SUMMARY			
B-01 : CO_2 blower	P-01/10/13/ : Feed pumps	P-07 : Reciprocating pump	PV-101/102 : Pervaporator
BR-101 : Fermenter	P-02 : water pump	P-8/9/15: Water solution pump	U-101 : Ultrafilter
C-101/102/103: Condensers	P-03 : Slurry feed pump	P-12/16/18 : Condensed water pump	V-101 : Hydrolysis reactor
E-01-08 : Heat exchangers	P-04 : Air pump	P-11/14/19 : Vapor solution pump	
D-101 : Distiller	P-06 : broth circulation pump	P-05: Yeast feed pump	

PROJECT NAME	Fig. 1.5 PR	
DESIGNER	DATE	BIOETHANOL
Neil L. Egloso	8-Sep-13	Stream Number

Cash Flow Analysis

The construction of the plant is assumed to be 2 years. It is assumed that the first year expense is the engineering, construction and contingency cost. The payment of the fixed capital investment is paid in second year. The working capital and start-up costs are discounted from the first operating year (third year of investment) income. During construction, the line slopes downward from the zero line to indicate increasing negative cash position. As income starts, the line heads up, gradually reducing the investment to zero and this crossing of the zero line represents payout time of 3.06 years. As cash continues to come in, the slope continues upward into positive cash position (profit) area. In the region the cumulative cash flow is positive; the project is earning a return on the investment.

Data for calculation for the annual cumulative cash flow is shown in Appendixes. The summary of cash flow analysis is shown in Fig. 1.6.

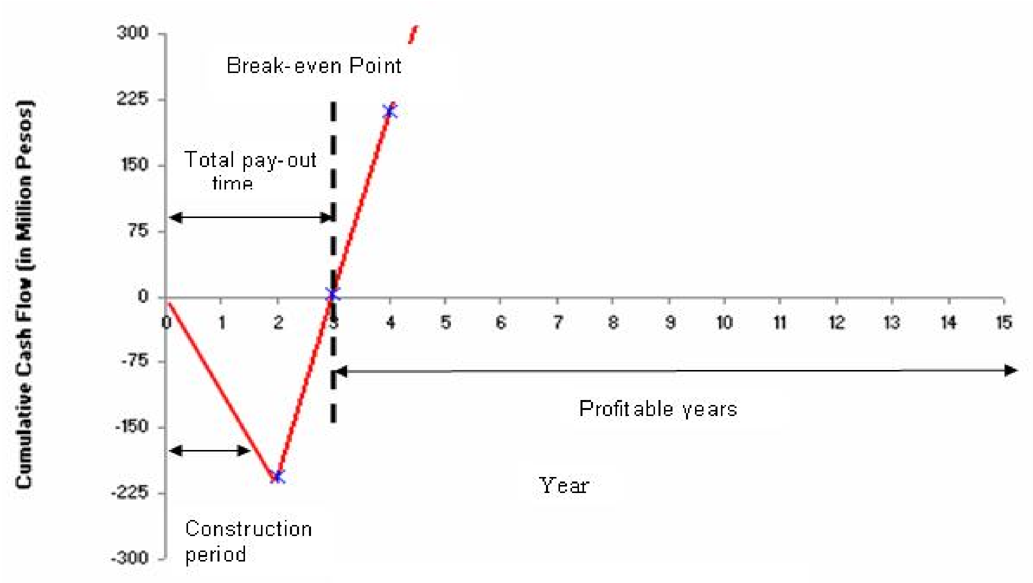


Fig. 1.6 The cash flow diagram

Sensitivities

Sensitivity to economic criteria with respect to product cost, raw material cost and maintenance cost is determined. This anticipates variability of these factors and is taken into consideration. Variance of +50% and -30% are used for product cost, raw material cost, and maintenance cost. Table 1.3 shows the sensitivities of applied variance to economic criteria and Fig. 1.7, sensitivity analysis for cumulative cash flow.

Table 1.3 Sensitivities of Economic Criteria

		Maintenance cost		Raw material cost		Product cost	
Economic Criteria		- 30%	+ 50%	-30%	+ 50%	-30%	+ 50%
ROR	**32.68%**	36.28%	26.68%	43.49%	10.62%	3.99%	80.51%
POT	**3.06**	2.76	3.75	2.30	9.41	25.06	1.24
Average Net Profit	**189.20**	211.78	151.55	256.98	50.81	9.20	489.20
Average Cash flow (with dep.)	**205.03**	227.62	167.39	272.82	66.65	25.03	505.03

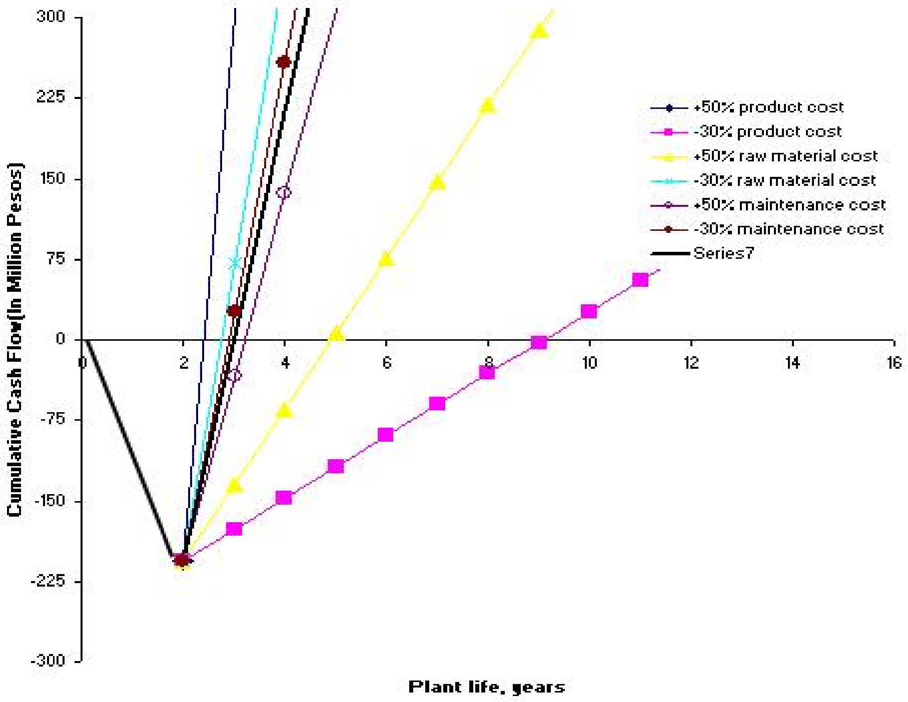


Fig. 1.7 Sensitivity analysis for cumulative cash flow

Sensitivity analysis as shown in Fig. 1.7 describes that it gives no detrimental effect in a raw material cost because the raw materials used are relatively inexpensive except if it would increase by 50%. However, product cost and maintenance cost plays the major role in giving life to the operation of the plant. As observed, variance of -30% in product cost and +50% maintenance costs give a low value of ROR. So, it is necessary to impose strict regulations in the company in case of utilizing resources and utilities of the plant such as manpower, water, and electricity. The company can help minimize operating cost by adopting new technologies that is more efficient and cost-effective. A +50% increased on product price and -30% reduction on maintenance cost would give the higher ROR based on the sensitivity analysis. Hence, annual net cash flow or the earning power may even go higher than what was estimated and would eventually boost the economy of the plant.

CONCLUSIONS

Careful consideration and a specific criterion were used in order to determine which processes were best suited for the design in order to optimize productivity and produce high quality products. This design incorporates the technological advancements and developments by updating the process and makes it relevant to the industry.

A novel separation technique used by integrating pervaporation and ultrafiltration is considered in this study with respect to process design and economics. It increases in productivity and substrate conversion which lead to reduction of the production costs of ethanol, in comparison with traditional processes like batch and continuous fermentation with ethanol recovery by distillation.

Cassava is chosen prior to other crops capable of producing alcohol due to its availability throughout the country. Aside from these, it can obtain several quantity of alcohol as three times rather than sweet potatoes and sugar cane [Combis *et al*, 1995]. It is cheap and is indigenous which costs about 30% from total production cost.

Economic analysis of the plant had shown that the design is economically viable with a rate of return of 32.68% and a pay out time of 3.06 years is expected for the production plant. It is also shown that the product cost and maintenance cost are the most sensitive among other criteria justified. However, the process can be made more profitable and economically appealing by optimizing the operations in order to increase operational efficiency.

Thus, the design calculations proved that ethanol production from cassava starch are technically and economically feasible to invest on.

RECOMMENDATIONS

1. It's highly recommended due to potential benefits of bioethanol in the community in terms of:

   1.1 Health impacts- Replaces bad gasoline additives (MTBE and lead), which are sources of surface and ground water contamination, and dangerous to human health;

   1.2 Political impacts- It potentially replaces crude oil, which is a finite, non-renewable resource; It can be domestically produced, thus reducing *dependence* on oil imports; It can potentially cut oil *import costs*.

   1.3 Socio-economic Impacts- Bioethanol uses agri-products as a feed-stock; It is a renewable source of energy, which can replace fossil fuel in the future; It increases value added and price of agri-products, which increases net farm income; It creates more jobs in the rural sector;

   1.4 Environmental Impacts- Ethanol, richer in octane, promotes more complete combustion of gasoline thus reducing exhaust emissions.

2. In a pilot-scale design, the product bioethanol can be used as an IGP in the Institution and technological-transfer program for research and extension.

3. It serves an *education campaign* to inform consumers of the purpose and benefits of bioethanol**.**

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Effect of Hormone Replacement Therapy on Osteoporosis and Its Complication on Adults Female Albino Rats

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ABSTRACT: This study was conducted to show whether hormonal replacement treatment would offer ameliorating effects against abnormal alterations associated with osteoporosis in female albino rats. Two experiments were carried out, in the first experiment, the rats were randomly divided into two main groups. The first group, were let without surgery and served as control while, the second group were obeyed to bilateral ovariectomy surgery to induce osteoporosis; after 4 weeks induced acute hormonal disturbance indicated by decreased estradiols and progesterone levels. While, the level of follicular stimulating hormone and luteinizing hormone were increase in osteoporosis female rats regarding to levels in normal control female rats. In the second experiment, a remarkable correction was occurred in the levels of follicular stimulating hormone and luteinizing hormone by gradually decreased after 90 days of treatment. While, a considerable amelioration effect was occurred in the estradiols level by gradually increasing of levels with the time and treatment with estrogen replacement. These corrections were dependent on the time of treatment (30, 60 & 90 days). According to the pre-mentioned results, it is importance to concluding that the treatment with estradiol replacement ameliorates chance of recovery from hazardous effects of osteoporoses. The obtained data were discussed according to available obtained researches.

KEYWORDS: Hormonal treatment, Osteoporosis, female albino rats, estradiol, ovariectomy.

1 INTRODUCTION

Osteoporosis is a skeletal disorder characterised by loss of bone mass and deterioration of micro-architecture, leading to bone fragility with a consequent increase in risk of fracture[1],[2]. It is the most common global bone disease, and is a risk factor for fracture of a magnitude similar to the way that hypertension is a risk factor for stroke [1]. It is estimated that approximately 50% of women >50 years' experience an osteoporosis-related facture at some point in their lifetime [1], [3] The most common fractures are those of the vertebrae, proximal femur and distal forearm. Vertebral fractures are experienced by 1 in 8 patients >50 years, of which two thirds are clinically silent [1], [3], [4]. They are associated with a high risk of future fracture, morbidity and mortality. Hip fractures, which affect 1 in 3 women >80 years, are among the most devastating results of osteoporosis [4]. They are associated with a 36% increase in mortality within one year. Complications include emboli, pneumonia and a 2.5 fold risk of future fractures [1], [3]. Up to 20% of patients who experience a hip fracture require long-term nursing care and only 40% of patients fully regain their pre-fracture level of independence. Osteoporosis represents a major public health problem. For example Irish figures indicate that approximately 300,000 people ≥50 years have osteoporosis and that these figures may double in the next 20 years [3]. Osteoporosis-related fractures carry a heavy economic burden; it is estimated that in Ireland, osteoporotic fractures cost up to €551 million to treat in 2010 and will cost more than €1 billion by 2020 [3].

In particular, there are three clinically relevant indications for utilizing bone markers, first, to monitor bone loss in the postmenopausal period, second, to assess overall fracture risk and third, to monitor response to therapy [5]. Menopause, whether natural or surgically induced, is associated with elevated levels of circulating total cholesterol and LDL cholesterol, placing postmenopausal women at greater risk for osteoporosis [6]. According to observational studies, up to 50% of osteoporosis in postmenopausal women could be prevented by postmenopausal hormone replacement therapy (HRT). However, a recent randomized secondary prevention study was not able to confirm these results. The hormone is also the principal determinant of the bone remodeling activation threshold, and hence of the amount of remodeling in the total skeleton. estrogen replacement therapy (ERT) remains controversial. On the one hand, hormone replacement seems to play a role in the prevention of osteoporosis and heart disease, and the reversal of some aspects of neurological decline [7], [8], [9].

The Food and Drug Administration (FDA) guideline has appropriately designed the need for rat experimentation in the preclinical evaluation of agents used in the prevention or treatment of postmenopausal osteoporosis. The ovariectomized rat is an excellent preclinical animal model that correctly emulates the important clinical feature of the estrogen depleted human skeleton and the response of therapeutic agents. Its site-specific development of cancellous osteopenia/osteoporosis is one of the most reproducible biologic responses in skeletal research [10].

2 MATERIAL AND METHODS

2.1 MATERIAL

This study was carried out on female albino rats ***Rattus rattus*** as an animal model for induction of osteoporosis. 30 adult female albino rats were employed in the current study. Animals were allowed ten days pre-experiment period to adapt to laboratory conditions in order to avoid any complications along the course of the experiment. They were housed in metallic cages at 28±20C and 50% relative humidity and received food and water ad-libitum with fresh supplies presented daily.

2.2 METHODS

The current study was included two experiments. In the first experiment, the rats were randomly divided into two main groups. In the first group, ten rats were let without surgery and served as control while, the second group of twenty rats were obeyed to bilateral ovariectomy surgery to induce osteoporosis as described by [11], [12].

The first experiment was conducted for 4 weeks to facilitate the development of osteoporosis occurrence. At the end of four weeks, a comparison was occurred between five normal control rats and another five ovariectomy rats to evaluate the osteoporosis occurrence due to the disturbance in hormonal pattern.

In the second experiment, osteoporosis rats were further divided into three equal subgroups (five rats for each). They were received subcutaneous injections of 2.0 mg 17-ß-estradiol-3-benzoate (Sigma Chemical, St. Louis, MO, USA)/ 100 g B.wt. in 100 µl sesame oil every 4 days between 10:00 and 11:00 a.m. for three months to simulate estrus cycles. control injections were 100 µl sesame oil. Dosing began at the 5th week after the surgeries. However, the dose of 2.0 mg estradiol in 100 µl reportedly produces plasma estradiol levels similar to peak levels occurring during the ovarian cycle in intact rats [11], [12].

Bilateral ovariectomy surgery was performed in anesthetized with sodium pentobarbital, hair around the skin area where the incision was planned was shaved, and skin was scrubbed with 70% alcohol. Surgery in female rats was making bilateral dorsal abdominal incisions through the skin, such that the ovary and oviduct could be rapidly removed. The success of the bilateral ovariectomy procedure was confirmed at the end of the study by measuring serum estradiol [11], [12].

At the end of each experimental period, rats were overnight fasted, killed by decapitation. Blood samples were collected using polyethylene tubes, blood samples were taken from each rat within each group into clean and dry screw capped centrifuge tubes and left to clot at room temperature, then been centrifuged at 3000 rpm for 15 minutes in order to separate clear serum samples and divided into small aliquots to avoid the effects of repeated thawing and freezing. All sera were stored at - 20°C until used for determination of hormonal profile.

2.3 Biochemical methods

Serum rat follicle stimulating hormone (FSH), luteinizing hormone (LH), and Progesterone were estimated according to [13], [14] & [15] respectively using commercial kits purchased from Isotope Co., Budapest, Hungary. Estrone (E_1) was estimated according to [16] using commercial kits purchased from Fuji Rebio Diagnostics, Inc. U.S.A. Estradiol (E_2) was estimated according to [17] using commercial kits purchased from Diagnostic Products Corporation (DPC), Los Angeles. California. U.S.A. Estriol (E_3) was estimated according to [18] using commercial kits purchased from IBL- Company, U.S.A.

2.4 Statistical analysis

All recorded data were analyzed by applying the following mathematical principles, two-way analysis of variance (F-test) followed by Duncan's multiply range test [19], [20].

3 RESULTS

The current study was carried out to determine the possible therapeutic role of estrogen replacement treatment (ERT) in terms of amelioration of the common side effects of postmenopausal osteoporosis, which induced in female albino rats by removing their ovaries. The study was extended to determine the hormonal profile in normal female rats as well as ovariectomized female rats to find the various, significant changes and relationships between these parameters.

At the first experiment, The levels of estimated hormones were significantly decreased. The mean values recorded were 16.99 ± 0.89, 40.01 ± 1.90, 24.06 ± 1.29 and 7.03 ± 0.49 ng/ml for estradiol's (E1, E2, E3) and progesterone levels in osteoporosis female rats regarding to 30.87 ± 1.69, 113.69 ± 3.71, 43.15 ± 2.41 and 12.19 ± 0.77 ng/ml levels respectively in normal control female rats.

While, the levels of follicular stimulating hormone (FSH) and luteinizing hormone (LH) were increase ($P<0.001$) significantly in osteoporosis female rats. The percentages of these increment were 59.16 and 48.94 for FSH and LH levels respectively as compared to their normal control rats group table(1).

Table 1. The mean values of hormonal profile levels in normal and ovariectomized female rats.

Parameters \ Groups		Control	Osteoporosis
LH uIU/ml	Mean±SD	4.09 ± 0.13	6.13 ± 0.34*
	%		48.94
FSH uIU/ml	Mean±SD	5.73 ± 0.16	9.12 ± 0.61*
	%		59.16
Progesterone ng/ml	Mean±SD	12.19 ± 0.77	7.03 ± 0.49*
	%		- 42.09
E_1 ng/ml	Mean±SD	30.87 ± 1.69	16.99 ± 0.89*
	%		- 43.27
E_2 ng/ml	Mean±SD	113.69 ± 3.71	40.01 ± 1.90*
	%		- 65.48
E_3 ng/ml	Mean±SD	43.15 ± 2.41	24.06 ± 1.29*
	%		-45.16

In the second experiment, the mean value of LH and FSH levels were elevated in ovariectomized rats and recorded 5.41 ± 0.27 and 6.91 ± 0.32 uIU/ml after 30 days regarding to 4.04 ± 0.13 and 5.29 ± 0.16 in normal control rats respectively. Such elevation gradually decreased after 90 days of treatment and reached 4.41 ± 0.31 and 5.66 ± 0.21 uIU/ml respectively at the last interval.

However, two way analysis of variance (F- test) followed by Duncan's multiply range test was revealed a significant interaction between the mean values of the level of LH and FSH at different times in treated groups and those levels alter different times of treatment.

On the other hand, The mean value of E_1, E_2 ,E_3 and Progesterone levels were depleted in ovariectomized rats and recorded 21.43 ± 1.14, 53.19 ± 2.17, 25.71±1.43, and 8.04 ± 0.66 ng/ml after 30 days regarding to 32.04 ± 1.75, 117.75 ± 3.84, 43.93±2.42, and 11.81 ± 0.77 in normal control rats. Such depletion gradually increased with the time and treatment with estrogen replacement and reached to 26.29 ± 1.52, 83.74 ± 2.59, 34.76± 1.78 and 10.13 ± 0.68 ng/ml at the last interval 90 days (table 2 and figure 1).

The data were subjected to statistical evaluation using two way analysis of variance followed by Duncan's multiply range test which revealed a significant interaction ($P< 0.001$) due to the main affects, intervals of estimation, dose of estrogen replacement administration.

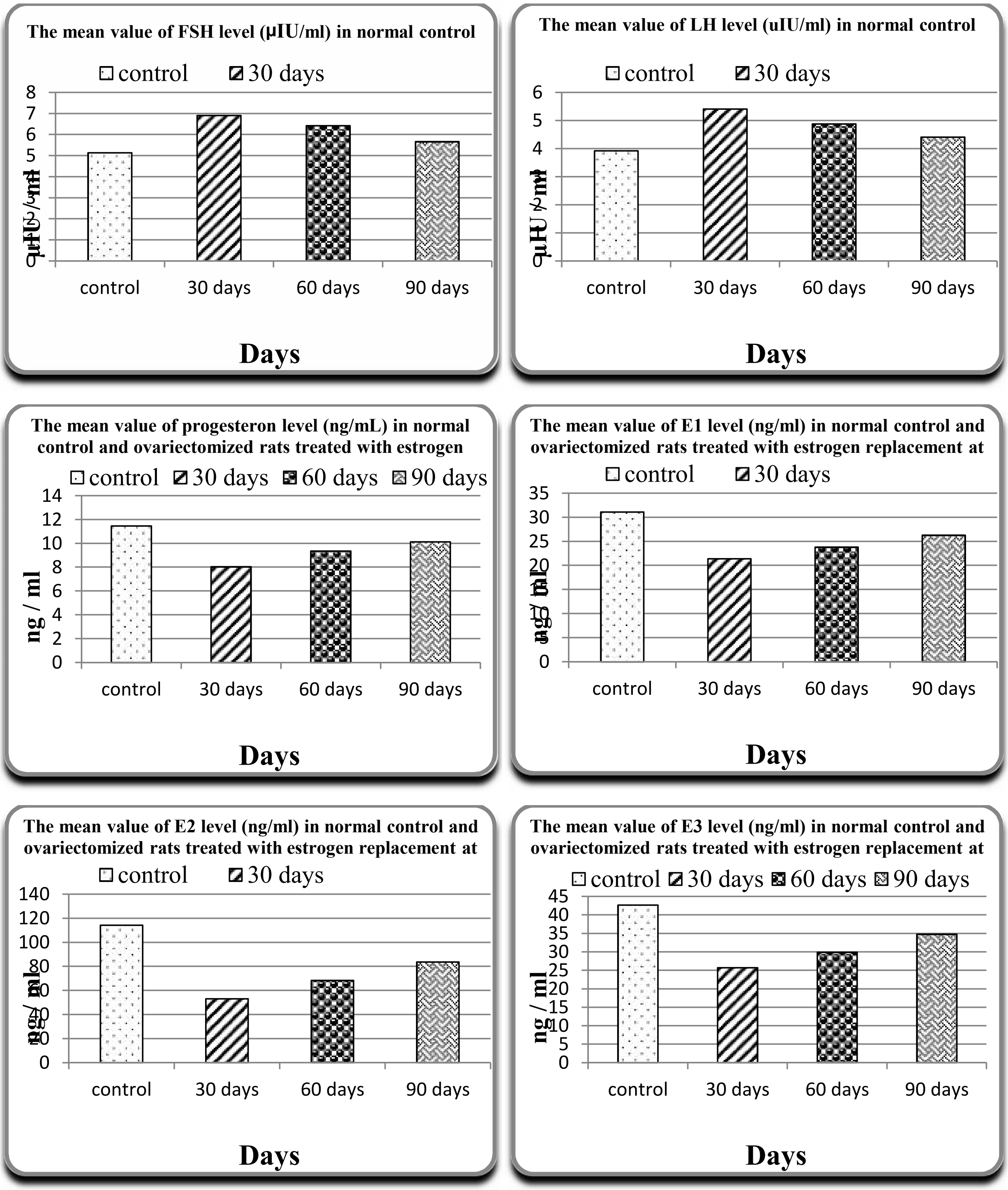

Fig. 1. The mean values of hormonal profile in normal control and ovariectomized rats treated with estrogen replacement at various time intervals

4 DISCUSSION

Osteoporosis is a disease characterized by a decrease in bone mass (osteopenia) and a deterioration in bone micro-architecture which leads to an enhanced fragility of the skeleton, and therefore to a greater risk of fracture. The study group of the World Health Organization has qualified this definition as to state osteoporosis is present when the bone mineral density or bone mineral content is over 2.5 standard deviation below the young adult reference mean. If fractures are present, the condition is known as “severe” osteoporosis [21], [22].

Following ovariectomy, rapid loss of cancellous bone mass and strength occurs, which then proceeds in a less rapid rate in a site-specific fashion to reach steady state phase of bone mass with an increase in rate of bone turnover following oophorectomy or menopause in humans. Not all cancellous bone sites in the rat exhibit such bone loss nor do all cancellous bone sites lose bone at the same rate [23].

These bone loss features mimic the bone changes. The loss of ovarian hormones causes an increase in bone turnover and results in a negative bone balance due to relatively high bone resorption rate compared to bone formation rate, which is also enhanced [24]. Several lines of evidence suggested that a high rate of bone turnover causes great loss of bone [25].

After the mild age or perhaps beginning earlier, bone loss occurs and is accentuated by estrogen deficiency. The protective role of estrogen against bone loss has been proved. FSH and LH may modulate the effect of estrogen in bone, perhaps by activating the estrogen receptor [26].

In the female, the ovaries produce two groups of steroid hormones, estrogens and progesterone. Estrogens, including estradiol, estrone, and estriol, are extremely important in the development of secondary sex characteristics and regulation of the menstrual cycle. Estrogens also influence libido and the metabolism of electrolytes and nitrogen, and help maintain pregnancy and prepare the breasts for lactation. Progesterone, which resembles estrogen chemically, helps regulate changes that occur during menstruation and influences the development of fetal membranes and mammary glands during pregnancy. Three gonadotropic hormones produced by the pituitary gland regulate the secretion of estrogens and progesterone: follicle-stimulating hormone (FSH), luteinizing hormone (LH), and prolactin [27].

In the current investigation, a significant decrease in the levels of estrogens hormones (E_1, E_2 and E_3) and progesterone was occurred in ovariectomy rats. While, a significant elevation in the levels of FSH and LH was occurred in ovariectomy rats. These results may be attributed to the disturbance in the hypothalamus-pituitary-gonadal axis (HPGA) or/ and elevation in the gene expression of insulin growth factor-1 (IGF-1), resisting and neuropeptide hormone (NPY).

This severe deficiency of circulating estradiol in the osteoporotic group may reflect the role of estradiol in regulating bone remodeling. This explanation is depending on several facts, that, estrogen is one of the hormones among several factors regulates the bone remodeling, estrogen deficiency may be an etiological agent for postmenopausal osteoporosis, and can also alter the balance of multiple growth factors and cytokines that regulate bone turnover leading to increase bone resorption than bone formation [28].

Depending on the well-known findings that postmenopausal women with higher estradiol concentrations appear to have greater bone density. Therefore, the dramatic decrease of estrogens hormones (E_1, E_2 and E_3) and progesterone in the ovariectomy rats in the current investigation may increase the risk of osteoporosis.

Hormone therapy (HT) is based on the idea that the treatment may prevent discomfort caused by diminished circulating estrogen and progesterone hormones. It involves the use of one or more of a group of medications designed to artificially boost hormone levels. The main types of hormones involved are estrogens, progesterone or progestin's. It often referred to as "treatment" rather than therapy [29], [30], [31].

The Journal of the American Medical Association and elsewhere based on these findings warn that women with normal rather than surgical menopause should take prescribed HRT treatment at the lowest feasible dose, for the shortest possible time. For health problems associated with menopause such as osteoporosis (a small percentage of postmenopausal women are at risk of severe bone loss), other life-style changes and/or medications are now recommended [32], [33].

HRT may help to prevent or delay the development of many diseases, including the following: osteoporosis, Alzheimer's disease, colon cancer, macular degeneration (the leading cause of visual impairment in persons over age 50), urinary incontinence and skin aging [34], [35].

In the second experiment of this study, the treatment of ovariectomy rats with intrascapular subcutaneous injections of 2.0 mg 17 ß-estradiol-3-benzoate for three months led to a considerable correction in all investigated parameters dependent on the time of administration.

The benefits of hormone replacement therapy include: (1) Controlling menopause symptoms, (2) Preventing heart disease, (3) Preventing osteoporosis, (4) Preventing some hard-to-detect female cancers and (5) Other good reasons. Major studies have reported that women who take estrogen after menopause experience fewer bone fractures than women who do not [34], [35].

5 CONCLUSION

In conclusion, menopause is a normal part of aging. It is not a disease or something that has to be treated. Women may decide to use menopausal hormone therapy because of its benefits, but there are also side effects and risks to consider. Two benefits of menopausal hormone therapy are treating some of the bothersome symptoms of menopause and preventing or treating osteoporosis. Hormone replacement therapy (HRT) can help protect women against osteoporosis. HRT decrease hot flashes, night sweats, decrease the development of hair on the face, a loss of muscle tone in the bladder and urethra, skin changes and improve the mode of sleeping in night.

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Impact of Dividend Policy on Shareholders' Wealth: A Study of Selected Manufacturing Industries of Pakistan

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ABSTRACT: This study examines the impact of dividend policy on shareholders' wealth in context of Pakistan. Thirty five companies randomly from three sectors; Textile, Sugar and Chemical are observed in the study. The annual data for these companies from 2006 to 2011 is used in the study. Simple OLS technique for analysis is used to derive the results of the study. The findings showed that dividend policy of the firm has significant positive impact on shareholders wealth. Similarly firm growth rate also has significant positive impact on shareholders' wealth. Firm size has significant positive impact on shareholders wealth; indicating that large domain of operations of a business make it more capable to exploit maximum opportunities and in position to earn greater amount of return due to greater growth prospects so it ultimately place greater value to shares of large size companies. The results of study help the corporate management to better decide the level of dividend to be distributed so that shareholders wealth could be maximized.

KEYWORDS: Dividend, Shareholders' wealth, Relevance theory.

INTRODUCTION

Dividend policy has the significant importance in the financial decisions of the corporation. Dividend policy is cause to increase the wealth of shareholders, finance manager make different financial decisions and dividend policy decision is one of them (Baker &Powell 1999). . Dividend decision has great impact on firm financial decision and stock price. The stock price increases when there is smooth payment of dividend exist. Investors do not prefer to purchase the shares of such type of companies which cannot make payment regularly and of which the dividend decisions have variability because of the risk of loss associated with these variations. Simians (1995) argue that shareholders' wealth is largely influenced by the organization's dividend policy. It is an approach which is used to distribute the profit back to its shareholders. If a company is in a growing stage, it may decide it will be reinvested in company's future projects rather than distributing the profit to shareholders .If a company decides to pay dividend, it must decide how much and at what rate dividend should be paid. Dividend policy plays a vitol role at company in financial markets and it directly affects the stock price of the company. If a company pays handsome return to its shareholders it will attract to the new investors to invest their money in the company and vice versa. So we can say dividend policy have a strong impact on its share price. Dividend policy is guidelines for financial managers, how to pay dividend to the shareholders either through cash dividend or through fixed percentage dividend.

The primary objective of any organization is to maximize the wealth of shareholders. Financial manager's aim is to take a decision in such a way that shareholders receive the high contribution of dividend which leads to increase the price of share. Because market price is indicator of profitability, progress and productivity, however, it is an unresolved issue whether the dividend policy has impact on its shareholders wealth.

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The literature describes that dividend policy has been a topic of discussion for many researchers and academia. Therefore, the present research study intended to analyze the impact of dividend policy on the wealth of shareholders.

THEORETICAL BACKGROUND

Dividend distribution is considered one of the strategic corporate decisions. The sudden increase or decrease in the dividend payout can affect stock price both positively and negatively (Fama et al. 1996). Further, Petit (1972) holds the similar view about the company's dividend policy and stock price reaction. In the same vein, Asquith and Mullins (1983) find that, like dividend increases, dividend initiations have a significant positive impact on shareholder wealth. Much subsequent research has focused on explaining the dividend increase induced positive stock market reaction. The predominant explanation, by far, has been the information signaling hypothesis significant impact on their wealth.

RELEVANCE THEORY

Relevance theory explains that dividend policy has significant effect on shareholders wealth as well as firms' values. If the dividend is paid on regular basis, there must be an optimum payout ratio, that ratio increase the market value of per share, Walter's model is supportive for relevant theory. Gorden & Lintner (1956-62) argue that, firstly distribution of current dividend reduce the level of uncertainty among shareholder as a result they discount the share price by lower rate thereby placing the higher value on share. Secondly the theoretical underpinning of dividend distribution impact on shareholder wealth is linked with the signaling theory.

SIGNALING THEORY

According theory of Jenson and Mekling (1976) whenever companies attempt to distribute the earnings among shareholder, information is disseminated in the market. Market price this information as good news as a result the share prices of the company climbs up.

LIFE CYCLE THEORY

The life cycle theory is also quoted as one of the clarifications for dividend payments. Mueller (1972) suggested a proper theory that a firm has a comparatively well-defined life cycle,which is important to the firm life cycle theory of dividends.The main theme of the theory is that the firms face different stages in their lives;they change their dividend policy according to the need of every stage. This theory explained that firms pay fewer dividends in growth stage as compared to their maturity stage;firms pay more dividends when there are no growth opportunities in future.

RESIDUAL THEORY

Residual theory of dividend given by Miller & Modigliani (1961) explained that if external financing for reinvestment is either not available or the external financing too costly in any profitability opportunity. If firm has better investment opportunity available for investment, so firm make investment and reduce dividend or pay no dividend at all. There is no investment opportunity for firm, so firm pays more dividends to shareholders.

PROBLEM STATEMENT

The impact of dividend policy on shareholders wealth remains controversial issue. The harder we look at the dividend picture, the more it seems like a puzzle, with pieces that just don't fit together. Previous research in context of Pakistan has been incapable to provide clear direction about dividend policy, a shift in importance is proposed. Despite the healthy body research exists, there is a lack of clarity that either dividend policy has significant impact on shareholders wealth or not.

RESEARCH QUESTION

The present study focuses ondividend policies and shareholder wealth. To achieve the objectives of the study, the researcher has adopted the following question:

Does dividend policy have an impact on shareholders wealth?

OBJECTIVES OF THE STUDY

The objectives of the study are as follow:

- To describe the concept of the dividend and its policy.
- To identify the effect of dividend policy on the shareholders wealth.

SIGNIFICANCE OF THE STUDY

This research have importance for both academicians and practitioners, dividend is the key decision at the corporate sector because this decision directly affects the business and the market value of the shares and the value creation process of the firm.

LIMITATIONS OF THE STUDY

As all research works have some limitation in one way or the other, therefore, the fundamental limitation of this research is that the study is based on secondary data. Further due to cost and time constraints the researcher limits the study to dividend policy and selected sample also.

LITERATURE REVIEW

Dividend payment policy is one of the most discussed topics and an essentialtheory of corporate finance which still has its significance. Many researchers presented numerous theories and pragmatic evidences, however the problem is quietunsettled and open for further debate. It is among the top ten unsettled issues in economic literature and one that does not have satisfactory clarification for the observed dividend behavior of the firms (Allen and Michaely, 2003; Black, 1976; Brealey and Myers, 2005). In advanced economies the stakeholders and management of the firms decides very deviously whether to pay dividends to shareholders or to retain in the business (Glen et al., 1995).

The first model about dividend adjustment was presented by Lintner in 1956. He suggests in his model that the changes in dividend are because of the dividend payout ratio of current and last year. He found that the shareholders wish to continue and return on their investment so managers tend to make partial adjustment in payment ratio instead of changes in payment.

However, the impact of dividend policy on a corporation's market value is a subject of long standing controversy. Black (1974) exemplifies the lack of consensus by stating "The harder we look at the dividend picture, the more it seems like a puzzle, with pieces that just don't fit together."

Because the academic community has been unable to provide clear guidance about dividend policy, a shift in emphasis is proposed. In the spirit of Lintner's seminal work, we asked a sample of corporate financial managers what factors they considered most important in determining their firm's dividend policy.

The academicians also engaged in finding out the facts and issues relating to dividend policy and they made different theories on this topic. There are various models presented by these researchers (Joos and Plesko 2004). They used the survey method for finding the issues and factors that have impact on such policy. On the basis of this survey they had found different views on such policy. The views of different researchers are as follows.

According to Hayn (1995), dividend payments reduce the earning of any corporation if there are low earnings are realized ,it make the decision uneven which enables managers to take strong decision for dividend and earning in future. Whereas, DeAngeb et al,1992& Charitou,2000) describe the changing in dividend policy make the managers informative about the cost of dividend payment. Spencer (1973) argues that dividends payout increases the investors' confidence in the company. Thus, the company can make future decisions of dividends payout on the basis of the past dividends policies. The study conducted by Farley and Baker (1989) suggests that dividends policy has a significant impact on stock prices. Dividend payout ratio is based on current and last year earnings, the changes in year wise earning and increasing rate of earnings. The past year dividend payments have great influence on current policy (Pruitt and Gitman 1991).

Manager tends to maintain the smoothness in such payment and they make the decisions for dividends independently from other financial decisions (Edelman 1986). The dividend payment decrease the company cash flows therefore, Easterbrook (1984) believes that due to reduction of free cash flows companies go to stock market for raising more funds.

A significant stream of prior research in the United States has empirically documented that unexpected increases (decreases) in regular cash dividends generally elicit a significantly positive (negative) stock market reaction (Fama et al; 1969 & Petit; 1972). Moreover, this finding persists even after controlling for contemporaneous earnings announcements (Aharony and Sway (1980). In the same vein, Asquith and Mullins (1983) find that, like dividend increases, dividend initiations have a significant positive impact on shareholder wealth. Much subsequent research has focused on explaining the dividend increase induced positive stock market reaction. The predominant explanation, by far, has been the information signaling hypothesis. According to Rozeff (1982) there is a negative relationship between dividend policy and stock price. Previous studies have identified major contributing factors in shareholder's wealth such as: current and past year profit, current and past year profit, year wise changing in earnings and earnings growth rate and dividend policy.

Black and Scholes (1974) state that if investors required higher returns for holding higher yield stocks, corporations would regulate their dividend policy to contain the amount of dividends payment, lower their cost of capital, and increase their share price. Similarly, if investors required a lower return on high-yield stocks, value maximizing firms would increase their dividend payouts to increase their share price. However, Black and Scholes (1974) found no statistically stead fast link between a portfolio's monthly stock return and its long-run dividend yield.

Zero yield stocks holds maximum return than paying out dividends to shareholders, however, higher yield stock realizing greater risks have lower return on investment (Blume 1980; and Keim, 1985)

Chen et al. (1990) show that tests relating returns to dividend yields are sensitive to the method of risk return adjustment. Gordon (1959, 1962) and Lintner (1962) prerogative that dividend policy does affect the shareholderswealth , and they provide some early evidence to support the view that a higher dividend payout reduces the cost of capital (i.e., investors prefer dividends). Others claim that personal and corporate taxes cause dividend policy to affect the firm's cost of capital, but the high payment of dividend raise the shareholders wealth and cost of capital (i.e., investors prefer capital gains).

Since managers have information that outside investors do not have, dividend policy is a costly to-replicate vehicle for conveying positive private information to market participants. Also, businesses consider the dividend policy obvious (Easterbrook 1984). In line with these arguments, signaling models by Bhattacharya (1979) and Miller and Rock (1985), among others, find that dividend increases convey information about the firm's current and future cash flows. In addition to supportive eventstudy results, empirical studies by Offer and Siegel (1987) and Healy and Palepu (1988) examine changes in dividend policy in relation to future earnings and related analysts forecasts, also consistent with the information-signaling hypothesis. Bernartzi and Thaler(1997) find that earnings are less likely to drop after a dividend increase; however, they do not find that dividend increases are followed by unexpected earnings increases. Their evidence is only weakly consistent with an information-signaling hypothesis. DeAngelo and Skinner (1992) find that a loss is a necessary but not a sufficient condition for a dividend cut, and that dividend cuts improve the ability of current earnings to predict future earnings. Moreover,DeAngelo, and Skinner (1992), Bernartzi, Michaely, and Thaler(1997), and Jensen and Johnson (1995) document that dividend cuts are followed by earnings increases, consistent with dividend cuts marking the end of a firm's financial decline and the beginning of its restructuring. In sum, the empirical evidence by prior research on the signaling value of dividend changes has been mixed. An alternative explanation for changes in corporate dividend policy stems from agency theory. Jensen (1986) suggests that managers, motivated by compensation and human capital considerations, have incentives to over invest free cash flows even in the absence of profitable growth opportunities (the free cash flow hypothesis). Dividend payout policy in this case becomes a vehicle for monitoring the managers' potential to misuse excess funds. Thus, the observed positive stock market reaction following dividend increase is consistent, in addition to information-signaling, with a reduction in agency costs. Lang and Lichtenberger (1989) attempt to disentangle between signaling and agency explanations by separating firms that are presumably over investing from all other value-maximizing firms. They find higher abnormal returns for over investing firms for which the agency-related benefits of a dividend payout increase are higher compared to value-maximizing firms.

Over and above, dividends policy implications on shareholders wealth carry diverse arguments from the previous researchers. One school of thought hold the notion that dividendpolicy does help maximizing the shareholders' wealth, however, the other argues that there is no such impact can be arguably supported. Therefore, the present research would identify the relationship between dividend policy and shareholder wealth in light of the previous literary studies on the basis of secondary data in non-financial organizations of Pakistan.

DATA DESCRIPTION AND METHODOLOGY

The study focuses the manufacturing sector. 35 companies randomly from three sectors namely Textile, Sugar and Chemical are observed in the study. These companies are selected on the basis of regular dividend payment pattern. Data from 2006 to 2011 for these companies is collected from balance sheet analysis of State Bank of Pakistan. Market capitalization data is collected from Business Recorder. Multiple Regressions is used to analyze the data and to get answer to the queries of the study. Following quantitative model is used for multiple regression analysis.

$$\mathbf{SHRW = \beta_1 + \beta_2 DPS + \beta_3 GRW + \beta_4 Size + U_t}$$

Where market capitalization is used as proxy for shareholders wealth (**SHRW)**, **DPS** is Dividend per Share, **Size** is measured in term of total assets and sale growth is used as proxy for measuring the growth (**GRW)**. $\mathbf{U_t}$ is there error term.

RESULTS AND DISCUSSIONS

The results of the study are arranged as follows: first tables show the descriptive statistics the second one exhibit the correlation matrix. Then the results of multivariate regression are presented.

DESCRIPTIVE STATISTICS

	DPS	GRW	SHRW	SIZE
Mean	3.287	0.315	6.839	9.577
Median	2.001	0.178	1.580	3.512
Std. Dev.	3.800	1.057	11.498	20.735
Maximum	30.000	14.803	63.519	183.004
Minimum	0.000	-0.364	0.159	0.337

Descriptive statistics during period from 2006 to 2011 of the variable used in the study are shown in above table. On average the companies under consideration of the study pay 3.287 rupees dividend per share (**DPS**). The possible deviation from average is 3.800. Companies paid 30 rupees dividend on maximum and rupees zero on minimum. The minimum figure zero basically shows the absence of dividend payment in any time period. Average market capitalization (**SHRW**) level of companies is 6.839 billion rupees and dispersion is 11.498. Average growth rate (**GRW**) of companies is 31.5 percent while dispersion from average growth rate is 105.7 percent; this is indication of high volatility of sale level in manufacturing companies under consideration. On average the level of firm **Size** is 9.557 billion rupees.

The results of correlation matrix show that level of correlation between shareholders wealth (**SHRW)** and **DPS**; between **EPS** and **GRW** and between **EPS** and size is not much significant. However positive correlation exists among variables.

CORRELATION MATRIX

	DPS	GRW	SIZE	SHRW
DPS	1			
GRW	0.066	1		
SIZE	0.076	0.104	1	
SHRW	0.188	0.094	0.381	1.000

The results of multivariate regression analysis show that (DPS) dividend payment has significant positive impact on shareholders wealth as p-value of DPS is significant as it is observed at 0.002. The coefficient of DPS shows that one percent change in dividend payment will lead to 47.6 percent change in shareholders wealth. Similarly the coefficient of growth (GRW) is also significant as p-value is 0.022; showing that growth level of company has significant positive impact on shareholders' wealth; that one percent change in growth level will result in 49.9 percent change in shareholders wealth. The size of firm has significant positive impact on shareholders' wealth as p-value is 0.001 and coefficient of size is positive indicating that size of firm has significant positive impact on shareholders' wealth. Coefficient of size (0.202) shows that one percent change in size will lead to 20.2 percent change in shareholders wealth in positive way.

MULTIVARIATE REGRESSION

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.181	0.929	3.425	0.001
DPS	0.476	0.154	3.102	0.002
GRW	0.499	0.217	2.300	0.022
SIZE	0.202	0.057	3.550	0.001
R-squared	0.173			
Adjusted R-squared	0.161			
F-statistic	14.351	Durbin-Watson stat		0.651
Prob(F-statistic)	0.000			

Explanatory power of model as depicted through R-Square (0.173); map that the studied independent variable explain almost 17 percent dynamics of shareholders' wealth. Model is good fit as p-value of F-Stat is significant.

CONCLUSION

This study provided orientation towards impact of dividend policy on shareholder wealth in scenario of Pakistan. The results of the study reveal that dividend policy of the firm has significant positive impact on shareholders wealth in context of Pakistan. So our hypothesis is accepted. Dividend payment effect is relevant to influence the shareholders wealth; current payment of dividend reduces the uncertainty of investors and they place high value on share price of the company. Similarly firm growth rate has significant positive impact on shareholders' wealth. This result also in line with the general argument and theories propositions that level of firms' growth and shareholders' wealth always move in same direction. Firm size has significant positive impact on shareholders wealth; this too is in discipline with theoretical argument as well as empirical realities. As large domain of operations of a business is in position to exploit maximum opportunities and in position to earn greater amount of return due to greater growth prospects so it ultimately place greater value to shares of large size companies.

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Impact of Leverage on Dividend Payment Behavior of Pakistani Manufacturing Firms

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ABSTRACT: This paper examines the impact of leverage on dividend payment pattern of Pakistani manufacturing firms. 44 companies from five different sectors having regular dividend payment history are included in sample. The annual data for these companies from 2006 to 2011 is used in the study. Simple OLS technique for analysis is used to derive the results of the study. The findings show that leverage has significant negative impact on dividend payment pattern of sampled firms. Dummies variable used to identify the sector specific impact of leverage on dividend payment reveal that affect of leverage on dividend distribution in sugar and textile industry behave differently as compare to other sectors. The results of study help the corporate management to better decide the level of leverage and dividend policy by highlighting the interaction between leverage and dividend payment pattern. That in turn ensures the equity market stability.

KEYWORDS: Leverage, Dividend, Profitability, Size.

1 INTRODUCTION

Dividend distribution decision is one of the fundamental components of corporate policy and has been viewed as an issue of interest in the financial literature. The discussion on this area was initiated by Miller & Modigliani (1956-61) and Gorden & Lintner (1956-62). They come up with contrary view first with relevance and later with irrelevance of dividend policy. Dividend; reward to stockholder for their investment and risk bearing, depends on various factors. Foremost of these determinants are; level of profits, financing constraints, investment opportunities, size of the firm, and pressure from shareholders and regulatory authorities. Dividend paid is the source of satisfaction to investors and way to increase their confidence on management that their resources are used economically and optimally by the directors. Almost every corporation use financial mix in its capital structure in order to coup with the growth opportunities offered by the external environment. This means that the firms finance its capital structure partly by owner and partly by debt equity. This tendency to finance the economic resources of the organization affects the corporate decisions regarding dividend policy.

Corporations usually tend to distribute low amount of dividend as retained earnings are important source of financing the economic resources of the organization (Jaaskelainen 1967). This research paper is aimed to see the impact of financial leverage on dividend payout decisions of the firms. Gitman and Zutter (11th edition) state that "financial leverage signifies the firm's ability to make potential use of fixed financial cost to magnify the impact of changes in earnings before interest and taxes on earnings per share" In simple words it illustrates that how debt financing is contributing towards the firm's profitability and ultimate dividend payout. No doubt that firm using debt financing tends to generate high profit on one hand but also subject to higher obligation to outsiders on other hand. The level of risk to which firms are exposed; with mixed capital structure is too high because there is always possibility that firm may not be in position to cover its fixed financial cost in coming future time. Afza and Mirza (2010) argued that firms' financial position and liquidity has key role for deciding on dividend level. Especially the firms which are operating in those countries where economic conditions are not certain always remain in such brackets. So every year firms set aside a part of its earning as contingency reserve to handle such situations so that firm credibility couldn't be shaken in the eyes of creditors and competitors. That's why; while making dividend payout decisions corporate management has to keep this factor under consideration along with other factors.

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1.1 SIGNIFICANCE OF STUDY

Corporation often seems much conscious while deciding about the dividend policy. As firm could not afford in long run if it distribute its maximum earnings among shareholders because it left less than required funds to make the firm able for internal financing. Further more if firm is highly leveraged then this strategy would lead to increased level of risk to cover fixed financial costs which will shake the external investor's confidence. Previous research studies have discussed in different context the dividend policy along with the different factors which could affect corporate decisions regarding dividend policy. This study is intended to specifically analyze the impact of leverage along with profitability on dividend policy in context of Pakistani Manufacturing firms. A sectoral tendency of dividend payment decision is analyzed under the influence of leverage. The study will help to understand the behavior of firm's management regarding dividend decisions under the influence of its mixed financial structure and potential of earning.

1.2 RESEARCH QUESTION

What is the relationship between leverage and dividend payout?

How level of earning effect the dividend decision of leveraged firm?

1.3 STUDY OBJECTIVES

"The Purpose of research study is to see the impact of debt financing; that if organization is going to finance its capital structure by debt equity equal to the proportion of owners' equity or by any proportion; how it will affect the corporate decision for distribution of residual earning available for the shareholder"

2 LITERATURE REVIEW

Dividend policy is the issue of interest in financial literature since many years. Much work has been done on this by many experts. Among early theories of dividend Miller and Modigliani (1956-1961) presented the roots of irrelevance of dividend policy that in perfect capital market dividend payout has to do nothing with value of firms and its shares value. They supported their argument by the fact that firm value solely depends upon earning power of its assets and risk associated. Later on Lintner (1961) and Gorden (1962) came up with the view of relevance of dividend policy. They argue that the firm's value is strongly affected by the dividend payout tendency. Their theory was based on "Bird in Hand" argument. They said that "one bird in hand is of more worth then two in bushes". That current dividend payout decreases shareholder's uncertainty and put high value on stock prices. If corporations are not inclined to build equity based fund to meet future dividend distribution and other certain overhead then they probably distribute most of their profit as dividend (Jaaskelainen 1967). Corporate dividend policy is subject to influence by many factors which managers keep in mind while labeling the dividend policy. Leverage is most dominant factor among all. Afza and Mirza (2010) concluded that the companies in which high proportion of shares are held by managers and individuals are more reluctant to pay high dividends as compared with the companies in which managerial and individual ownership is low. However, high operating cash flows increase companies' potential to pay high dividends. Large and highly leveraged firms are more reluctant to pay high dividend as compared to small and low leveraged firms, while profitability increases the companies' dividend payouts. Nissim and Ziv (2001) found that profitability is positively related to dividend payout.

John and Muthusamy (2010) inferred that Earnings per share and price earnings ratio are negatively related to dividend payout. They find that the leverage is negatively related with the corporate dividend payout. Those companies which have employed leverage in their capital structure are more conservative and maintain decreasing trend of dividend payout (Warne & Insan 2011). Malkawi (2008) concluded that more profitable firms are likely to pay higher dividend but firms' financial leverage poses negative impact on dividend payment level. Gill, Biger and Tibrewala (2010) reported Positive relation between profitability and dividend payout in service industry but in manufacturing industry profitability has negative relation with dividend payout. The further argue that dividend determinants are industry specific as reflected in our findings. Their findings also showed that there is insignificant positive relation between debt to equity ratio and dividend payout. Shah, Ullah and Hasnain (2010) argued that the presence of shareholders in board of directors direct the dividend policy in favor of shareholders. This argument is contrary to Franklin findings because influence of shareholders on BOD will make the negative impact of leverage insignificant on dividend payout. Twaijry (2007) argued that Companies' dividend payout is associated with earnings but this relation is not significant. On other hand the level of leverage is negatively related with the dividend level. Chai (2010) found that dividend policy is the function of firm size, capital structure (measured as Debt ratio) valuation and profitability. And foreign ownership has significant influence on dividend policy. Dragota and TATU (2009) inferred that dividend policy of Romanian is not much influenced by Tax regulations which mainly due to delay in implementation. Dividend payout is positively associated with the gross earning of the firms. Highly profitable firms tend to pay more dividends for shareholders satisfaction but in well developed countries firms follow low dividend payout policy (Abor & Bokpin 2010). Kim, Rhim and friesner (2007) argued that Ownership and Leverage level both affect the dividend payment positively and leverage is negatively associated with ownership. Haddad, Zorqan, Musa and Noor (2011) concluded from their study that dividend policy of Banks in Oman is subject to periodic fluctuation which is mainly due to supervision of Central Bank of Jordan to increase the capital and reserve to ensure liquidity against debt obligation and to face foreign competition. Ajmi and Hussain (2011) found the profitability is significant determinant for dividend decision reflecting positive association and leverage is not found as a determinant of dividend; the reason may be that Saudi firms usually low geared. Esteban and Perez (2001) research study comes up with results which show positive relationship between earnings and dividends such that an increase in profits enables higher payouts. They concluded that Companies while deciding dividend payout consider not only profitability but also indebtedness position, growth opportunities and asymmetry information also. Consler, Lepak and Havranek (2011) tested earning per share (EPS) and cash flow per share (CFS) in separate model and found both significantly positively associated with dividend per share (EPS). However they concluded cash flow per share is better predictor of dividend per share. Khan, Burton and Power (2011) found that in Pakistan the determinants of dividend payout levels is influenced by corporate focus on current year earnings, liquidity position and past payout pattern. Literature reviewed demonstrates that firms' dividend policy is negatively influenced by level of financial leverage. However profitability enhances the firm capacity to distribute dividend among shareholders. Highly leveraged firm usually tend to generate high profit on one hand and high risk on other hand as such organization are subject to a larger obligations to creditors. So impact of financial leverage on dividend policy is to be analyzed. This study attempted to conduct this analysis by looking into the corporate practices of dividend distribution of manufacturing concerns.

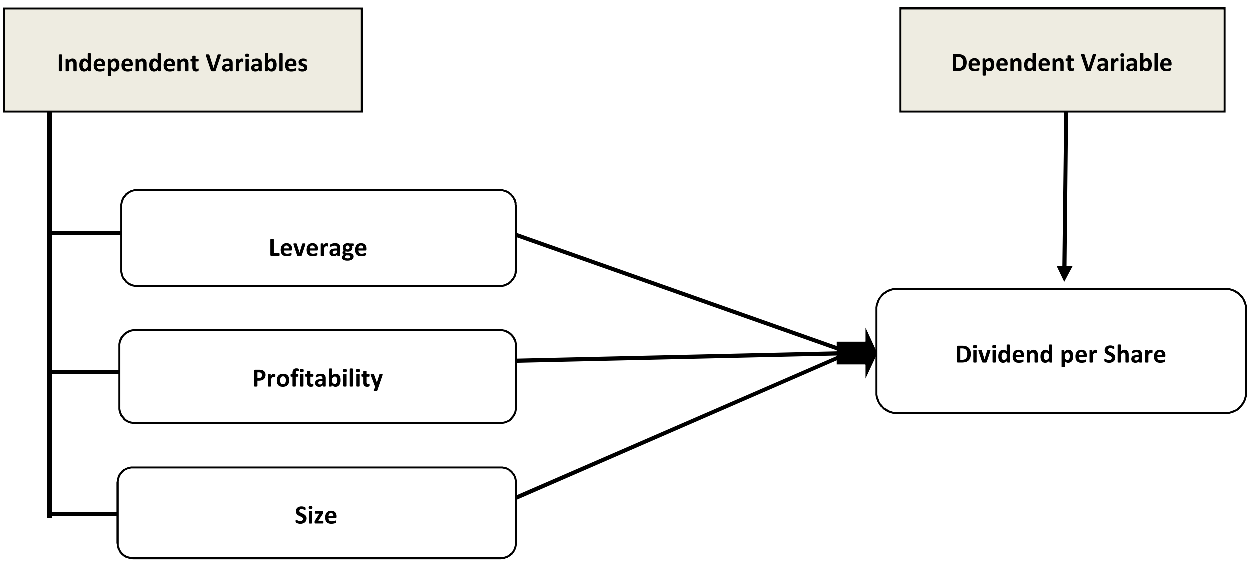
2.1 Hypothesis Statements

On the basis of literature reviewed following hypothesis are derived:

H_1: Debt employment in capital structure is negatively related with dividend per share.

H_2: Level of profitability has positive impact on dividend payment pattern.

3 Conceptual Framework



Debt to equity ratio is used as proxy to measure the level of leverage (LEV) in capital structure of firm. Earnings per share (EPS) are used as proxy for profitability. Size of firm is measured in term of total assets. Size is used as control variable in the study. Dividend per share (DPS) is observed as dependent variable of the study.

4 RESEARCH DESIGN AND METHODOLOGY

The study focuses the manufacturing sector. 44 companies from five sectors namely Textile, Sugar, Pharma and Bio Tech, Chemical and Fertilizer are observed in the study. These companies are selected on the basis of regular dividend payment pattern. Data from 2006 to 2011 for these companies is collected from balance sheet analysis of State Bank of Pakistan. Descriptive statistics are used to map the general behavior of the data. Correlation matrix is used to see the direction and intensity of relationship among variable. Then Multiple Regressions is used to analyze the data and to get answer to the queries of the study. Following quantitative model is used for multiple regression analysis.

$$\mathbf{DPS = \beta_1 + \beta_2 LEV + \beta_3 EPS + \beta_4 Size + \beta_5 \Sigma DM + U_t}$$

Where **DPS** is Dividend per Share, **LEV** is leverage measured in term of debt to equity ratio **EPS** is earning per share used to measure the level of Profitability, **Size** is measured in term of total assets and **ΣDM** are the sector dummies used to capture the sector specific behaviour of dividend payment in presence of leverage in capital structure. $\mathbf{U_t}$ is there error term

5 RESULTS AND DISCUSSION

The results of the study are presented in tables appearing below. Sequence of results presented is as follows: first tables present the descriptive statistics the second one exhibit the correlation matrix. Then the results of multivariate regression is shown; after that the result of general misspecification test is presented

Table-1

	DPS	LEV	EPS	SIZE
Mean	3.693	2.199	15.734	10.305
Median	2.500	1.400	9.015	3.465
Std. Dev.	4.033	6.755	24.973	20.664
Maximum	30.00	84.33	284.17	183.00
Minimum	0.000	0.090	-38.530	0.337
Skewness	2.427	10.94	5.821	4.899

Descriptive statistics during period from 2006 to 2011 of the variable used in the study are shown in above table. On average the companies under consideration of the study pay 3.69 rupees dividend per share (DPS). The possible deviation from average is 4.033. Maximum level of dividend paid is 30 rupees and minimum is zero. The minimum figure zero basically shows the absence of dividend payment in any time period. The average level of leverage employed in capital structure is 2.199% of owners' equity. Level of dispersion of leverage from mean is 6.75. The maximum level of leverage in capital structure of sampled firms is observed at 84.33 and minimum is 0.09. On average the level profitability remain 15.73 rupees per share. Average size of the firms sampled is 10.305 billion rupees measured in term of total assets.

The results of correlation matrix (Table-2) show that there is significant negative relationship between level of leverage and dividend per share. Firm size and level of profitability is positively correlated with dividend per share. The relationship between firm size and dividend payment is not much significant.

Table-2

	LEV	SIZE	EPS	DPS
LEV	1			
SIZE	0.054	1		
EPS	0.027	0.036	1	
DPS	-0.480	0.204	0.565	1

The result of multivariate regression (Table-3) shows that leverage employment in capital structure has significant negative impact on dividend payment behavior of a firm. The coefficient exhibits that 1 percent change in leverage lead to 3.2 percent change in dividend per share. Due to negative impact of leverage on DPS this change will be in opposite direction that increases in leverage lead to decrease in the amount of dividend payment. EPS has significant positive impact on dividend payment pattern of firm. But coefficient of size is insignificant that reveal that the size of the firm doesn't affect the dividend payment behavior of the sampled manufacturing firm.

Table-3

Variable	Coefficient	Std. Error	T-Stat	Prob.
C	4.016	0.648	6.199	0.000
LEV	-0.032	0.011	-2.808	0.005
EPS	0.098	0.010	9.931	0.000
SIZE	0.023	0.021	1.101	0.272
DM-S	-2.703	0.659	-4.103	0.000
DM-T	-3.413	0.659	-5.181	0.000
R-squared	0.504			
Adj. R-squared	0.495	Durbin-W. Stat		1.123
F-statistic	52.494		Prob	0.000

In order to capture the sector specific behavior of leverage impact on dividend payment; the sectoral dummies are used. First dummy is used for sugar sector. The result reveals that behavior of leverage impact on dividend policy in sugar industry is different as compare to other sectors. Similarly the results of textile industry show that affect of leverage on dividend payment pattern behave differently as compare to other sectors. Intercept **(C)** is significant this indicate that there are still other variables which also explain the dividend payment behavior of the firm; which are not included in the study model equation. R-square value shows that this model explains the 50.4 percent dynamics of the dividend policy of sampled firms. The value of F-Stat is significant that show model is good fit.

The results of Ramsey RESET Test (Table-4) in below table exhibit that the functional form of model equation used in the study is correct as value of both T-Stat & F-Stat is insignificant. So there is no issue of general misspecification in model equation of the study.

Table-4

	Value	Df	Probability
t-statistic	0.753	257	0.452
F-statistic	0.567	(1, 257)	0.452
Likelihood ratio	0.582	1	0.446

6 CONCLUSION

This paper provided an account of impact of leverage on dividend payment behaviour of manufacturing firm in context of Pakistan. 44 companies of five sectors are observed for the period from 2006 to 2011. The results of the study reveal that level of leverage negatively affect the dividend payment pattern in sampled firms. The results of the study are consisted with the theoretical arguments that employment of debt in capital structure increase the firms' uncertainty related to coverage of fixed financial cost. Because there may be a situation in future that firm couldn't able to cover even its fixed financing cost. So corporations always attempt to put a portion of current profit aside to play safe. This in turn curtails the firm ability to distribute the residual earnings among its shareholders. So on basis of the results of study it is suggested that corporate management should decide diligently while deciding the employment of debt in capital structure and devising the dividend policy too after financial mix has been decided. Because unrealistic leverage employment leads to increase the uncertainty of the equity holders that in turn could affect the stability of the equity market.

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Paysage agricole intensif au centre-ouest tunisien : Essai d'une gestion intégrée éco-pommoïcole à Foussana

[Intensive agricultural landscape with the Tunisian mid-west: A tentative of an integrated eco-pommoicole management into Foussana]

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ABSTRACT: In countries with arid and semi-arid climate such as Tunisia, the over-exploitation of ground water resources became intolerable, in particular that of the delegation of Foussana located in the mid-west of Tunisia, object of this study. This situation of overexploitation requires the characterization of the agricultural landscape and the characterization of water resources using a Geographical Information System SIG: ArcGis 9.3. The approach followed in this work is articulate on the installation of an agricultural and hydrological database; these plans of information were combined by methods of multicriterion analysis through the software ArcMap 9.3 to produce cards sets of themes which make it possible to describe the agricultural landscape in this area and to represent the hydrological potentialities of Foussana. Spatialization presents one of the best approaches to characterize the landscape of the area. Thus, this work enabled us to traverse the territories while revealing the wealth in water resources which present a factor supporting the differentiation of the agrarian landscapes in a typology of "rainfed agriculture" (83.4%) and of "modernized agriculture" (16.5%) requires large amounts of water. The irrigated area accounts 179.6 ha (between cultivations of cereals, arboriculture, truck farming and fodder) in 1980, to attain 4620 ha in 2010, for example the apple orchard landscape very demanding of water factor, which accounts for 50% of arboriculture sector in the study zone.

KEYWORDS: Intensive farming, water resources, hydrological potential, irrigated perimeters, apple orchards landscape.

RESUME: Dans des pays à climat aride et semi-aride tels que la Tunisie, la surexploitation des ressources en eau, est devenue intolérable pour certaines nappes notamment celle de la délégation de Foussana située au centre-ouest tunisien, objet de cette étude. Cette situation de surexploitation nécessite la caractérisation du paysage du secteur agricole de Foussana et la caractérisation des ressources en eau moyennant un Système d'Informations Géographiques SIG l'ArcGis 9,3. La démarche suivie dans ce travail s'articule sur la mise en place d'une base de données agricole et hydrologique, ces plans d'information ont été combinés par des méthodes d'analyse multicritère à travers le logiciel Arc Map 9.3 pour produire des cartes thématiques qui permettent de décrire le paysage agricole dans cette région et de représenter le potentiel hydrologique de Foussana. La spatialisation présente une meilleure approche pour caractériser le paysage de la région. Ainsi, ce travail nous a permis de parcourir les territoires tout en révélant la richesse en ressources hydriques qui présente un facteur favorisant la différenciation des paysages agraires en une typologie « agriculture pluviale » (83.4 %) et en « agriculture modernisée » (16.5 %) très consommatrice en eau. Les superficies irriguées ont évolué de 179.6 ha (entre céréalicultures, arboriculture,

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maraîchage et fourrage) en 1980 pour atteindre 4620 ha l'année 2010, un bon exemple du paysage pommoïcole très exigeant en eau, qui représente 50% du secteur arboricole de la zone d'étude.

MOTS-CLEFS: Agriculture intensive, ressources hydriques, potentiel hydrologique, périmètres irrigués, paysage pommoicole.

1 INTRODUCTION

Le paysage est tout à la fois le paysage très minéral des géographes physiciens, celui que masque le couvert végétal étudié par les écologues, et bien entendu celui auquel les hommes donnent une forme [1].

L'agriculture constitue un potentiel important sur le plan social et économique et offre une opportunité remarquable de mise en valeur d'un véritable développement durable du gouvernorat de Kasserine. On s'interrogera dans ce travail particulièrement à une typologie agraire et paysagère : le paysage pommoïcole et le paysage hydrologique de la délégation de Foussana.

La délégation de Foussana, située dans la Tunisie centrale au Gouvernorat de Kasserine, couvre une superficie de 94 454 ha, présente des ressources hydriques importantes et variées. La zone présente une partie de la sous-région des hautes steppes alfatières, le secteur agricole à Foussana se présente comme le secteur socioéconomique principal. Depuis quatre décennies, la mutation socio-économique de cette région a engendré un véritable bouleversement des groupements paysagers aussi bien dans leur nature que dans leur vocation.

Le paysage des zones d'étude se caractérise essentiellement par une structure hétérogène où alternent les cultures pérennes représentées surtout par les vergers. L'introduction de l'irrigation dans le secteur agricole au début des années 80 entraîne une réorganisation des activités agricoles et par la suite des mutations dans le secteur agricole de la région. Ce qui a induit un développement assez intéressant des pommoïcultures qui se traduit à l'heure actuelle d'une superficie des vergers des pommiers équivalente à 50% de tous le secteur fruitier de la région.

La culture des pommiers est une tradition chez les agriculteurs de Kasserine, notamment de la région de Foussana, et en 2004 la productivité a atteint 10,4 t/ha contre 5 t/ha à Kairouan et Sidi Bouzid [2]. Cette culture constitue un potentiel important et une opportunité remarquable de mise en valeur d'un véritable développement durable pour la région.

2 MATÉRIELS ET MÉTHODES

2.1. SITE D'ÉTUDE

La région de Foussana située dans le Gouvernorat de Kasserine, à l'avant pays de la chaîne alpine à l'Ouest de la Tunisie centrale au niveau de l'Atlas tunisien [3], couvre une superficie de 94 454 ha (10% de la superficie totale du Gouvernorat).

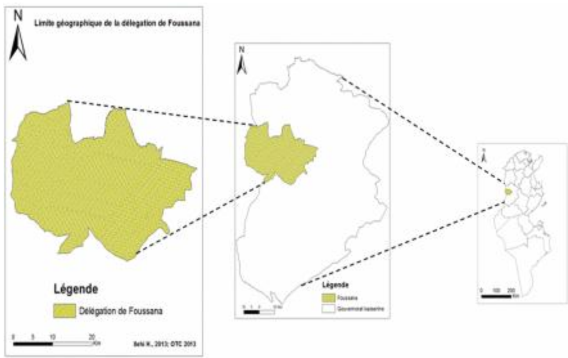

Fig. 1. Localisation géographique de la zone d'étude

Le secteur d'étude s'intègre dans les zones à climat aride à semi-aride, fortement marqué par la continentalité avec une température annuelle de 15 à 10°C et une pluviométrie annuelle moyenne de 250 à 300 mm [4]. La superficie agricole utile est évaluée à environ 82 841 ha (97,9 % de la superficie totale de la délégation) et l'arboriculture est la culture dominante.

2.2. SPATIALISATION DES DONNÉES AGRICOLES

La démarche suivie afin de caractériser le paysage agraire de la délégation de Foussana s'articule sur la mise en place d'une base de données agricole et hydrologique permettant une exploitation des données. Ce qui nécessite une compilation de ces données en utilisant des techniques de spatialisation. Moyennant l'ArcGis on a créé des cartes thématiques utiles pour caractériser le paysage agricole et hydrique de la région d'étude, et moyennant leur base des données on a essayé d'analyser et évaluer de manière explicite les paramètres naturels de Foussana.

Pour aboutir aux résultats prévus, Nous avons recours à la carte d'occupation du sol du Gouvernorat de Kasserine conçue en mai 2004 à l'échelle 1/50 000 (M.A), un logiciel SIG (Arc Gis version 9.3) est utilisé, aussi des statistiques du Ministère d'agriculture, et on a recours aux statistiques de l'institut national météorologique.

Et dans le but de valoriser ce paysage, on a eu recours à la méthode de cotation de Neuray (Toussaint, 2008 modifiée).

2.2. APPLICATION DE LA MÉTHODE DE COTATION DE NEURAY : CAS DES PAYSAGES AGRICOLES À FOUSSANA

L'application de la méthode de cotation de Neuray nous permet d'évaluer le paysage agraire à la délégation de Foussana et de suivre son évolution qui résulte des interactions naturelles et anthropiques.

Dans le but de la détermination de la valeur paysagère par la méthode de COTATION DE NEURAY on a fait une sortie dans la zone d'étude (zone rurale à Foussana). On a choisi deux points d'observation ; une du côté Nord, et l'autre du côté Sud.

Les coordonnées géographiques N et E prises par le GPS pour chaque point d'observation sont transformés en cordonnées métriques moyennant un logiciel **«** GEOCALC **»**, puis projetés sur la carte topographique numérisée de la zone d'étude pour calculer la longueur de vue exacte.

La méthode de cotation ne fournit que des valeurs paysagères ; elle repose sur une analyse des vues prises aux endroits sensibles. Elle donne à la fois une valeur globale du paysage et une évaluation séparée des différents éléments importants. La méthode tient compte du principe de RECIPROCITÉ (si je vois je suis vu) [5].

- A chaque point de vue on détermine plusieurs données :
- La longueur, l'orientation et la largeur de la vue,
- Les dimensions verticales de la vue,
- Les facteurs de valorisation,
- La valeur de la base de la vue.

La valeur de base de la vue est calculée selon la formule suivante : **V = L x R x S**. Cette valeur de base de la vue représente une situation actuelle du paysage perçu à partir d'un point de vue (tableau 1). La cotation de la somme de la valeur des éléments ajoutée à la valeur de base donne la valeur totale de la vue selon la formule : **V' = V + ∑e = L x R x S + ∑e**. La somme des valeurs des éléments tient compte de leur nature.

Situation et groupements paysagers de la zone d'étude

Le périmètre d'étude qui englobe la zone agricole appartenant au périmètre irrigué à la région de Foussana occupe un secteur compris dans un quadrilatère aux coordonnées suivantes : 35° Latitude Nord - 35° 23' Latitude Nord.

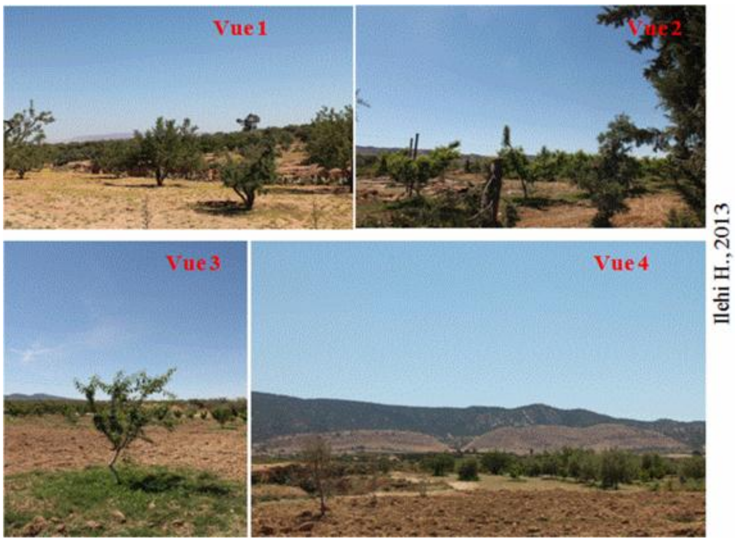

Fig. 4. Les sites d'observation du paysage agricole à la région de Foussana

Sur le plan topographique, ce périmètre est assez homogène sur toute son étendue. Il présente une uniformité d'ensemble où le pendage est relativement faible compris de 0 à 5 %.

Tableau 1. Caractéristiques des points de vue- Features views

Points de vue / Caractéristiques	Site : Foussana			
	Station 1	Station 2	Station 3	Station 4
Direction de la vue	Sud	Sud	Nord	Nord
Longueur de la vue (l) (ha)	95	75	110	140
Angle visuel des dimensions verticales (°C) α	6	5	15	10
β	32	20	25	24
Γ	35	30	31	28
Dénivellation perçue (D) (m)	06	00	04	05

3 RÉSULTATS

3.1 ANALYSE DES PAYSAGES AGRICOLES

L'analyse de la base des données de la carte de végétation de Foussana nous a conduit à rétablir le tableau suivant :

Tableau 2. Secteur arboricole entre l'irrigué et le pluvial à Foussana

Occupation	Cultures irriguées	Cultures pluviales	Total
Olivier	5 910 ha	1 890 ha	7 800 ha
Arboriculture fruitière	2 200 ha	7 800 ha	10 000 ha

- Les vergers d'arboricultures fruitières occupent une superficie de 10 000 ha, c'est-à-dire 33.87% des terres arboricoles.
- Les vergers d'arboriculture fruitière pluviale occupent 7 800 ha, c'est-à-dire 78% des terres arboricoles.

9690 ha des terres arboricoles sont conduits en irriguer, l'oléiculture en irriguer occupe 1890 ha (19.5 % des terres arboricoles irriguées) (tableau 2).

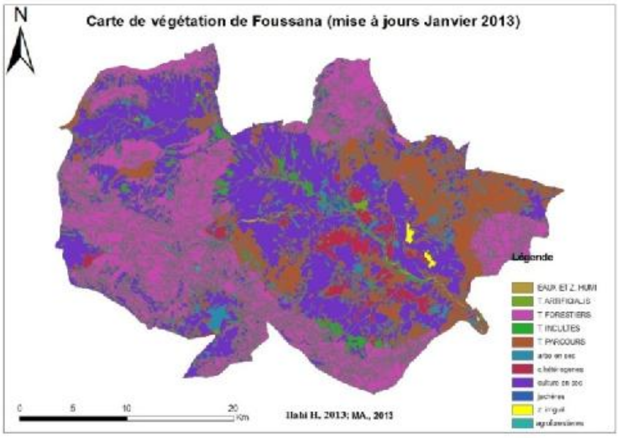

Fig. 2. Carte de végétation de la délégation de Foussana

3.2 LE SECTEUR AGRICOLE EN IRRIGUER A FOUSSANA

L'analyse de la base des données de la carte des sources du périmètre irrigué à Foussana montre que ces périmètres s'étalent sur une superficie de 4 680 ha dont 640 ha sont des zones publiques irriguées.

Les agriculteurs afin d'irriguer leurs exploitations ont recours à l'installation des puits de surface, des puits profonds et à l'utilisation des eaux de ruissellement. On constate que 2 050 ha des superficies sont irrigués moyennant 463 puits profonds, 1088 puits de surface équipés pour l'irrigation de 2 150 ha, 549 ha sont irrigués en utilisant les eaux des oueds.

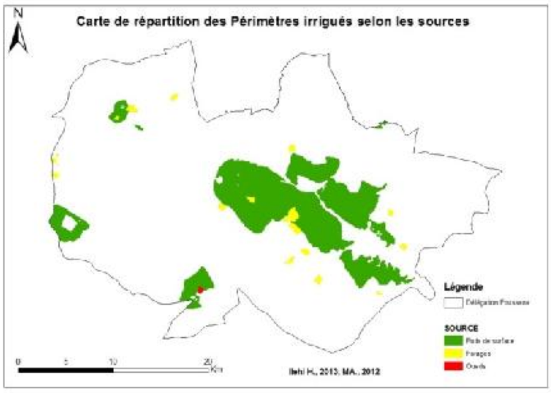

Fig. 3. Carte de répartition des périmètres irrigués selon les sources d'irrigation

3.3 L'ARBORICULTURE FRUITIERE A FOUSSANA

L'article L'analyse de la carte des activités agricoles montre que le secteur d'arboriculture fruitière est le second secteur agricole dans la région d'étude après les grandes cultures qui occupent 11710 ha c'est-à-dire 39.6% des superficies agricoles utiles.

La base des données de la carte du secteur arboricole montre que :

- le secteur des arbres fruitiers conduits en irriguer occupe 2200 ha c'est-à-dire 47 % des terres appartenant aux périmètres irrigués,
- l'arboriculture pluviale occupe 7800 ha dont 5910 ha sont des oliviers,
- la culture de figue de Barbarie occupe 18000 ha,

- les vergers arboricoles en intercalaire avec des cultures maraîchères et/ou fourragères occupent une superficie de 737 ha ce qui est équivalent à 15,7% des terres agricoles irriguées.

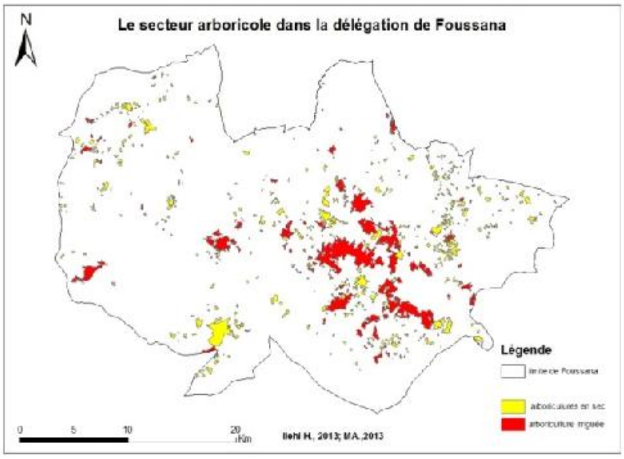

Figure 4. Carte des vergers d'arboriculture fruitière de la délégation de Foussana

3.4 PAYSAGE POMMOÏCOLE

L'analyse de la base des données de la carte de localisation des vergers d'arboriculture fruitière à la délégation de Foussana montre les résultats suivants:

- 22 % des exploitations arboricoles sont des exploitations conduites en irriguer,
- 50 % des vergers arboricoles sont des vergers de pomiculture,
- la culture des pommiers occupe 1100 ha (23,5 % des terres appartenant aux périmètres irrigués) (Figure 5).

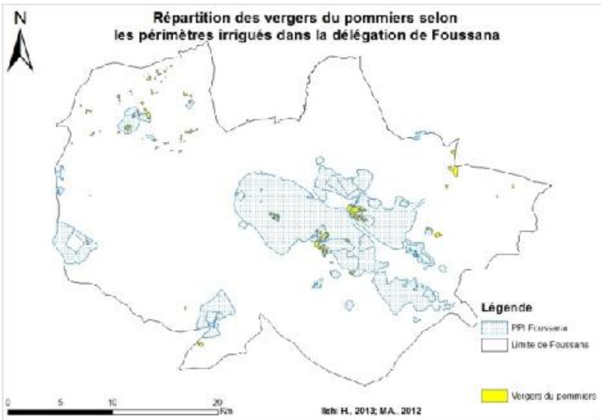

Fig. 5. Carte de répartition des vergers pommoïcoles dans les périmètres irrigués dans la délégation de Foussana

3.5 PAYSAGE HYDROLOGIQUE DE LA REGION DE FOUSSANA

La lecture de la carte des ressources hydriques reflète l'abondance des ressources souterraines et des ressources superficielles à la région de Foussana.

Les ressources souterraines se marquent par la présence des nappes phréatiques et des nappes profondes, les ressources superficielles se présentent essentiellement par le réseau hydrographique composé par un ensemble des oueds et des affluents, le principal Oued dans la région c'est Oued Hatob.

Le bassin versant de Foussana fait partie du grand ensemble hydrologique d'Oued Zroud.

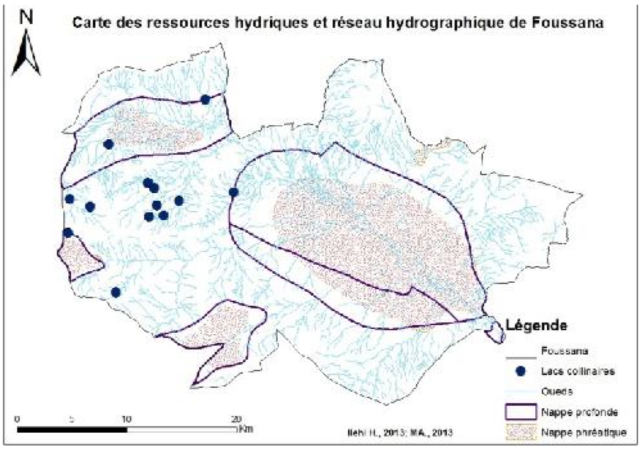

Figure 6. Carte des ressources hydriques et réseau hydrographique

3.6 EVOLUTION DU SECTEUR IRRIGUE A LA DELEGATION DE FOUSSANA

La base des données de la carte d'installation des périmètres irrigués montre que les premiers périmètres installés étaient dans les années 1980 :

- Périmètre Foussana 4-5 d'une superficie de 138.6 ha,
- Périmètre Foussana 6 d'une superficie égale à 40 ha.

Ces deux périmètres représentent les seuls lieux où on trouve de l'agriculture irriguée durant ces années ; et par la suite il y avait l'installation du périmètre Foussana 11-15 en 1985 pour augmenter la superficie agricole irriguée de 81 ha. On ne trouve pas des périmètres irrigués privés durant les années 1980.

Le dernier périmètre était installé pendant l'année 2005 pour une superficie de 35 ha ; pour atteindre ainsi une superficie de 638.7 ha. En associant la superficie des périmètres publics avec celle des périmètres privés on atteint une superficie irriguée de 4680 ha pour l'année 2012.

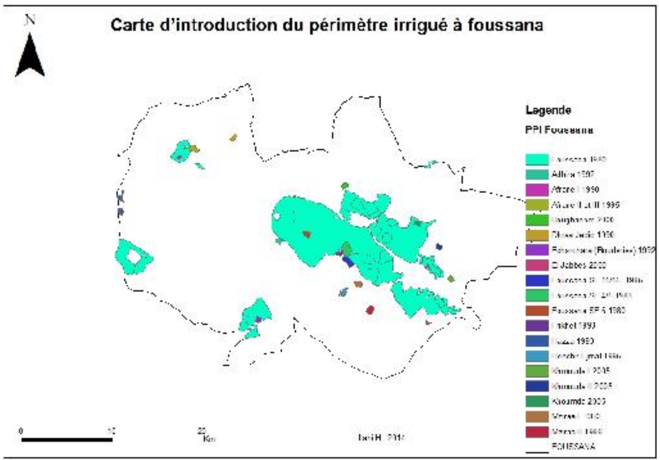

Figure 7. Carte d'installation des périmètres irrigués

3.7 GESTION DES RESSOURCES EN EAU A FOUSSANA

Pour explorer les ressources en eaux superficielles et souterraines à la délégation de Foussana, l'implantation des installations hydrauliques s'avère nécessaire, dans cette délégation se trouvent 337 forages, 1000 puits de surface, 15 lacs collinaires et 6 barrages.

Le bassin de Foussana présente une superficie de l'ordre de 1350 Km^2. La base des données de la carte des installations hydrauliques, montre une présence très nette des forages et des puits de surface dans la zone du bassin versant.

Oued Hatob est alimenté par le bassin de Foussana : l'amont de ce bassin versant est drainé essentiellement par cet oued qui s'écoule le long de l'axe de la cuvette de Foussana et débouche dans la plaine de Kairouan.

On remarque aussi que la répartition des installations hydrauliques est mal placée de part et d'autre de l'axe de la cuvette.

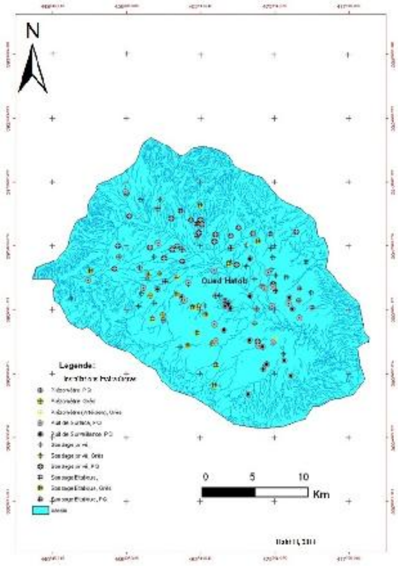

Fig. 8. Carte des installations hydrauliques dans le bassin versant de Foussana

3.8 VALORISATION DE PAYSAGE POMMOÏCOLE A LA DELEGATION DE FOUSSANA PAR LA METHODE DE COTATION PAYSAGERE

Pour les vues choisies dans les deux sites d'étude (Sbiba et Foussana), la méthode nous donne les résultats suivants :

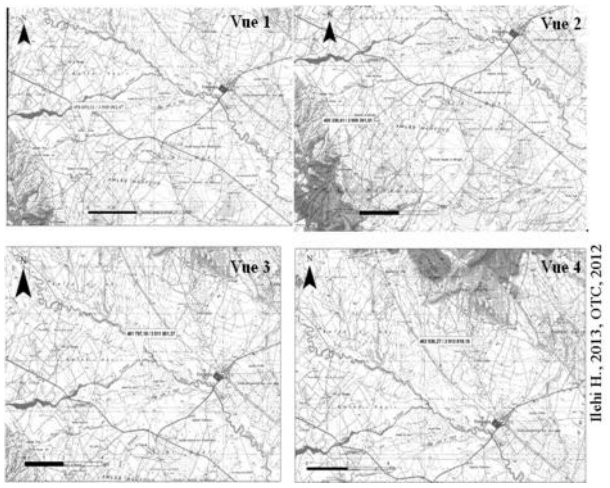

Figure 6. Coordonnées métriques des sites d'observation sur la carte topographique de la région de Foussana

Les résultats des calculs des valeurs des quatre vues pour chaque site sont consignés sur le tableau 2. Ils englobent aussi bien la valeur de base de la vue (V) et la valeur totale de la vue (V') calculée à partir de la valeur de base de la vue à laquelle est ajoutée la somme de la valeur des éléments (Σe).

Tableau 3. Valeur des vues

Points d'observation	Site : Foussana			
	Station 1	Station 2	Station 3	Station 4
Direction de la vue	Sud	Nord	Nord	Sud
Valeur de base des vues	86.31	73.76	57.86	79.18
Valeur des vues	89.31	76.76	59.86	81.18

De ce tableau, il ressort que les valeurs des vues ayant la direction Nord sont les plus faibles. Par contre celles qui ont une direction Sud enregistrent les plus fortes valeurs. Les vues enregistrent des valeurs de vue égales ou inférieures à celles des valeurs de base de vue.

Celles qui ont une direction Sud ont subi soit une augmentation ou ils ont stagné à la valeur de base. L'évolution positive a été constatée dans les stations 1 et 2.

4 DISCUSSION

Les résultats obtenus nous renseignent sur une forte richesse paysagère sur les plans agricole qu'hydrologique :

Les résultats nous renseignent sur une activité agricole en développement, surtout pour le secteur pommoïcole; le secteur agricole irrigué se développe depuis les années 1980, on a remarqué l'implantation de plus en plus importante des périmètres irrigués, pour aboutir nos jours à un paysage agricole dépendant du facteur eau. Ce qui influe puissamment les ressources en eau de la région.

La caractérisation de secteur hydrique à Foussana montre que la zone est riche en ressources hydriques (superficielle et souterraine), en revanche il existe une surexploitation qui se traduit par une implantation excessive des forages ; puits de surface et puits profonds ce qui induit une mauvaise gestion de ces ressources.

L'étude d'un cas de paysage pommoïcole moyennant la méthode de cotation de Neuray à Foussana nous indique la valeur paysagère élevée du site étudié, la valeur calculée favorise le choix de conserver et d'améliorer l'espace agraire de la région.

La lecture paysagère nous montre que ces paysages agricoles ont subi une dévalorisation par la présence des éléments dévalorisants. Cette dévalorisation accrue de l'environnement visuel est la conséquence de l'implantation désordonnée des éléments artificialisés tels que les pylônes électriques et les constructions anarchiques qui ont dégradé le paysage qui était initialement ruralisé et bien structuré qui était facilement saisissable visuellement [6], [7].

Les plus fortes valeurs enregistrées sont obtenues grâce à l'absence de tous éléments artificiels et à la présence d'éléments valorisants qui s'intègrent harmonieusement dans le paysage (point d'eau, végétation). La présence des points d'eau permet aux agriculteurs de mieux valoriser leurs terrains agricoles et l'absence des éléments artificiels montrent la forte relation entre les propriétaires et leurs terres agricoles.

Le travail que nous avons réalisé est en soi une nouvelle expérience et un exemple à suivre dans le domaine de la gestion de l'espace par tous ceux qui ont en charge la politique de l'aménagement du territoire. En effet, l'estimation quantitative des groupements paysagers agricoles de Foussana répond à des questions précises et réalisables sur le terrain sur une éventuelle valorisation des champs visuels et sur les séquences paysagères de l'Est à l'Ouest du gouvernorat du Kasserine. Les fortes valeurs des vues peuvent aider à orienter les décisions d'implantation des nouveaux projets vers ces zones.

5 CONCLUSION

L'analyse du paysage participe de l'étude prospective : elle permet de juger les répercussions de mesures de politique agricole, influençant la production, sur le territoire [8], et l'exploitation de ces ressources.

Tout d'abord, notre analyse nous a permis de montrer la diversité dans l'extension spatiale des actions, en outre, elle nous a également amené à souligner l'importance de la biodiversité végétale dans le paysage agricole. Il s'est avéré que, bien souvent, les actions anthropiques non labellisées 'paysage' avaient un impact réel sur la matérialité du paysage, souvent même plus conséquent que les actions dites 'paysagère'.

Le paysage constitue un moyen de communiquer sur le rôle de l'activité agricole au sein de la société [9].

La valorisation et l'insertion des territoires naturels dans des projets de développement durable demandent, tout d'abord, une reconnaissance des processus de changement et d'évolution de ce type d'espace. Ceci implique la prise en compte de ses valeurs économiques, sociales et spatiales par une gouvernance territoriale appropriée.

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Review of Performance of Rectangular Fins under Natural Convection at Different Orientation of Heat Sink

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ABSTRACT: Among heat transfer augmentation techniques, passive cooling technique found more suitable for electronic cooling than active technique. In this paper, natural convection heat transfer analysis through rectangular fins is reviewed. Various experimental studies have been made to investigate effect of fin height, fin spacing, fin length and fin thickness over convective heat transfer. Effects of thermodynamic properties like heat input, base-to-ambient temperature difference are also studied by many researchers. Some investigators make known sets of correlations screening the relation between various parameters of heat sink. Experiments are taken by some researchers for upward and downward facing rectangular fins. Also, trivial investigation has been carried out for different angle of inclination of the heat sink. The sensitivity of inclination over geometric parameters found to be great importance.

KEYWORDS: rectangular fins, convective heat transfer, heat sink, angle of inclination.

INTRODUCTION

Many engineering systems during their operation generate heat. If this generated heat is not dissipated rapidly to its surrounding atmosphere, this may cause rise in temperature of the system components [8]. This by-product cause serious overheating problems in system and leads to system failure, so the generated heat within the system must be rejected to its surrounding to maintain the system at recommended temperature for its efficient working. The techniques used in the cooling of high power density electronic devices vary widely, depending on the application and the required cooling capacity. The heat generated by the electronic components has to pass through a complex network of thermal resistances to the environment.

COOLING TECHNIQUES

Passive cooling methods are widely preferred for electronic and power electronic devices since they provide low-price, noiseless, and trouble free solutions. Some passive cooling techniques include: heat pipes, natural convection air cooling, and thermal storage using phase change materials (PCM). Using fins is one of the most inexpensive and common ways to dissipate unwanted heat and it has been successfully used for many engineering applications. Fins come in various shapes; such as rectangular, circular, pin fin rectangular, pin fin triangular, etc., see fig. 1-1, depending on the application. Rectangular fins are the most popular fin type because of their low production costs and high thermal effectiveness [5]. Configurations of rectangular fins protruding from rectangular bases are popular because they offer an economical, trouble-free solution to the problem [4]. Heat sinks with rectangular fin geometry have been used for both forced and natural convection. In the case of forced convection, the geometric parameters of a heat sink highly depend on the remaining components of the cooling system, such as the fan and the enclosure; therefore, the optimal values of these parameters depend on the considered application. In contrast, in natural convection, it is possible to optimize the parameters of the heat sink geometry in an application independent manner. Thus, study and selection of heat sink geometry viz. fin length, fin height, fin spacing, angle of inclination found to be essential.

Fig. 1.1 Types of fins

REVIEW OF PREVIOUS WORK

Wide review has been made in this paper initiating from pioneering experimental work by Starner and McManus [1]. They presented natural convection heat transfer performance data for four large rectangular fin arrays with the base vertically, at 45° and horizontally oriented. The range of geometric parameter variation was limited to inter-fin separation distances (S) of 6.35 or 7.95 mm, and fin heights (H) of 6.35, 12.70, 25.40, or 38.10 mm. Parameters kept constant were the fin length (L), thickness (t), and the width of the base plate (W). Only one base-plate width to the fin length ratio, W/L=0.5 (W=127 mm and L=254 mm), was employed. They concluded that relative to the horizontally based, the use of the vertically based orientation is the most favorable system for achieving high heat-transfer rates for arrays of the same geometric dimensions and power input. F. Harahap, Daru Setio [2] studied experimental data for heat dissipation from five duralumin horizontally oriented fin array. Effect of fin length and optimal inter-fin distance was investigated. Thus, two sets of correlation was developed showing fin length and optimum fin spacing as prime function of thermal performance of heat sink. F. Harahap, H. Lesmana [3] studied heat dissipation from miniaturized vertical rectangular fin arrays. Experiment was conducted under steady state heat dissipation and dominant natural convection condition for 3mm and 11mm fin spacing. They concluded that effect of the parameter W/L on heat dissipation rate is relatively less for the vertically base array. Also, higher heat dissipation rate was observed for non-square base, same base area and orientation with fins parallel to short side of the base plate than fin parallel to longer side (W/L≤1) of the base. B. Yazicioglu, H. Yuncu [4] performed experiments over thirty different fin configurations with 250 and 340 mm fin length. Optimum fin spacing of aluminum rectangular fins on vertical base was examined. The range of base-to-ambient temperature was kept quiet wide from 30 to 150K for fin height and fin spacing from 5 to 25mm and 4.5 to 85.5 mm, respectively. It was found that optimum fin spacing varies for each fin height which is between 6.1 and 11.9mm. They developed Eq.1 to evaluate the optimum fin spacing value and corresponding maximum heat transfer rate at given fin length and base-to-ambient temperature difference for vertical base fin array. They commented that the larger fin height results in higher convective heat transfer from fin array but for low base-to-ambient temperature difference it was insignificant. H. Yuncu, G. Anbar [5] investigated natural convection heat transfer for 15 sets of rectangular fin array with horizontal base. Fin spacing and fin height was varied from 6mm to 26mm and 6.2 to 83mm, respectively, meanwhile fin length and fin thickness was kept constant at 100 and 3mm, respectively. They concluded that fin spacing to fin height ratio is strong factor influence for convective heat transfer. They commented that optimum fin spacing is not dependent on temperature difference but it decreases with increase in fin height. For fin height 16 and 26mm, optimum fin spacing found 11.6 and 10.4mm, respectively. Eq.2 shows a correlation presenting relation between enhancement of heat transfer from fin array with fin spacing, fin height and number of fins. S. Baskaya, M. Sivrioglu, M. Ozek [6] analyzed parametric effect of horizontally oriented fin array over natural convection heat transfer. They stated that to obtain optimum performance in terms of overall heat transfer, interaction of all design parameters must be considered. They found that optimum fin spacing for L=127mm and L=154mm are S_{opt}=6 and 7mm, respectively. Q/A_b values found reduced with increase in fin length since flow pattern changes from single chimney to multiple chimney flow. L. Dialameh, M. Yaghoubi, O. Abouali [7] studied 128 fin geometries with short length and thick fins. Aluminum rectangular fins of 3mm< t < 7mm with length L≤ 50mm were tested. They illustrated two type of flow pattern in channel. They concluded that for maximum heat transfer, optimum value of fin spacing S_{opt}=7 for fin arrays with H/L≤0.24. They commented that for fin arrays with H/L>0.24 and S/L<0.2, air enters from the fin end region while another range, air enters from middle parts of fin. H. M. Mobedi, H. Yuncu [8] numerically studied steady state natural convection heat transfer from short fin array for Rayleigh number ranging from 120 to 39000. They concluded that H/L ratio is governing parameter for fluid field and flow pattern. Furthermore, for H/L≤0.25 and S≥10mm, flow field is up and down type flow pattern. For wide range of angle of inclination of heat sink was tested by Ilker Tari, Mehdi Mehrtash [9, 10, 11] with upward and downward orientations. By modifying Grashof number with cosine of inclination angle, they suggest the modified correlation given by Eq.3 which is best suited for inclination angle interval of $-60^\circ \le \theta \le +80^\circ$. Combined convection and radiation analysis have been done by V. Dharma Rao, et.al. [14].

Experiments were conducted for horizontal fins over vertical base. Natural convection and radiation heat transfer from a vertical base and horizontal fins in a fin array was theoretically formulated. Vinod Wankar, S.G.Taji [15] investigate flow pattern through rectangular fin under natural convection. Nusselt number for 10mm fin spacing was 58.35. The highest value of h_a is 5.7929 W/m^2 K at the spacing of 12 mm. Maximum value of Nu_L for fin spacing 10mm was found 58.35. Effect of orientation of fins was tested by Saad M. J. Al-Azawi [16]. They performed experiments for trapezoidal fins maintaining Rayleigh number ranging from 1400 to 3900. Sideward and upward orientation was kept with horizontal and vertical fins. Sideward horizontally oriented fins had lowest heat transfer coefficient. The heat transfer coefficient of the upward orientation is less than that is for sideward orientation by 12%. A correlation was found for vertically oriented sideward fin array, given by Eq.4. Enhancement in natural convection heat transfer was studied for circular perforations to rectangular fins by Wadhah Hussein Abdul Razzaq Al- Doori [17]. They concluded that Heat transfer coefficient for perforated fin that contained a larger number of perforations higher than the perforated fin that contained a small number of perforations. Vertical base plate was tested by Mahdi Fahiminia et.al [18] under natural convection to determine heat transfer coefficient. Different configuration of the rectangular fins was tested, keeping vertical base of fin array. Experimentation was carried out for fixed value of fin length, fin height, fin width. They found that optimum fin spacing value decreases from 6.42mm to 5.84mm with increase in base-to-ambient temperature difference. The CFD simulations were carried out using fluent software. Micro-fin geometry was tested under natural convection by S. Mahmoud [19]. Copper heat sink was kept horizontally oriented to determine effect of micro fin height and fin spacing keeping fin height ranging from 0.25 to 1.0 mm and fin spacing from 0.5 to 1.0 mm, respectively. The highest value for convective heat transfer coefficient of was recorded at the lowest fin height of 0.25 mm and spacing of 1.0 mm. Notched fin arrays were tested by S.S. Sane, N. K. Sane and G.V.Parishwad [20].They found 41.82% enhancement in heat dissipation through notch fins. Fluent software was used for computational fluid dynamic analysis. Study on effect of inclination of base on heat transfer has been made by S. V. Naidu, V. Dharma Rao et.al [21]. Five different inclination angles 0°, 30°, 45°, 60°,90° were selected. Heat dissipation was analyzed for natural convection by Shivdas S. Kharche, Hemant S. Farkade [22]. Moreover notches of different geometrical shapes have also been analyzed. Copper fin for greater heat transfer rate was chosen for analysis. They found that the average heat transfer coefficient for without notched fin is 8.3887 W/m^{2}K and for 20% notched fins it is 9.8139 W/m^{2}K. A correlation was developed to investigate optimum fin spacing of vertically based rectangular fin arrays by Burak Yazicioğlu and Hafit Yüncü [23]. The average relative improvements in convection heat transfer rates from identically spaced fin arrays for fin heights of 5, 15 and 25 mm are 37.44 %, 39.01 % and 41.28 %, respectively. Experiential analysis of natural convection heat transfer from horizontal rectangular notched fin arrays was studied by Suneeta Sane and Gajanan Parishwad [24]. The performance of notched fin arrays is 30 to 50% superior to corresponding unnotched arrays. They commented that to investigate further the optimization of all geometrical parameters viz. aspect ratio of the fin array will be interesting. Effect of angle of inclination of permeable fins for natural convection was studied. U. V. Awasarmol, A. T. Pise [25] analyzed comparative effect of rate of heat transfer with solid and permeable fins and the effect of angle of inclination of fins. It was found that using permeable fins, heat transfer rate is improved and convective heat transfer coefficient increases by about 20% as compared to solid fins with reduction of cost of the material 30%. The sink was made incline with 0°, 15°, 30°, 45°, 60°, 75°, and 90°from horizontal. Burak Yazicioğlu [26] conducted the heat transfer performance of rectangular fins on a vertical base in free convection heat transfer. 30 fin configurations were tested. An optimum fin spacing value which maximizes the convective heat transfer rate from the fin array is made available for every fin height. The average relative improvements in the rates of convection heat transfer from identically spaced fin arrays for fin heights of 5 mm, 15 mm and 25 mm are 37.44 %, 39.01 % and 41.28 %, respectively. It is observed that the optimum fin spacing varies between 8.8 mm and 14.7 mm. Their conclusion reveals that the optimum fin spacing is sensitive to the variations in fin height, fin length and base-to-ambient temperature difference parameters. Kamil Mert Çakar [27] found optimum fin spacing from both numerically and experimentally studies. Natural convection from vertically placed rectangular fins is investigated numerically by means of a commercial CFD program called ICEPAK. They observed that convection heat transfer rate from fins increases with fin height for given fin spacing. They experimentally concluded that optimum fin spacing value for vertical fin arrays is approximately 10 mm and suggest a correlation for optimum fin spacing, by Eq.5. Investigation has been done for external natural convection heat transfer from vertically-mounted twelve rectangular interrupted fin arrays by Golnoosh Mostafavi [28]. A two-dimensional numerical model for investigation of fin interruption effects was developed by using FLUENT and COMSOL. The result showed that interrupted fins not only reduces weight of heat sink but also increases thermal performance. The optimum interruption length for maximum fin array thermal performance was found and a compact relationship for the Nusselt number based on geometrical parameters for interrupted walls was presented. They declared that the purpose of these interruptions was to reset the thermal boundary layer associated with the fin in order to decrease thermal resistance. The effect that reduction of the base-plate dimensions as on the steady-state performance of the rate of natural convection heat transfer was investigated by Filino Harahap, et.al [29]. They found results that shown a reduction in the base-plate area by 74 percent increased natural convection coefficient by 1.5 times to 26.0 Wm^{-2} K^{-1} for single fin system and by 1.8 times to 18 W m^{-2} K^{-1} for fin arrays. It was found that increasing the H/L ratio by reducing the base-plate area through reducing L under conditions of constant H, S, and n, has the effect of increasing the average natural convection coefficient of fin arrays. They suggested that the fin length *L* and the number of fins *n* are prime geometric variables. Fractile geometries, which have significant gains in available surface area without affecting fin volume, was studied experimentally by Daniel Dannelley [30] for his dissertation of the degree of Doctor of Philosophy. He observed that fractal-like fins could results in increased fin effectiveness per unit mass by as much as 59%.

$$\frac{S_{opt}}{L} = 3.94 Ra_L \qquad (1)$$

$$\frac{Q_{fc}}{Q_{pc}} = e^{[1.336(1^{-0.013n})\frac{H}{S}]} \qquad (2)$$

$$\frac{Q_c}{kH\Delta T(W/L)} |H/L]^{032} = 1.24\ (Ra \cos\theta)^{0385} \qquad (3)$$

$$Nu = 1.911\ Ra^{0.31} \text{ for } 1663<Ra<3540 \qquad (4)$$

$$\frac{S_{opt}}{L} = 3.059(Ra_L^{-0236} \qquad (5)$$

Table 1 Range of geometrical parameter

Reference No.	Fin Length (L)	Base width (W)	Fin Height (H)	Fin Thickness (t)	Fin Spacing (S)	Optimum Fin spacing (S_{opt})	No. of fins	Angle from vertical (θ°)
1	127	254	6.35-25.4	1.02	6.35-7.95	-	-	0,-45,-90
2	177.5, 250	6.35, 13.1, 23.9	13.5	1.02-3.10	6.25, 6.35,6.40, 7.35	-	10,13,17	-90
3	25,33,49	25,33,49	13.5	1	3,11	-	3,5,7,9,13	0
4	250,340	180	5,15,25	3	5.85,8.8,14.7 ,32.4,85.5	10.4-11.9	3,6,11,16,21	0
5	100	250	6,16, 26	3	6.2,9.4,19,35,83	10.4,11.6,19.5	4,8,14,27,41	-90
6	127,254	-	6.3,13,25,38	-	6.3,8	6,7	-	0
7	50,25,12,7	-	7,12	3,7	4,7,10,12	7	-	-90
8	100,65, 130,195	130	34, 105, 215	2.2	7	-	-	+90
9,10,11	250,340	180	5-25	3	5-85.5	11.75		0,4,10,20,30,45, 60,75,80,85,90
14	250	-	10,20,30,40,50	-	7.3,16, 32.3,58.75	-	-	0
15	200	100	40	2	2,3,4,5,6,8,10,12	9-11	-	-90
16	100	110	67	-	-	-	-	0,+90,-90
18	80	59.8	29.2	1	2.1,3.9,7.4,8.8,13.7,18.6	5.86-6.42	4,5,7,8,13,20	0
19	31.75	31.75	0.25,0.5,0.75,1	1	0.5,0.75,1	1	-	-90
21	20,40	100	-	3	7,19,47	-	4,8,17	0,-30,-45,-60, -90
22	127	-	38	1	9	-	7	-90
23	100-500	180-250	5-90	1-19	2.85-85.5	-	-	0
24	150	100	50	-	6,8,10,12	8-10	9,11,13,17	-90
25	25	75	-	2	-	-	-	0
26	250,340	180	5,15, 25	3	5.75-85.5	8.8,14.7	3,6,11,16,21	0
27	250,340	180	5,15, 25	3	4.5,7.3, 16,32.3,58.75	10	5,8,14,25,34	0
28	25,49	25,49	13.5	1.5	10.25,10.37	-	3,5	-90

CONCLUSION

Compact, closely packed heat sink problem is vital to analyze to avoid electronics failure. Upward, sideward and downward facing fin arrays has been studied by some researchers. Geometric parameters of fin array i.e. fin height, fin spacing, fin length, fin thickness, number of fins affects convective heat transfer rate. Rectangular fins with vertical base vertically orientation has maximum heat transfer rate. Optimum fin spacing which maximizes heat transfer is a function of fin height and fin length. Fin thickness has not significant effect over heat dissipation. Different orientations of the fin arrays find sensitivity for convective heat loss.

From the extensive literature review, it is seen that many researchers have shown interest to analyze effect of geometric parameters over heat dissipation and to find out optimum fin spacing for different fin configuration. Furthermore, different orientations of the heat sink are tested and optimum orientation is find which maximizes heat transfer rate. Separate effect of fin length, fin height and fin spacing has been found. However, combine effect of fin length and fin height for optimized fin spacing at certain orientation has not studied. Also, study of slight inclined model from vertical or horizontal position of heat sink seems importance for closely packed model.

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LIST OF SYMBOL

Symbol	*Quantity*	*Units*
A	area	m^2
h	convection heat transfer coefficient	W/m^2K
θ	Angle of inclination from vertical	°
C_p	specific heat at constant pressure	KJ/Kg.K
g	gravitational acceleration	m/s^2
H	fin height	mm
k	thermal conductivity	W/mK
L	fin length	mm
m	mass flow rate	Kg/sec
β	volumetric thermal expansion coefficient	1/K
Gr	Grashof number	
Ra	Rayleigh number	
Nu	Nussult number	
n	Number of fins	
S	fin spacing	mm
t	Fin thickness	mm
W	Base plate width	mm
ν	Air kinematic viscosity	m^2/sec
α	Thermal diffusivity	m^2/sec
ε	Emissivity	
σ	Stefan-boltmann constant	W/m^2K^4
T_a	Ambient air temperature	K
T_w	Average base temperature	K
T_d	Base-to-ambient temperature difference	K
T_f	Film temperature	K
Q	Power input to the heater	W
Q_c	Convection heat transfer rate	W
Q_r	Radiation heat transfer rate	W

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Dinámica del fósforo en agua y sedimentos de un embalse subtropical (Salta, Argentina)

[Dynamics of phosphorus in water and sediments of a subtropical reservoir (Salta, Argentina)]

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ABSTRACT: General Belgrano reservoir, in a subtropical region of the province of Salta, is one of the most important in Argentina because of its size and purposes. Previous studies indicate a high speed of increasing its trophic state, adversely affecting the quality of the resource. This paper characterizes the structure (grain size, organic matter content) and amount of phosphorus fractions in sediments, to establish its dynamics during the transition from stratification until mix period. Physical-chemical major variables (temperature, pH, redox potential, conductivity) and phosphorus content (total, reactive soluble and organic) were analyzed according to standardized techniques, at three Secchi depths, interfase and sediment, from March to July, 2011. Water quality in all sites showed high uniformity: it was slightly basic with high conductivity and low concentration of bioavailable phosphorus indicating the extreme mobility of the nutrient in the food chain. The sediments, whose characteristics differed significantly from the overhead compartments, were neutral, with highest conductivity and redox potential values indicating anoxia throughout the study. The tributaries zones have clayey composition, while the lentic area is sandy, which is related to the raised content of phosphorus adsorbed in the first ones. The great amount of phosphorus in sediments demonstrated its relevance as a source of internal eutrophication of the reservoir.

KEYWORDS: grain size, physicochemical characteristics, nutrient recycling, phosphate, hydrologic cycle.

RESUMEN: El embalse general Belgrano, en la región subtropical de la provincia de Salta, es por sus dimensiones y finalidades, uno de los de mayor relevancia en Argentina. Estudios previos indican que incrementa su estado trófico a altas velocidades, perjudicando la calidad del recurso. El presente trabajo caracteriza la estructura (granulometría, tenor de materia orgánica) y contenido de las fracciones de fósforo en los sedimentos, para establecer su dinámica durante la transición de estratificación hasta el momento de mezcla. Se analizaron las principales variables físico-químicas (temperatura, pH, potencial redox, conductividad) y el contenido de fósforo (total, reactivo soluble y orgánico) a tres profundidades del disco de Secchi, interfase y sedimentos, según técnicas estandarizadas, en tres áreas representativas del embalse, de marzo a julio del 2011. La calidad del agua, en todos los sitios, mostró elevada uniformidad: levemente básica, con alta conductividad y baja concentración de fósforo biodisponible revelando la movilidad extrema del nutriente en la cadena trófica. Los sedimentos, cuyas características se diferenciaron significativamente de los compartimentos superiores, resultaron neutros, con los mayores valores de conductividad y de potencial redox que indican anoxia durante todo el estudio. La granulometría de los ingresos es netamente arcillosa, mientras que en la zona lenítica es arenosa, lo que se relaciona con el mayor contenido de fósforo adsorbido en los primeros. El elevado tenor de fósforo en los sedimentos demuestra su relevancia como fuente de eutrofización interna del embalse.

Palabras Clave: Granulometría, Características Físico-Químicas, Reciclado de Nutrientes, Fosfato, Ciclo Hidrológico.

1 Introducción

El embalse General Belgrano ubicado en la región subtropical serrana de la provincia de Salta, por sus dimensiones es considerado uno de los de mayor relevancia de la Argentina. Si bien se opera para control de crecidas y producción de energía hidroeléctrica, sus usos alternativos no son menos significativos (riego, pesca deportiva y recreación turística). Precisamente por su extensión (115 km^2) y en especial por su profundidad media (27,5 m) se considera que la velocidad con la cual incrementa su estado trófico es llamativa, debido principalmente a que recibe aguas de un valle fértil dedicado a las actividades agropecuarias, donde se ubican algunos de los asentamientos urbanos de mayor densidad de la provincia de Salta.

Son diversos los estudios limnológicos realizados en el reservorio vinculados a la variación de la calidad del agua ([1],[2],[3],[4],[5] entre otros), las comunidades del fitoplancton ([6]; Borja, 2011-en prensa-) y la estructura de las poblaciones ictícolas ([7], [8], entre otros), si bien no existen antecedentes de estudios que permitan conocer la tipología de los sedimentos y la magnitud del contenido relativo de los nutrientes existentes en ellos.

La región semiárida posee una marcada estacionalidad de precipitaciones que condiciona el máximo ingreso exógeno de nutrientes al embalse de diciembre a abril de cada año, a través de dos afluentes principales: por el Norte: el río Arias-Arenales, colector del mayor conglomerado antrópico y actividades económicas industriales y agropecuarias, y por el Sur: el río Guachipas, colector de aguas de los Valles Calchaquíes. Precisamente las cargas ingresadas tanto de sedimentos en suspensión como de fósforo son más significativas durante los picos iniciales de la fase de crecidas [9]. La liberación del fósforo entrampado en los sedimentos depende de varios factores tales como su granulometría, las condiciones del agua situada sobre ellos y las comunidades bentónicas capaces de alterar el equilibrio de intercambio, retornando el fósforo a la fase soluble, si bien la característica reguladora más evidente de esta exportación es el contenido de oxígeno del agua más próxima.

El presente trabajo pretende caracterizar los sedimentos del embalse en la zona de ambos ingresos lóticos y en la zona léntica intermedia del embalse, de marzo a julio de 2011, para establecer cómo se comportan los tres compartimentos: agua, interfase agua-sedimento y sedimentos en relación al fósforo durante la transición de estratificación hasta el momento de mezcla.

2 Materiales y métodos

El embalse General M. Belgrano, conocido localmente como Cabra Corral, ubicado a 70 km al sur de la ciudad de Salta (de 25° 08'S a 25° 27' S y de 65° 20' O a 65° 27' O), a 945 msnm, abarca 11.720 ha. El volumen de embalse es 3.130 hm^3, su profundidad media, 23,84 m y la máxima de 90 m. Recibe aguas de los ríos Guachipas, Rosario y Arias-Arenales, irriga un área de 700 km^2 y tiene una producción eléctrica instalada de 102 MW. El influjo anual promedio al embalse es del orden de los 1246 hm^3 de los cuales el 80% es recibido entre los meses de diciembre y abril. La descarga media anual del embalse en el río Juramento es de 992 hm^3. Las fluctuaciones de los volúmenes embalsados presentan una marcada regularidad, con niveles máximos de febrero a junio y mínimos de octubre a enero [10].

Se muestrearon tres sitios del embalse (fig.1): dos localizados luego del ingreso de los tributarios Arias-Arenales (M) y Guachipas (Z) y el tercero, en un sector léntico intermedio (L), con una frecuencia mensual de marzo a julio de 2011. Las muestras fueron extraídas en la columna de agua (A) a tres profundidades (uno, dos y tres Secchi), en la interfase agua-sedimento (I) y en los 5 a 10 cm de la fracción superficial de los sedimentos (S). Se midió con sondas específicas in situ: temperatura, conductividad (uS/cm), pH, potencial de óxido-reducción (ORP - mV). En las muestras de agua se cuantificó: fósforo reactivo soluble (P-PRS - mg/L), fósforo total (P-PT - mg/L), fósforo orgánico (Porg - mg/L), según técnicas normalizadas [11]. En sedimentos también fueron determinadas las formas de fósforo precedentes por el método de Andersen [12], la granulometría [13] y el porcentaje de materia orgánica (por calcinación a 550°C). El análisis estadístico se efectuó con el programa estadístico InfoStat [14].

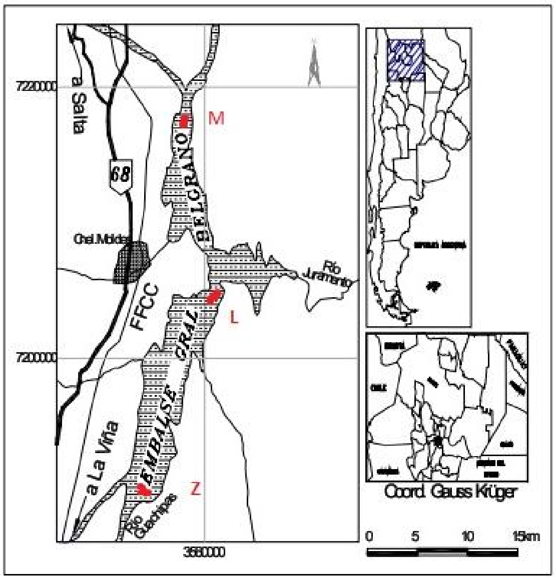

Fig. 1. Ubicación de los sitios de muestreo: ingreso del río Arias-Arenales (M), del río Guachipas (Z) y en zona léntica (L)

3 RESULTADOS Y DISCUSIÓN

En función de los perfiles térmicos (datos no mostrados) y en coincidencia con trabajos previos [1] se clasifica al embalse como monomíctico caliente con elevados gradientes térmicos estivales y posterior mezcla al inicio de la temporada fría. La temperatura media del agua, en el periodo de estudio, fue 17,4 ºC, con registro máximo en marzo (21,5°C) en Z y mínimo de 11,9°C en M en junio.

Existieron diferencias altamente significativas en la mayoría de los parámetros considerados en cuanto a su concentración en los sedimentos versus la interfase y el agua (tabla 1).

Table 1. Comparación de variables fisicoquímicas en los distintos compartimentos (S = sedimento, I = interfase agua-sedimentos, A = columna de agua) en los tres sitios de muestreo del Embalse Gral. Belgrano. Medias con una letra común no son significativamente diferentes (p > 0,05)

Variable	Compartimento	Promedio	Estadístico
pH	**S** **I** **A**	7,31 a 8,09 b 8,22 b	H= 29,38 P<0,0001
Conductividad	**S** **I** **A**	589,29 a 478,13 b 470,41 b	H= 17,78 P< 0,0014
ORP	**S** **I** **A**	-236,23 a 286,48 b 288,46 b	H = 36,21 P <0,0001
P-PT	**S** **I** **A**	49,03 a 0,49 b 0,47 b	H=36,36 P<0,0001
P-PRS	**S** **I** **A**	38,72 a 0,32 b 0,35 b	H= 35,62 P<0,0001
Porg	**S** **I** **A**	10,31 a 0,17 b 0,22 b	H=35,22 P<0,0001

El pH de los sedimentos fue inferior a los otros compartimentos considerados, variando en el rango de 7,13 a 7,55, en tanto que el máximo valor de 8,86 se obtuvo en la columna de agua. En función de esto se puede clasificar al embalse como carbonatado, tamponado por sistema bicarbonato-carbonato, a valores próximos a pH 8, en el periodo estudiado (fig. 2). Esto puede explicarse, en parte, porque el basamento del reservorio es calcáreo dolomítico y además, una de las subcuencas que desembocan en él, discurre por afloramientos de piedra caliza, en los Valles Calchaquíes. Asimismo, estos valores son indicativos de la elevada actividad fotosintética. Resultados similares de pH fueron reportados varios años antes por Salusso [9] y Borja (2011-en prensa-), quien además encontró una correlación significativa y positiva con la concentración de clorofila a. Es destacable la uniformidad en el pH a lo largo de los años, en los diferentes sitios y profundidades en la columna de agua.

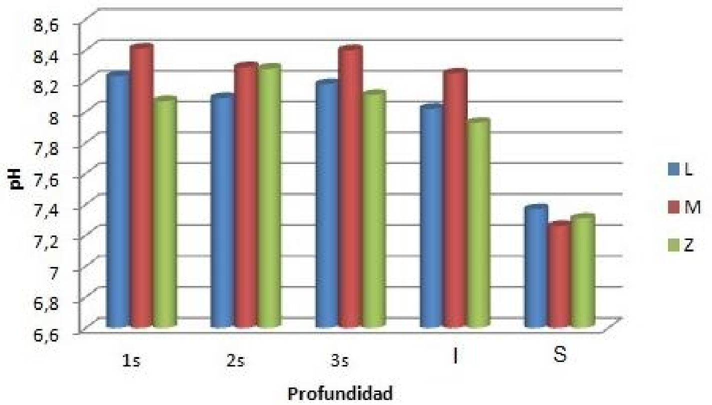

Fig. 2. Variación de pH según los sitios de estudio (media) y la profundidad (s=secchi, I=interfase, S=sedimentos)

Las muestras de sedimentos presentaron un promedio de conductividad significativamente mayor a la columna de agua y a la interfase en todos los sitios (tabla 1), debido probablemente, a la presencia de complejos de sales de calcio y magnesio provenientes de la descomposición de los materiales de la cuenca del embalse conformados por rocas sedimentarias calcáreas, principalmente calizas y margas. Si excluimos del análisis a los sedimentos, (fig.3) los registros significativamente más altos se observaron en el sitio Z (H=28,40, p<0,001). Esto se corresponde con las características de las aguas del río Guachipas, que presenta altas cantidades de sulfatos y fluoruros, ya que es colector final de sedimentos inorgánicos de la región árida, cuyo sustrato es fácilmente erosionable y está constituido principalmente por sedimentitas de la edad terciaria [15].

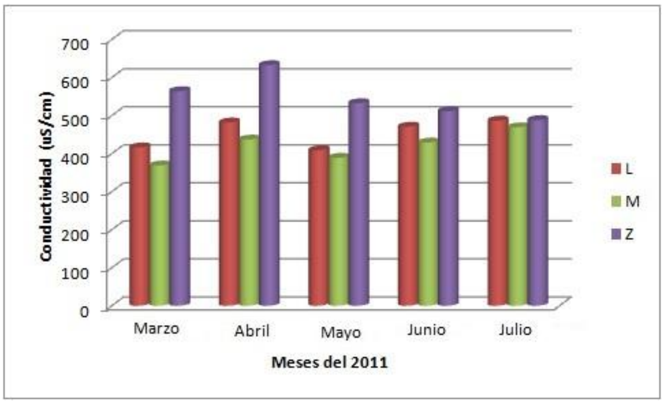

Fig. 3. Comparación de la conductividad del agua (medias) en los distintos sitios.

El potencial de óxido-reducción fue negativo en los sedimentos en todo el muestreo (tabla 1), lo que prueba las condiciones anóxicas imperantes en los tres sitios del embalse, independientemente de las diferencias existentes en la profundidad relativa. Su rango de variación tuvo un mínimo próximo a los -380 mV en Z y L, mientras que el máximo fue cercano a los -99 mV, correspondientes a julio, en M. Esto podría deberse a las diferencias en el contenido de materia orgánica de los sedimentos de estos sitios (tabla 2) dado que los sitios con menor potencial redox mostraron el mayor contenido de materia orgánica. Sin embargo no se encontraron correlaciones estadísticas entre estas variables.

Table 2. Porcentaje de materia orgánica (MO) en los sedimentos de los distintos sitios. Letras diferentes indican diferencias significativas (p<0,01)

Sitio	% MO (media ± D.E)
L	18,50 ± 5,42 b
M	4,59 ± 0,52 a
Z	9,01 ± 3,12 ab

Al analizar la variación temporal del potencial redox se observa la misma tendencia en todos los compartimentos, alcanzando hacia julio los valores más altos (fig. 4), en concordancia con la mezcla que incorpora oxígeno y eleva el ORP a valores próximos a los de las aguas naturales, que en condiciones estándar son cercanos a los +500mV, mientras que la oxigenación en los sedimentos se traduce en potenciales que se acercan a 0 mV [16].

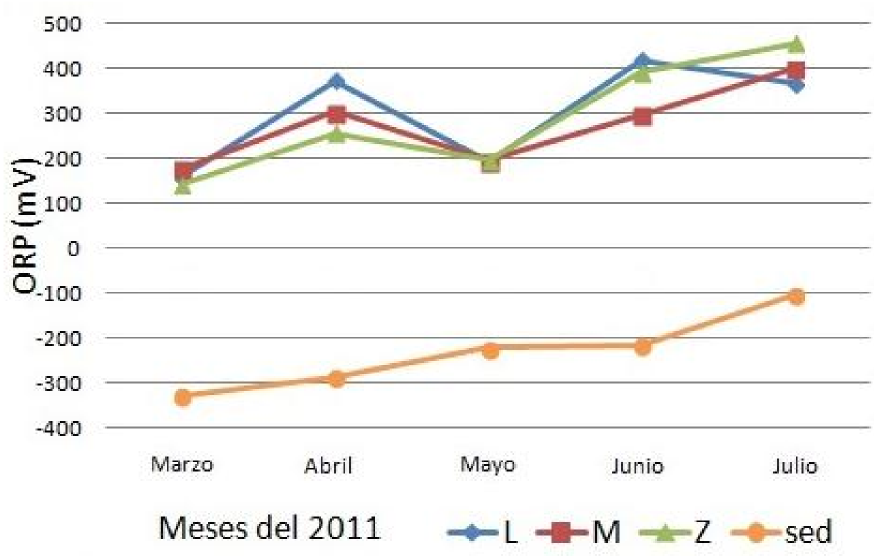

Fig. 4. Variación intermensual de valores del ORP (en mV) en sedimentos y en la interfase en los tres sitios del embalse Gral. Belgrano.

La capacidad de retención de fósforo en los sedimentos durante el período de análisis, quedó evidenciada en los valores medios obtenidos para todas las fracciones consideradas (fósforo total, soluble y orgánico), que superó hasta en dos órdenes de magnitud al contenido de los restantes compartimentos (tabla 1). Relaciones similares de varios órdenes de magnitud entre el fósforo total de sedimentos y del agua, fueron reportadas para otras cuencas ([17], [18], [19], [20], [21]) evidenciando la capacidad de los sedimentos de actuar como sumideros de nutrientes. Si bien hubo variaciones entre muestreos en cada sitio (fig. 5), la tendencia general fue un pico de máxima en mayo, cuando se completa el llenado del embalse por ingresos alóctonos, seguido de una declinación importante de los tenores de fósforo en los dos últimos meses muestreados. Cabe destacar que los tres compartimentos analizados (sedimentos, interfase y columna de agua) muestran las mismas fluctuaciones a pesar de diferir en la cantidad absoluta del nutriente. Esto es indicativo de altas velocidades de intercambio entre los sedimentos y el agua, con elevados coeficientes de difusión, como los encontrados por Mozeto et al. ([22], [23]) en sus estudios de embalses tropicales, para los flujos de especies solubles.

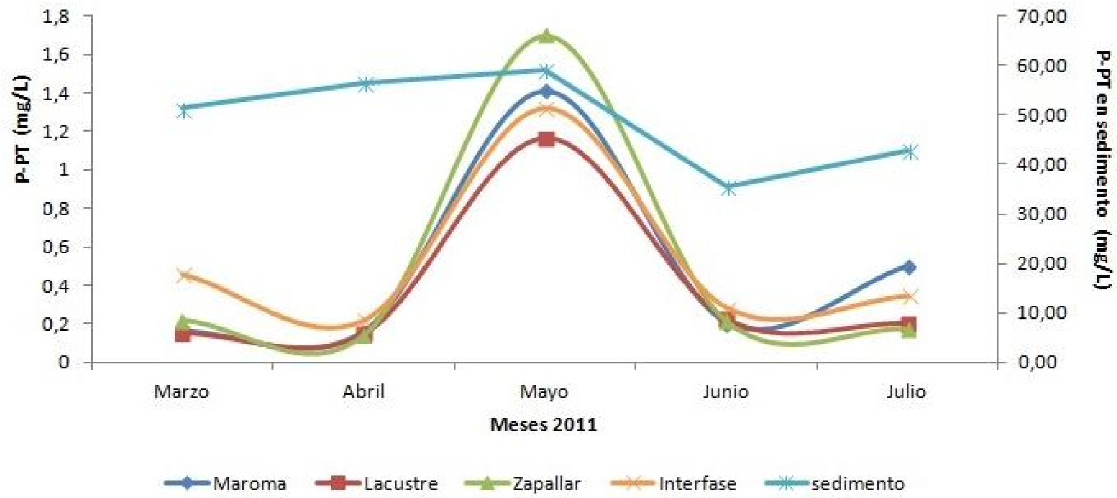

Fig. 5. Variación intermensual de valores del fósforo total (en mg/L) en sedimentos, en la interfase y columna de agua en los tres sitios del embalse Gral. Belgrano.

El pico de PT coincide con la disminución del potencial redox en la columna de agua. La bibliografía indica que ante el descenso del ORP, los complejos e hidróxidos de hierro y manganeso se reducen, se tornan solubles y el fosfato adsorbido a éstos es movilizado. Esto explicaría la disminución encontrada en el PT de los sedimentos posteriores a mayo, aunque los registros de ORP siguen indicando anoxia.

La mayor proporción de PT está conformado principalmente (más del 50%) por el PRS, en todos compartimentos y sitios estudiados (fig. 6 a y b), sin mostrar diferencias estadísticas según las distintas profundidades de la columna de agua, lo que justificaría la rápida declinación de los valores observados, dado que es la forma de fósforo consumida por las algas y macrófitas.

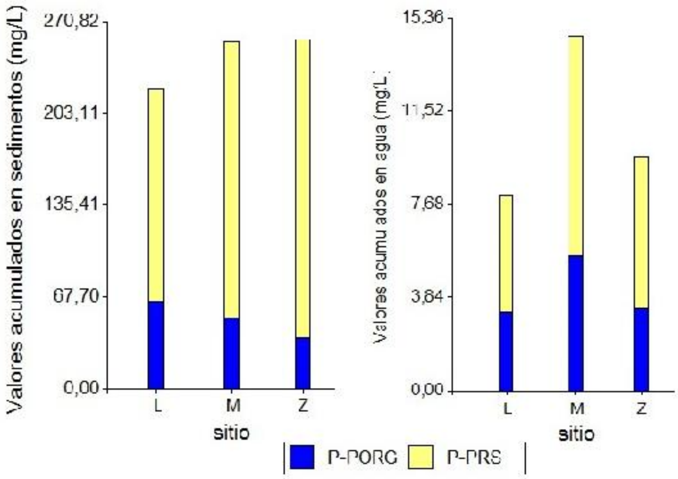

Fig. 6. Composición del fósforo total en sedimentos (a) y agua (b) en los tres sitios del embalse Gral. Belgrano.

Las diferencias en las proporciones de fósforo soluble y de fósforo orgánico en los sedimentos (fig. 6 a) fueron variables según los sitios sin llegar a ser estadísticamente significativas. En la región léntica (L) se registró la mayor proporción de Porg coincidiendo con el mayor porcentaje de materia orgánica encontrada en este sitio. Por el contrario, el contenido de estos nutrientes en la columna de agua (fig. 6b), mostraron sorprendentemente una alta uniformidad en su proporción (Porg/P-PRS=0,4 en L, 0,38 en M y 0,35 en Z) a pesar de la distancia longitudinal (aproximadamente 15 km) que separa los sitios entre sí.

El ingreso del Arias-Arenales (M) incorpora mayores tenores del nutriente en solución, que los restantes sitios, lo que puede estar vinculado con el hecho que estos ríos discurren en su porción inferior por suelos del tipo alfisoles [24], que presentan un horizonte subsuperficial con enriquecimiento secundario de arcillas. Es ampliamente conocido que el fósforo puede ser adsorbido como anión en arcillas, coloides y materia particulada, tales como carbonatos e hidróxidos [25]. En el mismo sentido, los datos de granulometría (fig. 7) mostraron que los sedimentos en M poseen significativamente (H=0,14 y P<0,05) mayor contenido de arcillas en relación a los valores que presenta el ingreso del Guachipas (Z) y en la zona lenítica intermedia (L), donde se encontró el mayor contenido de arenas (H=0,83 y P<0,01).

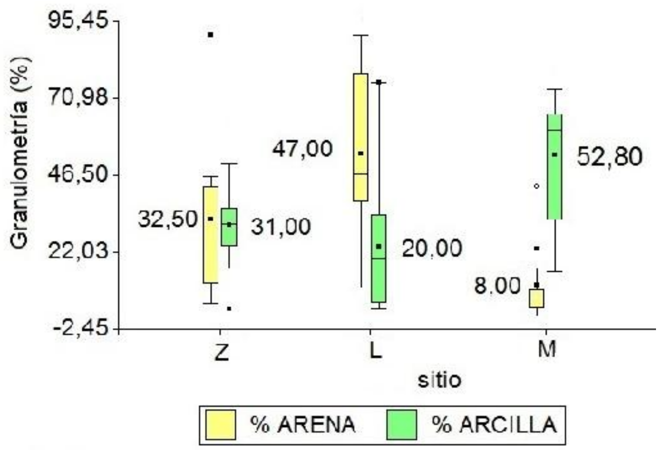

Fig. 7. Composición granulométrica del sedimento en los tres sitios del embalse Gral. Belgrano.

El análisis de componentes principales considerando los registros de 7 de las variables estudiadas agrupadas por sitio y fechas, permitió reducir la información contenida en los dos primeros componentes que explican el 85% de la totalidad de la varianza. (fig. 8).

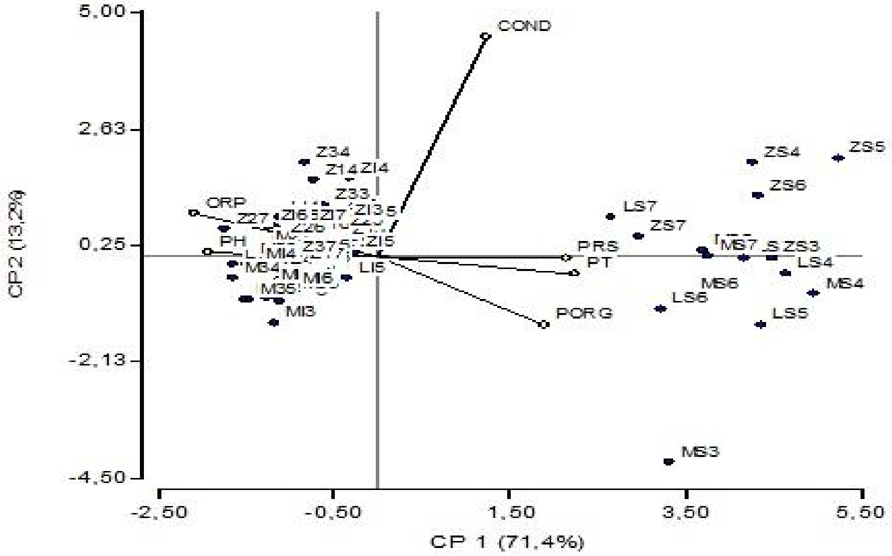

Fig. 8. PCA de los sitios en todas las fechas y variables características del agua, interfase y sedimentos. Código: primer carácter: sitio (L, M o Z), segundo carácter: profundidad (1=1secchi; 2=2s; 3=3s; S=sedimento; I=interfase), tercer carácter: mes de colecta. Ej: LS5=muestra del sedimento de la zona lenítica tomada en mayo.

El primer componente, explicó el 71 % de la variación total de los datos (tabla 3) y está definido por su relación inversa con el ORP y pH, y directa con el fósforo total, PRS y orgánico, consideradas éstas como las variables más importantes. Los sitios ubicados hacia la parte positiva del primer componente corresponden principalmente a las muestras de sedimentos. Así este análisis corrobora el mayor contenido de PT, menor pH y ORP registrado en los sedimentos de todos los sitios en todo el periodo de estudio. La parte positiva del eje permite destacar a los sedimentos de los ingresos (M y Z) que en abril y marzo presentaron los menores valores de pH (7,3) y elevado contenido de fósforo total (62,4 mg/L), lo que podría vincularse con los mayores aportes alóctonos y el gran volumen de ingreso en esos meses. El segundo componente explicó el 13% de la variación total y estuvo definido por su relación directa con los valores de conductividad y ORP, e inversa con los tenores de Porg. En la parte positiva del eje se destacan las muestras correspondientes a Z, que principalmente en el mes de abril presentó registros altos de conductividad en los estratos inferiores de la columna de agua (3 secchi, Interfase) cercanos a 700 uS/cm.

Table 3. Discriminación de las variables analizadas según su peso en cada componente principal.

Variables	CP 1	CP 2
pH	-0,40	-0,02
conductividad	0,26	0,94
P-PT	0,47	-0,07
P-PRS	0,45	-0,01
Porg	0,40	-0,29
ORP	-0,44	0,18

4 CONCLUSIÓN

- Los diferentes sitios del embalse, a pesar de la distancia que los separa, mostraron homogeneidad en los parámetros físico-químicos de la columna de agua: levemente básica, con alta conductividad y baja concentración de fósforo biodisponible indicando su movilidad extrema en la cadena trófica.
- Los sedimentos se diferenciaron de los compartimentos superiores: con pH próximos al neutro, valores de potencial redox que indican anoxia en todo el periodo de estudio y altas concentraciones de fósforo total que los convierte en sumideros del nutriente. A pesar de la gran extensión del embalse, el sedimento presentó uniformidad en la mayoría de las variables analizadas, excepto en la granulometría y conductividad, que permiten diferenciar claramente los sitios de ingresos de los influentes con respecto al sitio léntico.
- La movilización endógena del fósforo soluble, tuvo una vinculación estrecha con las condiciones electroquímicas que se generan en la interfase agua – sedimento luego de comenzado el periodo de mezcla, disminuyendo acentuadamente a medida que avanza la fase de mixis, probablemente por acción de la biota.
- A pesar de su granulometría netamente arcillosa, el tenor de fósforo en sedimentos provenientes del ingreso del río Arias-Arenales no se diferenció del resto, no obstante atravesar una subcuenca de mayor actividad antrópica. Sin embargo, el nutriente contenido en solución en la columna de agua fue significativamente superior.
- El contenido de fósforo en los diferentes compartimentos analizados guardó una alta proporción entre si, a lo largo del período considerado
- El elevado tenor de fósforo de los sedimentos demuestra su relevancia como fuente de eutrofización interna del embalse

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The Influence of Patrimonialism, *Guanxi* and *Xinyong* on Partnership Relationship in Chinese SMEs in Jakarta, Indonesia

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ABSTRACT: This study is conducted in Jakarta among Chinese SMEs. It tested influence patrimonialism on *guanxi* and *xinyong,* and influence *guanxi* on *xinyong,* and influence *guanxi* and *xinyong* on partnership relationship. This study finds that patrimonialism has significantly effect on *guanxi* and *xinyong. Guanxi* has negative effect on partnership relationship, but *guanxi* has positive and significantly effect on *xinyong* and *xinyong* has significantly effect on partnership relationship. So through this result of the research, it is known that partnership relationship among Chinese SMEs in Jakarta is built on personal and trust relationship (*guanxi* and *xinyong*) as mediating between patrimonialism and partnership relationship.

KEYWORDS: Chinese business, patrimonialism, *guanxi, xinyong,* partnership relationship.

1 INTRODUCTION

Many researchers interest to examine the overseas Chinese business networks phenomenon. Many researchers who have conducted the study, at least among social and economic researchers there are S. G. Redding [15], Robert W. Hefner [6], Gary H. Hamilton [5], Jamie Mackie [14], David L. Szanton [18], Leung [10] etc.. The attractiveness of the research on Chinese business can not be separated from Chinese predominance in business if be compared with their native neighbors, both on small and medium enterprises as well as large companies.

According to Hefner there were not economic and cultural aspects of Southeast Asia which caused controversy as the dominance of large-scale private enterprises by the Chinese. Hefner gave the example that Chinese in Indonesia amounted to only 4 % of the total population. But be estimated that they control 70-75 % of medium and large private companies (not belonging to the State) [6]. Gary Hamilton shows greatness of the Chinese business system in Taiwan [5], Jamie Mackie demonstrated the superiority of Chinese businessmen over their indigenous neighbors both at the level of SMEs and LEs in Southeast Asia [14], and David L. Szanton demonstrated the superiority of Chinese business be compared by indigenous neighbors in a fishing town in the Philippines [18]. Similarly, Yoshihara Kunio who explains that the Chinese people have many advantages over a native people because they have a network to help them acquire the training, capital to start a business, credit, supply of goods, and information. The network formed by a tribal relations which they have same language and come from same tribe/clan [8], for example, Hokkien, Hakka, Teociu etc.

All of above research indicate that there are the role of patrimonialism, *guanxi* and *xinyong* in building a network of business partnerships that deliver them on their economic dominance in Southeast Asia that be called with "network capitalists" by Robert W. Hefner [6] and the "ersarzt-capitalists" by Yoshihara Kunio [8]. Patrimonalism is a management ideology where a highest authority sources of company in the hands of head of family and core family members (sons of the founder) of the family companies. *Guanxi* is a business network that is built on personal relationships and *xinyong* is a network that is built on personal ties or beliefs (personal trust). The researchers also suggest a relationship between patrimonialism with *guanxi* and *xinyong*, a relationship between *guanxi* with *xinyong*, and a partnership relationship that is built on *guanxi* and *xinyong* networks.

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Based on the background above, formulation of the research problems can be made that there is the roles of patrimonialism, *guanxi*, and *xinyong* on partnership relationship in Chinese SMEs. Then based on the research problem can be given research questions such as the following: (1) Does Patrimonialism have an influence on *guanxi* in Chinese SMEs? (2) Does Patrimonialism have an influence on *xinyong* in the family business of Chinese SMEs? (3) Does *guanxi* have an influence on *xinyong* in the family business of Chinese SMEs? (4) Does *guanxi* have an influence on partnership relationship in the family business of Chinese SMEs? And (5) Does *xinyong* have an influence on partnership relationship in the family business of Chinese SMEs?

2 Literature Review

2.1 Previous Research

T. K. P. Leung, Kee-hung Lai, Ricky Y. K. Chan dan Y. H. Wong did research in China and the research results were published under the title "The Roles of *Xinyong* and *Guanxi* in Chinese Relationship Marketing" in *European Journal of Marketing;* 2005. Results of the study showed that *guangxi* has significant influence (40%) on *xinyong*, and then *xinyong* has significant influence (45%) on partnership relationship. This study showed indirect effect *guanxi* on Partnership Relationship [10].

Liang-Hung Lin and Yu-Ling Ho did research by took 446 employees who work and live in Taiwan and mainland China (especially in Shanghai, Nanking, and Suzhou) as their respondents. Results of the research were published under the title "*Guanxi* and OCB: The Chinese Cases" in *Journal of Business Ethics,* 2010. Results of this study demonstrated that *guanxi* has a significant influence on OCB or overseas Chinese business [12].

Mans Gellerstam and Jannike Wiesner did research for his master's thesis at University of Gothenburg with the title: "The Impact of *Guanxi* in Chinese Business: A Study of Swedish SMEs in Beijing." The research found (1) *Guanxi* impact on business relationships, (2) *Guanxi* impact on management control by promote an informal rather than formal controls; and (3) *Guanxi* was a key factor of success and led company to achieved an advantage competitive better than its competitors [4].

Feng Yang conducted research and published the results of his research in *Asian Social Science* under the title "The Importance of *Guanxi* to Multinational Companies in China" and he found a significant effect of *guanxi* on multinational companies in China [19].

Efferin dan Pontjoharyo conducted research among both Chinese LEs and SMEs in Surabaya, Indonesia in 2004 to 2005. Their results are published in the book, *Southeast Asia's Chinese Businesses in an Era of Globalization: Coping with the Rise of China* by Leo Suryadinata as an editor [3], [17]. The results of these studies indicate that ideology of patrimonialism especially among Chinese SMEs are very visible, especially relate with an authority source of company, corporate objectives, ownership of assets and a company's corporate successor. *Xinyong* (personal trust) becomes a very important factor in build their business networks that appear in these results. Partnership relationship, especially in to access main information sources of business relies heavily on *guanxi* and *xinyong* networks. However, *guanxi* (personal relationship) establishes a working relationship between companies owner or supervisors and employees are less apparent in principles of the Chinese SMEs.

2.2 Variables of the Research

- ***Patrimonialism***

Patrimonialism is an idea that the supreme power in a company is in the hands of company owner. Inseparability between ownership and management among Chinese companies is values of the family as a basic survival unit. The power is in the hands of company owner and will be handed over to family members as successors and not to others. In most Chinese organizations or enterprises, organizational structure is a duplicate of the family structure, in which a head of the family is a head of the organization, members of the family were members of a core staff, and one of his sons would be the heir to the company leadership [3]. According to Efferin and Pontjoharyo, if the company made huge profits, the family will invest the profits to set up branches of the company or start profitable new business, so that when a head of the family dies, the company's assets can be divided according to the allocation of corporate businesses separately to ensure his sons' surviving [3].

- ***Guanxi (Personal Relationship)***

According to Luo *guanxi* is a Chinese word that refers to a concept of connections in order to secure favors in personal relations. It is an intricate network which growing strongly among Chinese, not so obvious, but very impressive. The *guanxi* word has been used in the talks since a century ago, but it was not found in a classical Chinese dictionaries. It looks like the *guanxi* word is a combination of two words, *guan* and *xi*. *Guan* originally meant "the door", and its extended meaning is 'to close up'. Thinking metaphorically, inside the door you may be 'one of us', but outside of the door your existence are barely recognized. While the *xi* word means 'tie up' and extend into relationships. *Xi* can also be used to refer to a relationship that is built for a long term [13].

Hwang and Staley explains that *guanxi* has become very important to Chinese people for more than 2,500 years - since the time of Confucius (550-478 BC). According to *the Book of the Analects*, a book that contain the sayings and deeds of Confucius that be compiled by his followers, he gave three main teachings: loyalty, benevolence, and performing a responsibilities inherent in five fundamental relationships, named *wu lun* in Chinese language. The five relationships are hierarchical relationships as the following: (a) ruler-subject, (b) the father-son, (c) brother-brother, (d) husband-wife, and (e) friend-friend. All of the human relationships are derived from one or a combination of the five relationships. That's what makes Chinese society has been built on the concept of clan and then widened to include distant relations and finally unrelated individuals [7].

Luo gives some principle of *guanxi*. (1) *guanxi* is *transferable*, meaning that if A has *guanxi* with B and B is a friend of C, then B can introduce or recommend A to C or vice versa; (2) *Guanxi* also be *reciprocal*, it means that a person who does not follow the rule of equity and refuse to return favor for favor will lose his face (*mianzi*) and regarded as someone who should not be trusted; (3) *Guanxi* is *intangible*. This network is built on feelings of indebtedness and unspoken reciprocation and maintained long-term through unwritten commitments and sometimes even unspoken with each other in a network; (4) *Guanxi* is essentially *utilitarian* rather than *emotional*. *Guanxi* bonds two person who help each other through experience rather than through sentiment; (5) *Guanxi* is virtualy *personal*. Even *guanxi* between organizations is initially established by and continues to build personal relationships. So finally *guanx*i is personal relationships [13]. In this personal relationship, who you know is more important, at least as important as who you known. Friendship is very important in building relationships work [3].

- ***Xinyong (Trust Relationship)***

According to Leung et al., variable that is universally accepted as a basis for a relational exchange to Western society is a trust, interpersonal trust in [10]. However Western organizations do not depend on interpersonal trust or mutually agreed words in business transactions because it is not legally binding and less "objectivity" [10]. The managers that invest in PRC recently not want to use the "interpersonal trust" with their counterparts in PRC to manage risk and encourage "the system trust." On the contrary, Chinese put more emphasis on *xinyong* (personal trust) in the business interactions system because of imperfections in PRC legal system (Wong and Chan, 1999). Indeed there are business practices those are built on Chinese legal system, however, largely depends on *xinyong* (personal trust) and *guanxi* (personal relationship) [10]. *Xinyong* is a belief based on integrity, credibility, trustworthiness, or reputation and personal character [10].

According to Efferin and Pontjoharyo, *xinyong* or limited bounded trust refers to use of family members or people who are worthy be trusted to perform an essential functions of the organization in terms of improving an efficiency of the organization for a purposes of identification, motivation, and confidential information. Suspicions about professional may exist since they are seen as having a potential to weaken a paternalistic relationships that be built by business owners, and therefore the trust-based personal relationships favored over a neutral relationship. In an Indonesian context, ethnic suspicion and antagonism between Chinese and indigenous Indonesian was sharpened and strengthened by New Order regime which also led to some Chinese businessmen more trust Chinese employees of indigenous employees [3].

- ***Partnership Relationship***

Efferin and Pontjoharyo explained that partnership relationship or Chinese overseas business tend to manage marketing relationships with partnership agreement that be based on personal and trust relationship [3]. Chan in Efferin and Pontjoharyo [3] emphasizes that a network is based on personal relationships (*guanxi*) can be formed from many things, for example based on kinship, classmates, friendship and shared interests.

2.3 RESEARCH HYPOTHESIS

- ***The Effect of the Patrimonialism on Guanxi***

Gary H. Hamilton found that Taiwan is very successful as an economy of small and medium enterprises. Hamilton explained that private businesses in Taiwan are a family owned companies and are under control of the family [5]. According to Hamilton network that exists among family business groups are crucial to the economy of Taiwan with business networks that are within family, and the both became a main support for the Taiwan market culture [5]. Networks that Hamilton means are *xinyong* and *guanxi* network. *Guanxi* (reciprocal relationship) occurred outside field of direct family control; these networks are based on norms of reciprocity [5]. The results of these studies suggest effect of the patrimonialism on *guanxi*.

Hamilton also explained that in addition to ownership of family, business in general also have a second type of ownership, i.e., *guanxi* is a device of specific relationship bound by norms of reciprocity (*huibao*) or by what is more commonly called in the Chinese's person feelings (*renqing* or *ganqing*) [5]. We can build hypothesis on the above explanation as the following:

H1 = *Patrimonialism* has significantly influence on *guanxi*

- ***The Effect of the Patrimonialism on Xinyong***

According to Hamilton, a family networks that apply within a scope of strong family control is a network that is hierarchical where family networks in Taiwan have a range of vertical control shorter than hierarchical nature of family networks in Korea [5]. This shows the relationship between an ideology of patrimonialism and *xinyong* in Chinese SMEs business in Taiwan.

The research results of Efferin and Pontjoharyo showed that 81 percent of Chinese SMEs respondents in Surabaya assume that the source of a highest authority of the company is the company owner and 67 percent of them assume that the company's objectives should refer to owner's objectives of the company. They explained that patrimonialism among Chinese entrepreneurs are very real, especially in aspect of the source of authority associated companies, corporate objectives, ownership of assets and the company's corporate successor [3]. The results of these studies also showed a strong relationship between Patrimonialism with *xinyong* and we can build second hypothesis as the following:

H2 = *Patrimonialisme* has significantly influence on *xinyong.*

- ***The Effect of Guanxi on Xinyong***

According to Leung et al., if *xinyong* is a verbal contract to replace "system trust," then it must be based on building relationships prior to reaching the end of a agreement relationship, so *guanxi* has positively affect on *xinyong*. Someone will have more confidence (*xinyong*) to build relationship with his business partners, if he has good *guanxi* with his business partners [10].

The research results of Efferin and Pontjoharyo showed that 39 percent of the 69 respondents of Chinese SMEs in Surabaya assume that most people can be trusted is a family member, 69 percent assume that when there is no person ideal, they will recruit people who they have known personally, and 41 percent assume that Chinese people are generally more reliable [3]. The results showed a strong influence or relationship between *guanxi* and *xinyong*. So this is my third hypothesis of the research:

H3 = *Guanxi* has significantly influence on *xinyong.*

- ***The Effect of Guanxi on Partnership Relationship***

Hefner explained that the system of lateral relations and reciprocity known as *guanxi* is one of two principal types contained in a network in the heart of business life of Chinese people [6]. According to Hamilton it does not surprise that economic organizations in Taiwan is often the result of a network of *guanxi* and *guanxi* development. According to Hamilton for the largest business groups in Taiwan, *guanxi* network is a major source of capital investment and is an important form of ownership [5].

Lin and Ho explained that *guanxi* plays an important role that has been embedded in the Chinese society in building a good relationship interactions based mutual trust, mutual benefit and mutual maintain, so role of *guanxi* in Chinese overseas business (OCB) is very real. *Guanxi* can also encourage responsibility and effective performance in the OCB. One of

Lin and Ho's hypothesis is *guanxi* has a significant impact on OCB. The research results of Lin and Ho prove the hypothesis, that guanxi has a positive influence on OCB [12].

According to Gellerstam and Wiesner *guanxi* is critical to business success because business networks depend on *guanxi* relationships. *Guanxi* network can create a company's core competence and distinctive competitive advantage that can create a successful business in China. Study that was conducted on overseas Chinese people in Singapore showed that the people of Singapore because they have Chinese ethnic background, they have a competitive advantage when investing in China. Overseas Chinese people take advantage of the languages, ethnicity, kinship and culture to build networks in mainland China [4].

The research results of Efferin and Pontjoharyo showed that 62 percent of Chinese SMEs in Surabaya assume that their information sources of their main business is private networks with friends or relations [3]. It shows that there is a significantly influence both *guanxi* and *xinyong* on partnership relationship, especially in access sources of information for Chinese businesses. So *guanxi* affect on partnership relationship among Chinese SMEs. So fourth hypothesis of the research is:

H4 = *Guanxi* has significantly influence on partnership relationship.

- ***The Effect of Xinyong on Partnership Relationship***

According to Leung et al., *xinyong* is an important business cooperation mechanism in PRC. According to them *xinyong* implementation is proved that it is essential in building a partnership relationship between buyers and suppliers, for example managing manager of Gree Group Corporation confirms that personnel sales generate $ 10 billion per year just by relying *xinyong* without legal contract agreement with their retailers. They showed that there is a significant effect *xinyong* on the partnership relationship in China by 45% [10]. This supports an assertion Harvery [10] and Chan et al. [10] that there is a strong influence *xinyong* on partnership relationship in a poor legal system in China and weak morality of trade in China's socialist market economy. So fifth hypothesis of this research is:

H5 = *Xinyong* has significantly influence on partnership relationship.

The research model is based on above hypotheses as the following (Figure 1):

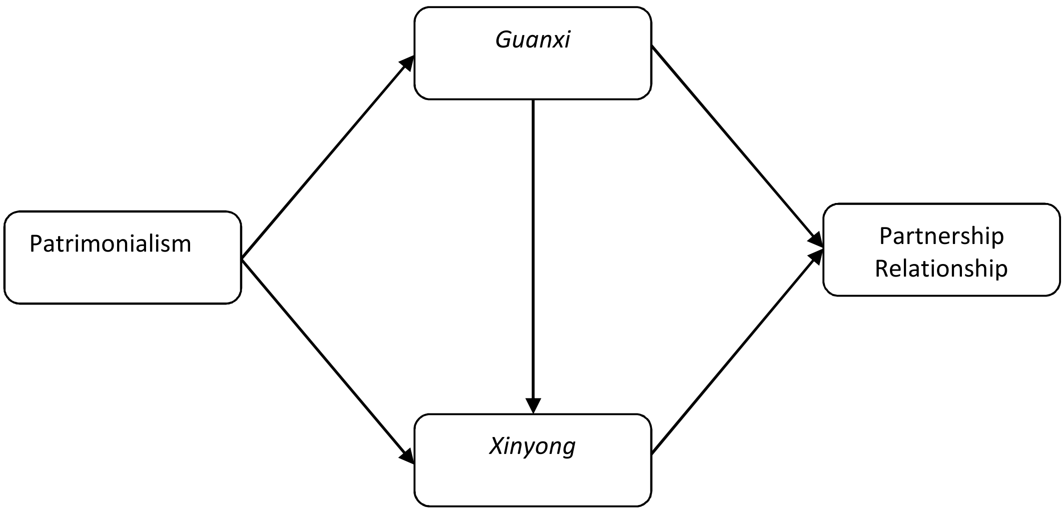

Figure 1

3 METHOD

This research design is quantitative. Sampling study conducted among owners of Chinese SMEs in Jakarta. While sampling techniques will be based on techniques is 10 times number of variables. As number of indicators in this study is 21, then minimum number of samples taken is 21 x 10 = 210, which means 210 samples of research here already qualified sampling. Measurement scale in this study was adopted from measurement scale of Efferin and Pontjoharyo [3]. As in quantitative research in general, in this study conducted a series of tests, which include a validity and reliability tests and multivariate analysis to determine the effect of patrimonialism on *guanxi* and *xinyong*, the influence of *xinyong* and *guanxi* on partnership relationship, the influence of *guanxi* on *xinyong,* and the influence of *xinyong* on partnership relationship. This study used AMOS 21.

4 Result and Discussion

4.1 Validity and Reliability

The CFAs indicate acceptable levels of fit and significant loading of all measurement items on their respective latent construct. In general, the results demonstrate adequate levels of fit, and all item loadings are greater than the cut-off point of 0.40 suggested by Nummaly and Bernstein [10]. Standardized Regression Weights on AMOS 21 output shows that all factor loading on the estimate column shows above 0.40 and it shows all the indicators can explain the constructs or existing variables.

Convergent validity and discriminant validity test show that all indicators of constructs are valid (see table 1). Eight indicators of patrimonialism have P value= ***. It means the regression weight for patrimonialism in the prediction of all indicators is significantly different from zero at the 0.001 level (two-tailed). Three indicators of *guanxi* have P value= ***. It means the regression weight for *guanxi* in the prediction of all indicators is significantly different from zero at the 0.001 level (two-tailed). Three indicators of *xinyong* have P value= ***. It means the regression weight for *xinyong* in the prediction of all indicators is significantly different from zero at the 0.001 level (two-tailed). And seven indicators of partnership relationship have P value= ***. It means the regression weight for partnership relationship in the prediction of all indicators is significantly different from zero at the 0.001 level (two-tailed).

Table 1. Regression Weights

			Estimate	S.E.	C.R.	P
P1	<---	Patrimonialism	1.000			
P2	<---	Patrimonialism	1.122	.126	8.925	***
P3	<---	Patrimonialism	.831	.114	7.277	***
P4	<---	Patrimonialism	1.276	.130	9.816	***
P5	<---	Patrimonialism	1.131	.130	8.695	***
P6	<---	Patrimonialism	.915	.125	7.313	***
P7	<---	Patrimonialism	1.037	.117	8.882	***
P8	<---	Patrimonialism	1.127	.125	8.994	***
G1	<---	Guanxi	1.000			
G2	<---	Guanxi	1.137	.160	7.122	***
G3	<---	Guanxi	1.266	.170	7.461	***
X3	<---	Xinyong	1.000			
X2	<---	Xinyong	1.271	.221	5.759	***
X1	<---	Xinyong	1.207	.238	5.075	***
PR1	<---	Partnership	1.000			
PR2	<---	Partnership	1.025	.119	8.629	***
PR3	<---	Partnership	.940	.131	7.171	***
PR4	<---	Partnership	.962	.122	7.854	***
PR5	<---	Partnership	.820	.125	6.577	***
PR6	<---	Partnership	1.101	.126	8.765	***
PR7	<---	Partnership	.868	.113	7.708	***

4.2 Test of Hypotheses

In Regression Weights on AMOS 21 output below (Table 2) shows the research hypotheses is proven. Significant influence of patrimonialism on *guanxi* is shown with p = *** or p < 0.001 and the estimate of 0.630, which means that when patrimonialism goes up by 1, *guanxi* goes up by 0.63. Likewise, there is a significant effect patrimonialism on *xinyong* that be indicated by p=*** and estimate= 0.436, which means that when patrimonialism goes up by 1, *xinyong* goes up by 0.436.

Xinyong has significantly influence on partnership relationship that be indicated by the significant p-value=*** and estimate=1.636 which means that when *xinyong* goes up by 1, partnership relationship goes up by 1.636. Thus, in the three relationships H_0 is rejected. *Guanxi* has significantly influence on *xinyong* and it showed by the probability of getting a critical ratio as large as 2.406 in absolute value is .016. In other words, the regression weight for *guanxi* in the prediction of *xinyong* is significantly different from zero at the 0.05 level (two-tailed) and therefore H_0 is rejected. Estimate=0.248 means that when *guanxi* goes up by 1, *xinyong* goes up by 0.248. The influence of *guanxi* on the relationship partnership is also significant. The probability of getting a critical ratio as large as 2.159 in absolute value is .031. In other words, the regression weight for *guanxi* in the prediction of partnership relationship is significantly different from zero at the 0.05 level (two-tailed). Estimate - .475 means that when *guanxi* goes up by 1, partnership relationship goes down by 0.475.

Table 2. Regression Weights

			Estimate	S.E.	C.R.	P
Guanxi	<---	Patrimonialism	.630	.107	5.903	***
Xinyong	<---	Patrimonialism	.436	.106	4.104	***
Xinyong	<---	Guanxi	.248	.103	2.406	.016
Partnership	<---	Guanxi	-.475	.220	-2.159	.031
Partnership	<---	Xinyong	1.636	.389	4.202	***

The results of this study support the research findings of Liang-Hung Lin and Yu-Ling Ho that *guanxi* has a significant influence on the Chinese business networks [12]. The results of this study also support findings of Leung et al. that *guanxi* has a positive influence on *xinyong*. Their findings did not show significantly effect of *guanxi* on partnership relationship, but *guanxi* affects on *xinyong* and then *xinyong* affect on partnership relationship [10]. The results of this study also support part of the findings of Gellerstam and Wiesner who found that *guanxi* has an influence on business relationships among Chinese [4]. The results of this study also support the research findings of Feng Yang that *guanxi* has an important influence in multinational business network of Chinese people [19].

The results of this study support research findings of Ai who conducted in Mainland China and in Taiwan where *guanxi* become business network that are a key to business success in China. Ai concluded that while Western business culture separation between an affairs of individuals and organizations clearly, and depend on legal contracts, and focuses primarily on the tasks to be done, otherwise the Chinese business culture prefers human-hearted, based on mutual respect and trust, as well as long-term oriented with more attention to an interests of all members of the network [1]. Ai found that trust relationship (*xinyong*) and personal relationships (*guanxi*) has correlations and greatly influenced business networking and cooperation between Chinese people both on the mainland China and in Taiwan [1]. The results also support the research findings of Sheng and Silva [16]. The study took 110 samples of the Chinese entrepreneurs who built their business in downtown São Paulo, Brazil. They found that one of the alternative Chinese SMEs entrepreneurs can gain access to capital through personal relationships (*guanxi*) and informal channels to access financial capital [16]. These findings also support the findings of Cheng and Tang who also found that *guanxi* has an influence on the performance of Chinese SMEs in China, especially the sampling was done in Sichuan, Xinjiang and Shanghai [2].

The results of this study also support the research findings of Law, Wong and Lau that the trust relationship (*xinyong*) has an important role in Customer Relationship Management for trust and relationship ties formulating various relational strategies which is the key to success in Customer Relationship Management [9]. The influence of *xinyong* on partnership relationship also supports the findings of Ai because in addition to finding the influence of *guanxi* on the partnership relationship [1]. Ai also found the influence of *xinyong* on partnership relationships in the Chinese business network in mainland China and in Taiwan [1]. This finding also supports most of the research findings Liao who found in the automotive industry, Chinese people see that salesperson should increase their *xinyong* to assist their customers in building *guanxi* because it can affect the sales promotion [11].

5 Conclusion

This study reveals that Overseas Chinese Model still can be found in Chinese business in Jakarta, especially Chinese SMEs. Partnership relationship or business network play an important role in Chinese SMEs. As be found in this study that the partnership relationship is built on trust relationship (*xinyong*), and *xinyong* is built on patrimonialism and personal relationship (*guanxi*). And *guanxi* is built on patrimonialism. This network framework led Chinese in Jakarta can predominate business be compared with their indigenous neighbors. The result of study proved all of research hypotheses.

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Contribution to the study of the flora in the central-west of Tunisia: landscape dynamics and evaluation of plant biodiversity of mountain Bouchebka

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ABSTRACT: The study was conducted during 2013 in Bouchebka, located in the central west of Tunisia.Such territory has a typical landscape of the transfrontier region. The series of the forest in Bouchebka is a part of the great mass of Aleppo pine. It is distinguished by the importance of the forest area which covers 92 % of the surface area (19,700 ha). The study attempts to inventory the natural vegetation and characterize ecological terms while highlighting the importance of environmental conditions. The method is based on a phytoecological analysis to quantify the floristic richness and diversity of the ecosystem in the forest of mountains in Bouchebka on the basis of floristic surveys and transects distributed in a stratified, systematic sampling in different vegetation formations that were previously distinguished. Statistical analyzes were performed using the Factorial Correspondence Analysis (FCA). The results show that the forest is composed primarily of the Aleppo pine trees, these forests are characterized by the abundance of young feet (10-25 cm diameter class). The ecosystem includes 12 families and 17 genera, 26 species. Thus the study has identified that the biological spectrum of the study area is characterized by a clear dominance of shrubs (41%) and chamaephytes (32 %). The distribution of plant species is influenced by ecological features of the region: the results show that 82% of species are drought tolerant which shows the arid environment. The region is also characterized by its windy side: 32% of species spread via anemochory. Factor analysis showed a pastoral aspect in the study area, with a presence of cultured human action exerted on the forest land species. Phytological spectrum indicates a predominance of woody species reflecting a territory dominated by open grassy areas, predominantly reflecting an arid climate.

KEYWORDS: Forest landscape, mountain, ecological traits, dynamic and floristic diversity, human impact.

1 INTRODUCTION

Tunisia, part of the Mediterranean basin, is one of the richest regions of the world in terms of biodiversity of flora and fauna [1]. Indeed, the Mediterranean countries hold almost 4.5% of the world's flora.

However, this plant heritage is threatened by degradation due to a combination of several natural factors (especially the recurrent droughts and arid climate) and anthropogenic, including overgrazing. This regressive dynamics of the natural vegetation has led several authors to sound the alarm about the risk, increasingly high, of attrition flora. Hence, the need to protect the natural vegetation cover, especially in arid areas, and assess the environmental impact and economic cost [2], [3].

Tunisian mountains cover about 2 million hectares, considering the terrain with elevations above 300 m. Areas of high potential contain vital resources. They are primary sources of water, agricultural land, grazing and forestry, which often enjoy good weather and are centers of biodiversity. The fragility of mountain ecosystems, interannual variability is associated with a Mediterranean climate. Proximity to the Sahara and the presence of a rural population in the mountains are the key factors in shaping landscapes observed. But also marked by strong natural and anthropogenic stresses generating competition, conflict and risk [4].

Of all the plant species that possess Tunisia, much of it is located in mountain ecosystems. Some are remarkable for their rarity, others by their abundance, some are considered for their economic interest, or simply scientific [5].

This article emanates from the study in the border zone: Bouchebka, the choice of this area is up to the need to conduct an impact on the vegetation inventory studies, monitoring and evaluation is an area border, landscape Bouchebka is a joint natural heritage between Tunisia and Algeria; a series of mountains belonging to the Tunisian dorsal and extending to the mountains of Tébessa Algeria.

This investigation attempts to characterize the floristic inventory of the landscape and vegetation of the area mountains of Bouchebka and diagnose the state of degradation taking into account the variables of natural environment and human interventions. The study distinguishes between plant formations and facies that constitute them. Indeed, vegetation identifying communities of plant species with faces more or less common features drawing landscapes.

2 METHOD

2.1 STUDY SITE

2.1.1 FORESTS BOUCHEBKA: A COMPARTMENT OF THE ANTHROPIC ECOSYSTEM

The series of national forests of Bouchebka are part of the large solid mass of Alepo pines located on the plate ranging between Djebel Chambi and the mounts of Tebessa. These forests are located in the Gouvernate of Kasserine, Delegation of Feriana [6].

They cover 16991 ha (82.27%) of the total surface area of the forests in the delegation of Feriana.

Covering by the vegetation seems to depend primarily on the action of the Man livestock [7].

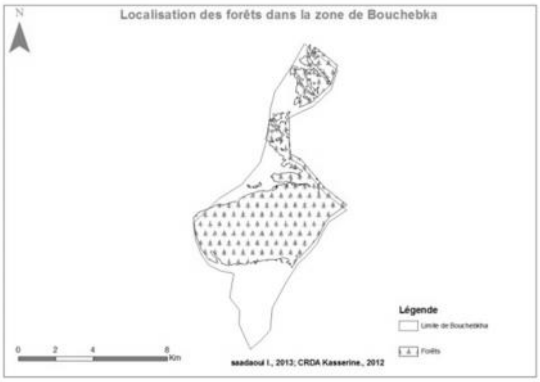

Fig. 1. Map of the distribution of the forest area of Bouchebka

2.2 GEOGRAPHIC LOCATION OF THE STUDY SITE

The series of national forests of Bouchebka fits entirely in the map to 1/50 000 Bouchebka (n) LXXXIII) between Lambert coordinates: X = 367-378 and Y = 207-215.

It is located in the Governorate of Kasserine, Delegation Feriana its limits, although sitting on the ground, are the following:

North: land of culture and Ain Amara forest which is separated from the first series of Dernaya by Ain Bou Deries track.

To the east: land of culture and forestry post Faider Remaïlia Sidi Baïssis.

South: land of culture Henchir el Goussa, the Ennafd el Bagrat until Henchir bel Houchet.

In the West: the land between the forest and the Algerian border cultures.

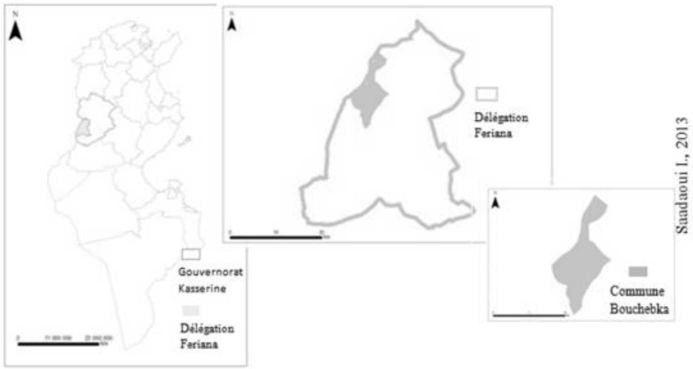

Fig. 2. Geographic location of the municipality of Bouchebka

2.3 METHOD

2.3.1 DETERMINING THE FLORISTIC COMPOSITION OF THE STUDY ENVIRONMENT

The botanical determination of the species is carried out directly on the ground in ecological stations of 10 x10 m ². When recognition of a species is not possible on the ground, a sample is kept in a herbarium and its identification is performed in the laboratory by means of the keys of botanical determination [8].

2.3.2 DESCRIPTIVE CHARACTERISTICS OF THE FLORA AND VEGETATION

The floristic list recorded on the ground (current list of the flora characteristic in the zone of the mountains), are supplemented by quantitative information and qualitative which will make it possible to characterize the flora and describe the vegetation. The quantitative information corresponds to various calculated indices of biodiversity, which characterize the flora of a site on a given date. The qualitative data are those of the auto ecology clean to the species, they inform on the distribution of the species according to their features of life.

The inventory carried out during the period of spring 2013 (END OF April and beginning of May), enabled us to collect 26 species different being in the area from study: the inventory covers the surface of one hectare pertaining to the forest post office of « Dernaya » ; it is a protected site (no human action grazing, deforestation ...).

Table 1. Number of the plants belonging to various plant species recorded

Scientific name	**code**	**Number of species (ni)**
Pinus halepensis	Ph	24
Juniperus oxycedrus	Jo	12
Juniperus phoenicea	Jp	9
Phillyrea angustifolia	Pa	2
Scirpus sylvaticus	Ss	12
Stipa capillata	Sc	145
Stipa tenacissima	St	12
GLOBULARIA alypum	Ga	116
Artemisia campestris	Ac	8
Retama retam	Rr	5
Rosmarinus prostratus	Rp	10
Thymelaea hirsuta	Th	15
Diplotaxis simplex	Ds	3
Scientific name	**code**	**Number of species (ni)**
Diplotaxis harra	Dh	3
Centaurea calcitrapa	Cc	9
Artemisia vulgaris	Av	6
Rosmarinus officinalis	Ro	29
Artemisia arborescens	Aa	42
Salvia officinalis	So	2
Mentha pulegium	Mp	4
Othonna cheirifolia	Oc	3
Ebenus pinnata	Ep	39
Artemisia compestris	Ac	8
Atractylis humilis	Ah	6
Artemisia herba alba	A-h-a	6
Thymelea tartonaria	Tt	4
Total number of speicies	534	

- **Biodiversity indices**

Calculated from the floristic lists established, we use several indicators of biodiversity, frequently used by biologists [9], [10].

Species richness; which represents the number of species.

The Shannon index H ' (Shannon, 1948)

$$H' = - \Sigma (pi \log pi)$$

Where **pi**, is the proportional abundance of species (**i**) in the sample.

$$Pi = ni / nj \Sigma$$

Where **ni**, is the number of individuals of species (**i**).

Its value depends on the sample size, but has the advantage of representing a number of the specific structure of the sample. It is even higher than the number of species which is large. The equitability (R), R = H / Hmax, measures the regularity of the distribution of species. The disadvantage of this index is that it presents a range of weak variation, in spit of its synthetic value. We do not retain in the study, so more as it is strongly correlated with the index of Shanon.

The advantage of this indicator is that it combines the composition and the relative importance of Two groups of the same type that have the same composition but whose species are distinct proportions constitute different entities which will have different values of index.

- For a factorial analysis of data from floristic surveys are used to XLSTAT 2013 software to describe the distribution of the floristic species in the study area.
- Diversity supra specific, aspect of the biodiversity largely neglected so far [11], corresponds to the diversity of tax evaluated on a level higher than the species. This index is important since it reveals otherness that could be masked if we considered only the species richness. We consider this diversity supra -specific level of the Gender and the Family.
- The biological type indicates the duration of vegetation of the plant. For the plants which can be presented under various types, the most common form was retained.
- The requirement with respect to the moisture of the ground indicates the preferential conditions of the plant compared to the water content of the ground.
- The mode of dissemination is identified according to the morphological attribute that the species developed to disperse their seeds. This data illustrates the aptitude of the plants to disperse across the landscape and their potential to colonize new mediums.
- The crossing of the floristic data and the descriptive characteristics now authorizes the characterization and description of the vegetation illustrated in the floristic list of the statements in the two sites.

3 RESULTS

3.1 FLORISTIC BIODIVERSITY

3.1.1 DESCRIPTION OF THE FOREST OF ALEPPO PINE

The inventory carried allows, taking into account the course of the species to determine the average composition of the population per hectare.

Table 2. Variation of stand structure of Aleppo pine

Class of diameter (cm)	Number of stems per hectare	Volume (m^3)	Basal area m²
10	60	1.380	0.4712
15	62	3.844	1.0956
20	53	6.678	1.6650
25	34	7.334	1.6690
30	18	6.066	1.2723
35	7.1	3.493	0.6831
40	3.0	2.043	0.3770
45	1.1	0.999	0.1749
50	0.35	0.411	0.0687
55	0.20	0.280	0.0475
60 et au-delà	0.05	0.090	0.0141
Total	238.80	32.628	7.5384
Average of the tree volume			0.136 m^3
The average height of the tree			8.55 m

The data analysis of table 1 shows that young feet Aleppo pine (of class with a diameter 10-25 cm) is the most abundant: their density is from 34 to 60 stems per hectare.

The old trees (of class of diameter higher than 35 cm) are slightly met: their densities are 0.05 to 0.35 stems per hectare.

The frequency distribution of the feet of Aleppo pine marks a clear variation while going from the East towards the West.

Table 3. Variation in the frequency of Aleppo pine trees in two different sites

Class of diameter (cm)	Number of stems per hectare	
	plot 1 (West)	plot 2 (East)
10	181	15
15	135	20
20	66	31
25	38	28
30	15	25
35	5.40	12
40	1.00	6.20
45	0.66	3.40
50 an beyond that	0.46	1.44
Total	442.52	142.04
Volume / ha	39.29 m^3	33.15 m^3

Class of diameter (cm)	Number of stems per hectare	
	plot 1 (West)	plot 2 (East)
10	181	15
15	135	20
20	66	31
25	38	28
30	15	25
35	5.40	12
40	1.00	6.20
45	0.66	3.40
50 an beyond that	0.46	1.44
Total	442.52	142.04
Volume / ha	39.29 m^3	33.15 m^3

Table 2 enabled us to notice that the young feet of Aleppo pine are more frequent in plot 1 of on the west side, while the oldest feet are met on the east side forest.

Fig. 3. Landscape of Aleppo pine forests

3.2 ESTIMATION OF THE VEGETATION BIODIVERSITY OF THE SITE OF STUDY

3.2.1 SPECIFIC RICHNESS

Table 4. Number of species

	Number of species
Site of observation of Bouchebka	26

The site of observation is of a surface of 1 hectare, which allows us to conclude that the flora of the site is rich (26 species).

3.2.2 FLORISTIC DIVERSITY

- The index of Shanon, H'

The species which represent the higher index is Stipa Caplillata with H '= 0.3539, respectively followed by shrub Globularia alypum, with H' = 0.3316, Artemisia arborescens, with H '= 0.1999, the weed Ebenus pinnata, with H' = 0.1910, the cultivated Rosmarinus officinalis which has an index H '= 0.1581, and the tree Pinus halepensis (Aleppo pine) with a index H '= 0.1392.

Table 5. Average of Shannon index of diversity

	H'moy
Site of observation (Bouchebka forest)	2.4059

The average index of diversity of Shannon of the study area is equal to **2.406**, given that the Shannon index is between 1 and 5 (1 <H '<5), hence we note that the floristic biodiversity of this site is average.

3.2.3 SUPRA-SPECIFIC DIVERSITY

Table 6. Number of Families and Gender

	Families	Gender
Site of observation (Bouchebka forest)	12	17

- Diversity of Families

The diversity of families in the current flora is equal to 12 (in a space of 1 hectare). It is mainly composed by the family Asteraceae, Lamiaceae, Brassicaceae, Cupressaceae and Poaceae. The total flora is dominated by the Asteraceae (presented by 8 species).

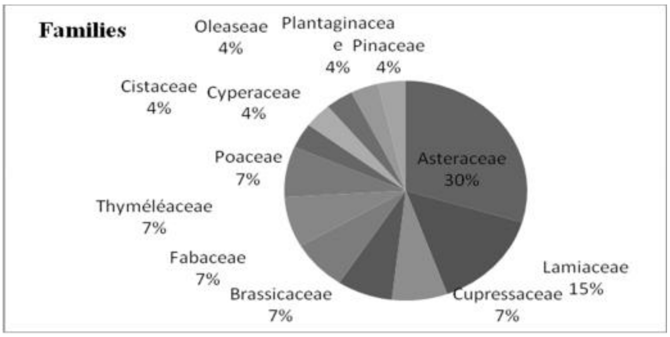

Fig. 4. Importance of the Families of flora in the site of observation

- **Variety of Genders**

The full total number of the current flora is equal to 17. Most genders are represented by only one species. Artemisia is the met the most with a percentage of 16%.

In the zone of observation, we met 5 genders represented by more than one plant species. The remains of the found genders are represented by only one species.

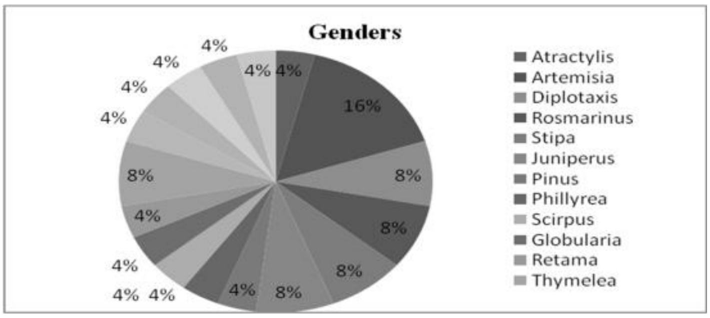

Fig. 5. Diversity of floristic gender in the study area

3.3 DESCRIPTION OF THE VEGETATION

The description of the vegetation in our study is based on the analysis of the distribution of species according to their features of life. For that, the data of the autoecology, collected from bibliographical sources are used.

For the floristic list made up following the statements on ground, the data of autecology inform on the reasons for the distribution of the species according to their intrinsic characteristics (Figure 6).

- Ecological Group: vegetation is especially represented by species whose optimal habitat corresponds to forest areas with 63% (adventitious, and forest formations). The species of the thin meadows account for 23% of the totality of the floristic list.

- Requirements of the species with respect to the light: A majority of the species pushes under strong conditions of light (85%), which testifies to the wealth of non wooded spaces, but also not very dense wooded mediums, in connection with the strong proportion of representatives of the ecological group of the forest species. The forest species, moreover, can colonize grassy formations. This singularity can mark the installation of the progressive succession in the grassy formations with spontaneous vegetation characterized by non xerophilous forest species

- Requirements of the species with respect to the moisture of the soil: A majority of the species request moisture of the relatively weak soil from very weak (steppe vegetation). Few species are with broad amplitude. Hygrophilous species were not met, which is linked to the scarcity of the aquatic environments. The strong proportion of species with trend mesophilous brand of the mediums with dry trend (62% of the species met), which prevails because of a broken relief, favourable to the streaming of water.

- Dissemination Mode: the flora of Bouchebka is especially made up of species without specialized dissemination mode (barochore: 30%), or being disseminated by effect of the wind (anemochores : 35%), a weak distribution of the species with endozoochory (15%) and epizoochory dissemination (20%).

- Biological type: flora is especially represented by annual plants and perennial herbaceous plants. The woody plants (trees, shrubs, chamaephytes) represent 67 % of the flora. The strong proportion of annual and perennial herbaceous species reflects a territory dominated by open grassy spaces.

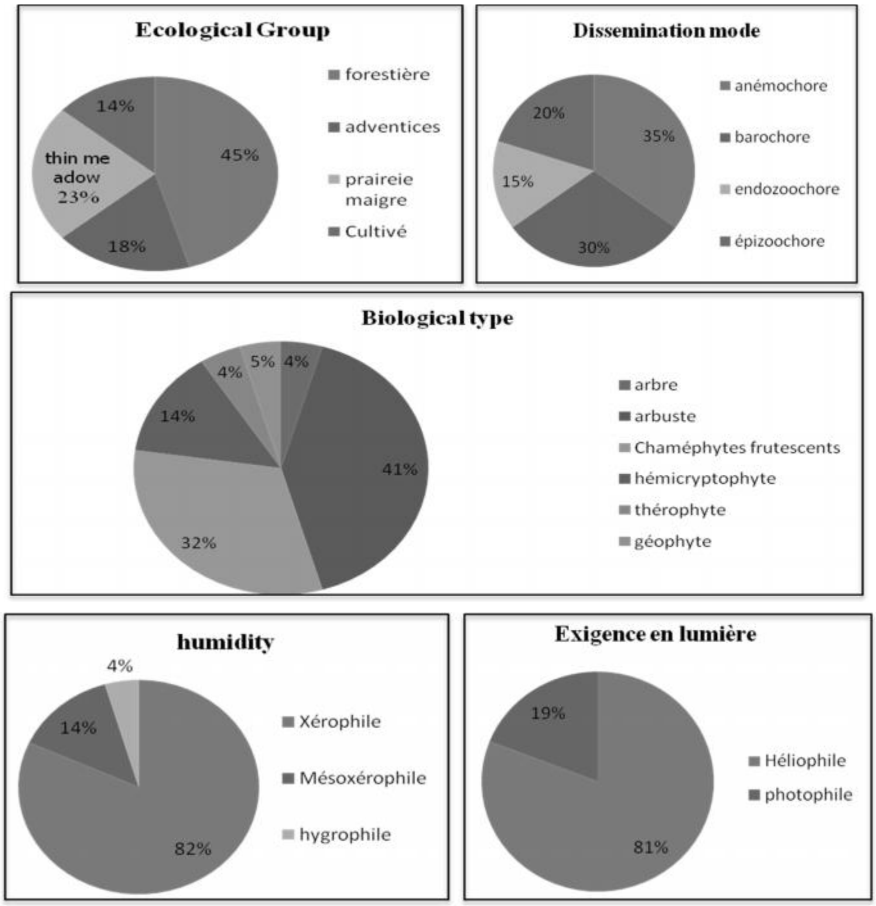

Fig. 6. Ecological characteristics or features of life of the species of floristic list-Distribution terms for each variable considered

Graph: factorial distribution of ecological groups in the site of study shows the projections in the factorial plane F1 x F2 profile associated with the terms of the plant species found in the study site (Figure 7).

From this graph we can draw the following table:

Table 7. Principal coordinate of ecological groups in the factorial design

	F1	F2
Forestry	0,468	0,214
Adventitious	-0,051	-0,304
Meadow steppe and lean	-0,362	0,331
Cultivated	-0,008	-0,073

Table 8 shows that only forest species, the steppe species and lean meadow for the factorial plane F1 x F2 present a positive index that reflects the forest and pastoral vocation midium, cultivation and crop species have a very low negative index. This shows us the low distribution of these species.

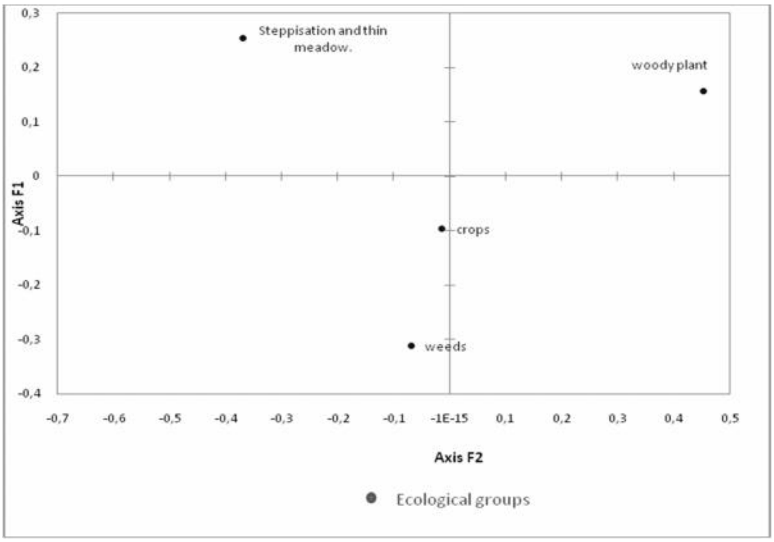

Fig. 7. Factorial distribution of ecological groups in the site of study

The joint analysis of axes F1 and F2 of the factorial plan allows us to characterize the vegetation, its distribution and its specific composition, according to the feature of life of the species.

Figure 8 shows that the level of plan F1- F2 , we find on the positive side tax them with the species which presents a steppe aspect presented mainly by (Stipa tenacissima and Stipa cappillata), there is a positive trend towards the steppe and training for poor grassland pastoral trend site. We also note the presence of woody species (Pinus halepensis , Juniperus oxycedrus , Phillyrea angustifolia , Cistus creticus , Scirpus sylvaticus , etc. .) .

On the negative side of the plan, we note the presence of crops appearance (Artemisia vulgaris, Rosmarinus officinalis, Othonna cheirifolia) marks a presence of human activities; these species have a very low indicating parameter, both the presence of weeds that accompanies the presence of crops.

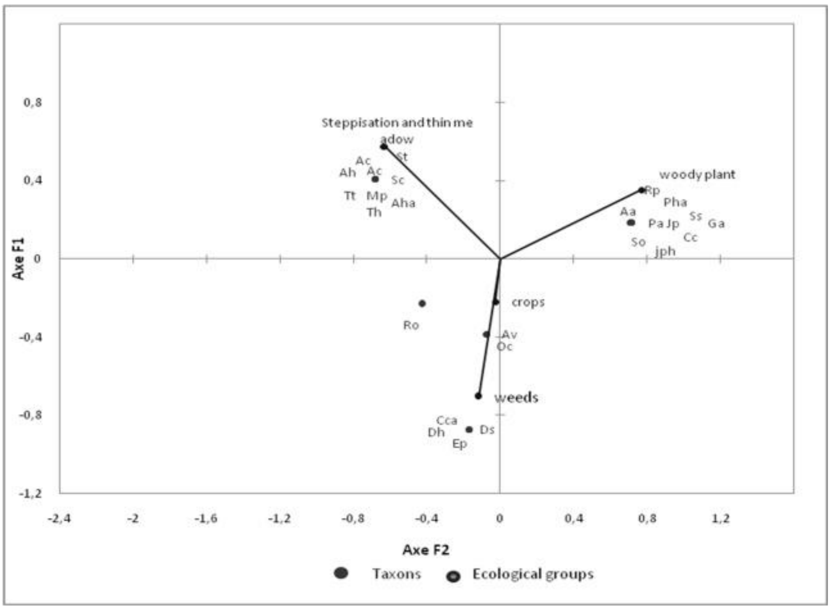

Fig. 8. Factorial plan showing the interaction of the species according to their ecological groups in the study site

Interpretation of the axis F1:

- Negative coordinates: cultivated vegetation and weeds, conducive to the presence of human action.

- Positive coordinates: of grassland plants colonized by steppe species (Stipa Stipa capillata and tinsacissima) and a large presence of woody species.

Interpretation of the axis F2:

- Positive coordinates: woody plants, a practice influenced by human nature (correlated with the steppe and grassland vocation)

- Negative coordinates: grassland plants, crops and weeds marking the pastoral vocation of the area.

The vegetation is marked mainly by species revealing conditions of the dry medium mainly: considerable proportion of species to xerophilous trend, related to a rugged relief and the small proportion of the demanding water species : hygrophile trend 4% testifies weak surface to the mediums with which they are dependent (stretches water, ditches, wadis etc.). The strong proportion of species of light, annual and herbaceous long-lived testifies to a territory dominated by open and grassy spaces or not very dense wooded plantations. That make us notes that a strong proportion of species being disseminated fixed on the animals.

4 Discussion

The results of analyzes carried on the floristic indicator and the composition of the vegetation, allow us to clarify the components of the floristic biodiversity in the zone of study. The richness of the results obtained by an analytical study thrust has enabled us to identify the importance of forms of degradation of biodiversity including human activity (the pasture, etc...). The clear presence of the young feet of Aleppo pine is the indication of stand regeneration of Aleppo pine in the western part of the forest and attenuation of the anthropogenic action toward the East, where it may notice a gradual disappearance of the old stand of Aleppo pine, this aspect is probably due to human actions (deforestation) and fires.

The floristic statements showed the difficult natural conditions of the zone according to their features of life:

The index of Shannon indicates that most of the share of the species are in fact far from abundant in the site of observation consideringthe natural conditions of the medium (scarcity ofthe factor water, nature of the grounds, an insufficient regeneration of the forest). It is an environment that is characterized by its aridity and windy side (82 % of species are drought-resistant and 36 % of species are disseminated by anemochory) , the index of Shannon which has an average value though has made our statement in a protected area which shows the fragility of floristic biodiversity factor in this zone threatened especially by anthropisation.

The factor analyzis showed the presence of a clear pastoral steppe and appearance, as well as the anthropic actions which influence negatively the forest aspect.

All these indices reflect the fragility of the medium. Such a study will be necessary at this time, because it is now clear that the conservation of biodiversity is a priority to implement for all human activities measurement processes, for its maintenance are still far from being completely understood.

The vegetation used to evaluate the vegetal biodiversity and to reveal the impacts of the human activities on the vegetable biodiversity in the landscapes natural, such as those mountains of Bouchebka, proved to be an original and appropriate biological indicator, reproducible other landscapes. This indicator is important to develop ‘landscape durability’ [12].

5 Conclusion

The main rationale of our work was to define the floristic spectrum in the region of the Tunisian mid-west in general and those of the common Bouchebka in particular.

As a conclusion, this study of the flora allows the development of a floristic catalogue. The highlighting of all the richness and floristic diversity. Thus, the series of the forest area of Bouchebka are strongly influenced by human action which is very old as well as demonstrating the many Roman ruins, some of which are located in the forest where the Aleppo pine in some recolonise. Harm military occupations (campaign 1942/1943 and the Algerian conflict) is added significantly to those committed by users. Forest Bouchebka represents diverse populations resulting from the action of fire, consumers, military occupations and forest.

The study of landscape dynamics in the region of Bouchebka starting from the biodiversity and the anthropic action applied to this territory shows its rich landscape scale biodiversity, but also the pressure exerted by the natural action and human threatening components of the landscape and their consistencies.

To ensure the landscape durability of these mediums, the conservation of these fragile zones from now on is regarded as being an urgent measure to be implemented for the national strategies of the development transborder.

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PROPOSAL OF A SCENARIO BASED ON NICT FOR INDUSTRIAL MAINTENANCE WORK

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ABSTRACT: According to the new economic and social challenges, the underlying global changes arising from globalization and the new competitive environment. Also, Technological development and that of the New Information and Communication Technologies NICT, and the race of competitiveness that drives the search for the total quality and the reduce costs and deadlines. The integration of NICT in different departments of the company has a positive impact in improving the performance of the company.
The industrial maintenance can take advantage of benefits with regard to the exploitation of its technologies in their processes to ensure efficient management of maintenance.
In this paper, we present a scenario of industrial remote maintenance based on NICT, while locating the actors study, the various dimensions of use, organization, cooperation and coordination for various maintenance tasks corrective and preventive.

KEYWORDS: NICT, Remote Maintenance, cooperation, coordination.

1 INTRODUCTION

The Industrial Maintenance has long played a curative role whose sole purpose was to restore the equipment in good working condition and reduce downtime. But with the development of control methods and diagnostics, maintenance has evolved to integrate preventive actions, which are systematic deviation (based on periodic checks) or conditional types (vibration analysis of the oils ...), this form of maintenance remains low contribution to the concepts of time and size [5].

The technological development and that of NICT has changed the concept of traditional maintenance to a remote maintenance concept that removes the barriers of time and dimension. This remote maintenance on access technologies, data processing, information and knowledge exchange between actors and remote appears to solve the problem of limited number of maintenance personnel with the skills, versatility and a high-level expertise.

These new forms of service tend to ensure maintenance tasks without physical access to equipment to maintain. Thus, there are two types of remote maintenance: remote maintenance and E-maintenance.

In this article, we will develop a comprehensive scenario based on ICT for industrial maintenance work, taking into account a study of actors, as well as various technical dimensions contributing to the concept of industrial remote maintenance.

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2 THE INDUSTRIAL MAINTENANCE : BETWEEN THE CLASSICAL CONCEPT AND THE MODERN CONCEPT

There are several decades; maintenance is considered a vital action in industrial companies. According to AFNOR standard EN 13306, maintenance is defined as: the set of all technical activities, administrative and management during the life cycle of a well-designed to maintain or restore it to a state in which it can perform a required function. [1]

This classic design maintenance has seen a radical change following the technological development and the concepts of ICT to remote maintenance and E-maintenance. These new forms tend to perform maintenance in real time to minimize repair time of production tools.

We present a scenario based on ICT for industrial maintenance work in the case of remote maintenance, while locating the actors of the virtual environment, as well as various technical aspects.

According to [1], the remote Maintenance is defined as "technique of execution of maintenance without physical access of personnel to the working tool".

The following figure shows the principle of remote maintenance.

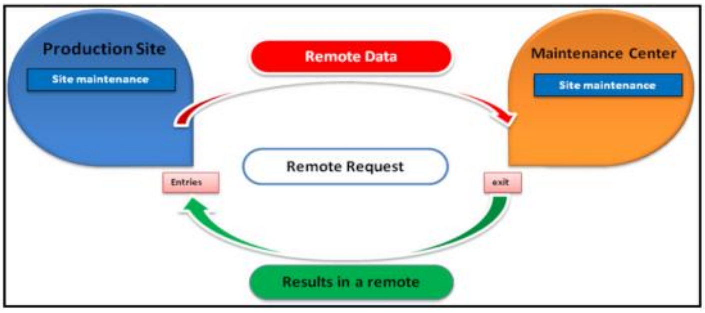

Fig. 1. Principle of remote maintenance

The remote maintenance concept refers to the remote maintenance system via a communication medium; it allows the incorporation remote maintenance activities by the establishment of telecommunications ensuring the distribution of maintenance tasks between functional units and a specialized center (expert).

E-service is an advanced form of remote service which allows making available remote resources, these resources can be material (spare parts, tools, documentation ...) or intangible (human, computer, virtual).

The outsourced resources are accessible through the Internet, tools for communication, exchange and access to information. [9]

Particularly our work is to model a situation of collaborative work for the work of industrial maintenance; FIG. 2 gives an overview of the activity of remote maintenance and disposal of intangible and tangible resources at different locations.

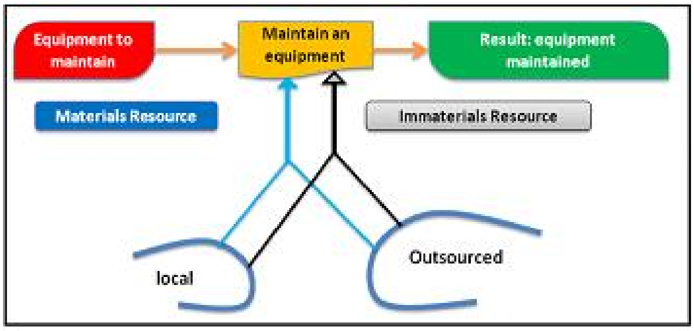

Fig. 2. Activity of the remote maintenance

This environment of tele-working needs more immaterial than material resources to carry out cooperative work provide remote resources.

3 DIFFERENT TOOLS CONTRIBUTING TO THE PROPOSED SCENARIO FOR INDUSTRIAL REMOTE MAINTENANCE

3.1 IMMATERIAL RESOURCES

The objective of our work converges to the design of a cooperative organization proposing the study of the different actors contributing to the virtual work environment [6] protocol. These intangible resources include human resources and virtual resources.

3.1.1 HUMAN RESOURCES

The presence of human resources aims to bring to the organization (or service), the staff necessary for its proper functioning. In our proposal, we need three types of personal power for starting the scenario.

Table 1. Different human resources

Personnel	Specification
Technicians of the site	Engaged in the repair of equipment (corrective maintenance) on the production site, as well as the periodic inspection of equipment (preventive maintenance) in collaboration with a set of local experts on the organization by using a tool NICT. It can manage its work.
Local Experts	Organize the operating modes of the preventive maintenance work for each equipment, the tracking of a stain of repair for the corrective maintenance, the achievement of the standards of repair for the most frequent problems ... The aid to the decision in the case of a new problem. (Nature unidentified)
External Experts	Organize the interventions for the preventive maintenance work as well as corrective concerning a failure unknown by the center of local expertise. The aid to the decision in the case of the lack of competence of local experts (nature non-identified, non-solution identified by the expert local)

3.1.2 VIRTUAL RESOURCES

The presence of human resources for remote maintenance is not enough, this is why the appeal of computer tools (virtual resources) that contain tools to help cooperative work to fill supply work group flexibly as groupware, a database contains all the information that can help validate and perform maintenance work, and finally, the tool of the Internet with a communication interface for real-time interconnection between resources human (technician site expert group, outside expert).

- **The GROUPWARE:**

Groupware or 'software group work' is a collection of applications (Groupware) to facilitate communication, coordination and collaboration between the members of a working group, that is to say, to facilitate cooperation and facilitate effective group work.

In its broadest definition, GROUPWARE means any system that supports collaborative work. It is a technology that covers areas as large as cooperation, human-computer interaction and interpersonal interaction via digital techniques [2].

Generally, a GROUPWARE has the following features: [6]:

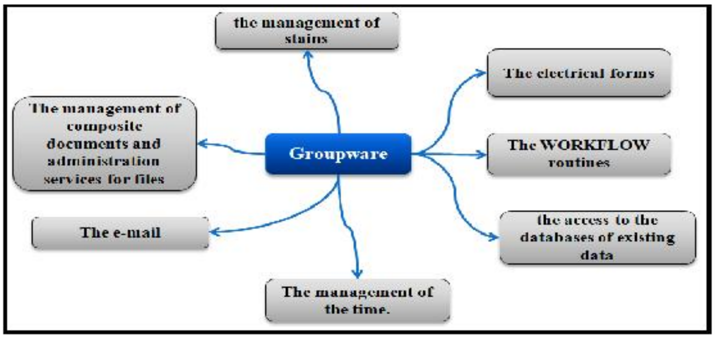

Fig. 3. Features of Groupware

- **Data base**

This tool contains the core of maintenance either preventive or corrective. The existence of this database provides us with technical documentation and knowledge base of each equipment of production to start the industrial remote maintenance scenario.

The following table shows the specification of each base.

Table 2. Components of the data base with their specification

Data base	Specification
Basis of failure	Contains a list of failure for each equipment
Basis of problems	Contains the natures associated with each failure for each equipment
Basis of cases	Contains a list of solutions to meet each problem (list of standards)
Basis of periodic work	Contains a list of works for periodic preventive maintenance for each equipment.
Basis of documentation	Contains a list of digital technical documentation for each device (i.e. its mechanical, electrical, pneumatic, computer, mechatronics ...) Contains a list of audio visual documentation on the mounting and dismounting.
Basis voice support	Contains a list for each case a voice so in the case of overload on the group of experts

- **The Internet & the human machine interface (HMI)**

The Internet offers a diverse enough value via its own speed and low cost making it potentially the most interesting communication medium in the world.

The main advantage of using the Internet is to have access to large amounts of information in real time. Can make decisions on the most recent data and wider. [3]

The internal network of the company and especially the maintenance department is connected to the internet to allow maintenance workers, local or external experts to exchange electronic messages, search for information about an anomaly to have assistance technique, and participate in discussions related to their activities (corrective maintenance, preventive maintenance) to an ugly GUI.

These virtual resources must be integrated into a graphical interface (HMI Human Machine Interface) which allows you to start a cooperative working remotely at the end to make remote maintenance of industrial equipment for assistance via the Internet, while maintaining interoperability between these virtual resources.

This system (HMI) provides access to information support and maintenance [14], and the provision of HTML pages that connects the database and guarantees a remote communication with the personal group (group experts, site technicians, external experts).

4 DESIGN A SCENARIO BASED ON NICT FOR INDUSTRIAL REMOTE MAINTENANCE WORK

4.1 TECHNICAL DIMENSION

Maintenance can be performed in different ways, using different methods and can follow different management. Kaffel proposes a distinction between modes of management of maintenance activities into three categories: [4]

- Do internally, with a service company dedicated to maintenance operations using the methods and strategies desired by the company.
- To do: outsource maintenance work to another company, usually specializing in maintenance.
- Do together: co-process maintenance work with another company within the framework of cooperation agreements, based on a combination of resources. Part of maintenance will be carried out by internal resources belonging to the company.

The total or partial outsourcing of maintenance can improve the conditions for intervention [12], by reducing the time and costs associated with holding action internally expensive [13] resources, increasing equipment reliability.

Our proposal scenario Remote is a mixed manner in order to keep the 3 methods of managing maintenance activities that Kaffel proposed, while maintaining flexibility and interactivity of maintenance work.

The figure.4 presents the organization of human resources in the proposed scenario of remote maintenance.

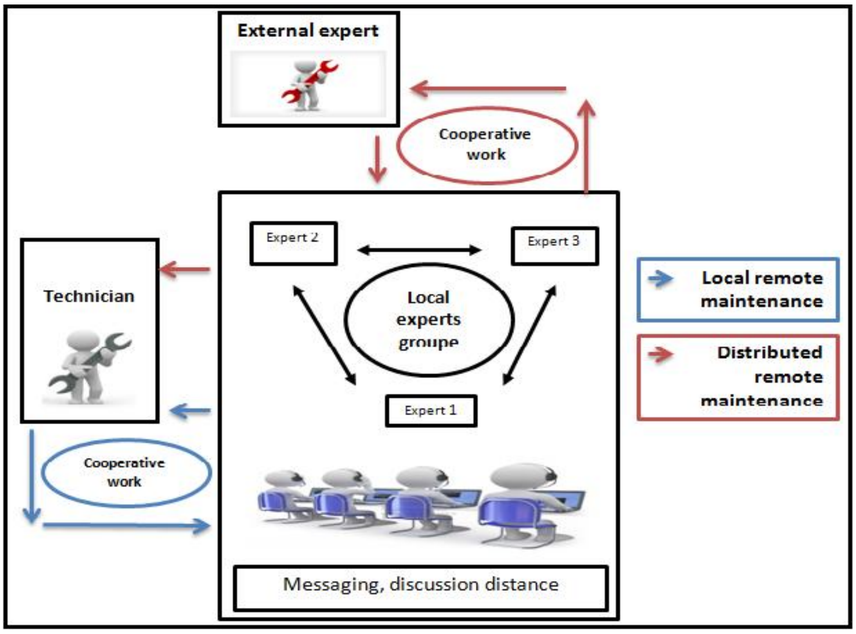

Fig. 4. Organization of human resources

- The service agent can perform corrective maintenance in the case of detection of a fault and the periodic inspection of equipment maintained (same time and same place)
- The maintenance officer finds a difficulty in resolving the failure, so he can ask for help in the decision with a group of local experts. (Same time and different place)
- The maintenance officer and the group of local experts find difficulty in rectifying the problem; in this case the group of local experts may seek decision support to an outside expert (technician provider machine X) according to availability. (Same time or different times and different location)

The following figure locates the concept of the proposed scenario matrix temporal space.

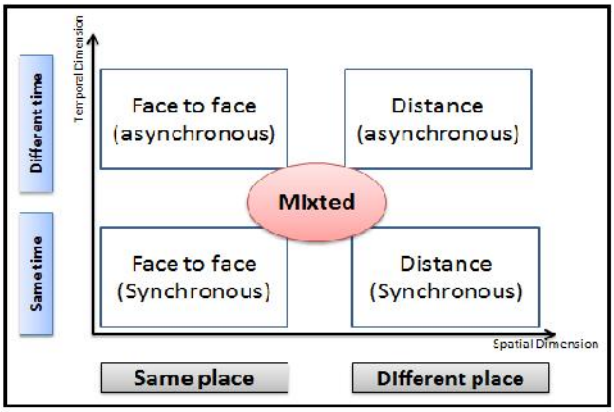

Fig. 5. Space-time matrix

4.2 SCENARIO OF THE INDUSTRIAL REMOTE MAINTENANCE

For corrective maintenance, the technician of the site detects a failure, a full digital record on machine X, if it happens to detect the nature of the failure, the fault becomes an identified problem. Otherwise, the technician starts a conversation with the remote group of local experts to identify the problem, once the nature is found, it must be associated with the failure and automatically saved in the root of the problems, the next step is the resolution of identified problems.

Solving the problem is mainly by the technician of the site if the associated solution to the problem is stored in the base case , if starting a conversation on the diagnosis of the problem (site technician, expert local group or Group local experts with outside expert) to locate a reliable solution (decision support).

Once the solution is found, the phase that comes next is the implementation of the corrective maintenance task by following the instructions in every detail.... Finally the validations of the work for keep the track already done.

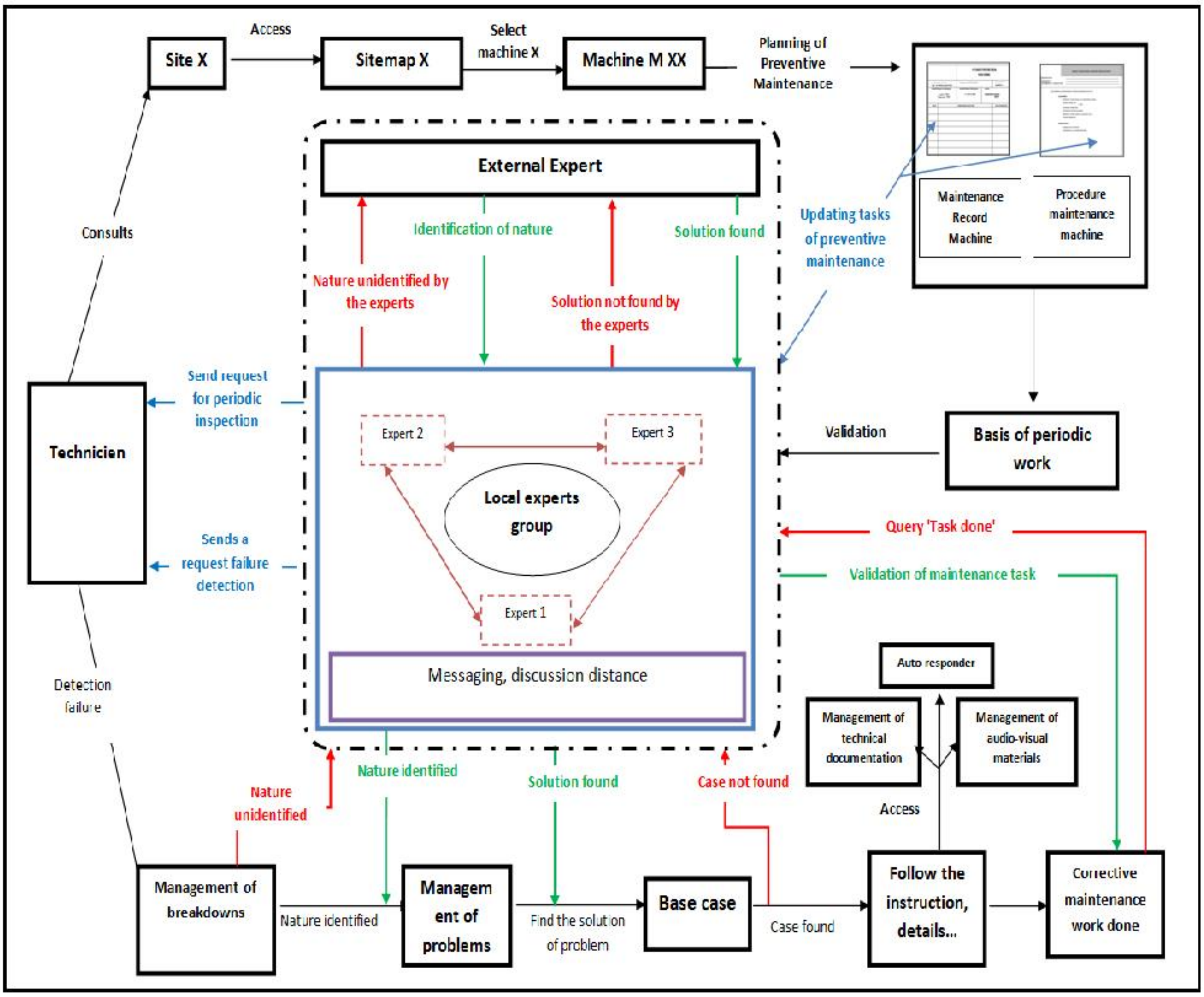

Fig. 6. Scenario of industrial remote maintenance work based on NICT

Regarding the task of preventive maintenance, the group of local experts sends a request to site technician for the periodic inspection of a Machine X, the technician consults the production site by choosing the desired machine for periodic inspection, it between the preventive maintenance schedule while keeping the maintenance procedure and recording in the machine maintenance record. Once the work done, the technician sends a request to the group of local experts to validate the task of preventive maintenance.

The panel refreshes periodic work for each machine, using calculation methods related to maintenance management as indicators MBF (Maintenance based on reliability) [10] as well as methods of quality as the FMECA (Failure Modes, Effects and Criticality Analysis) [11], the Pareto chart (chart 80/20), or the method ... ISHIKAWA, ensuring a reliable systematic forecasting production tools to put in the maintenance procedure (Fig. 6).

5 Conclusion

The use of NICT in industrial maintenance keeps a database of firm-specific knowledge regarding its equipment and reduces its capital lately. The effectiveness of NICT use in maintenance requires high expertise for maintenance personnel in the fields of telecommunications and telecommuting. [8]

In this article, we designed a protocol for cooperative work situations of industrial remote maintenance, while locating the various intangible and tangible resources contributing to this virtual environment, as well as the technical dimension concerning the tasks of corrective and preventive maintenance.

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Pour une meilleure clarification de la relation entre la personnalité de la marque et la publicité persuasive

[Clarifying the relationship between brand personality and persuasive advertising]

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ABSTRACT: The brand personality is one of the concepts that can improve the understanding of brand-consumer relationship. A successful brand management requires the building of a distinct desirable and sustainable brand personality. However, few studies have focused on the antecedents of this concept.
This research attempts to determine the level of traits alteration of brand personality in the case of either three types of processing that relate to central, transitional and peripheral persuasive advertising.
Relying on a literature review, the basic concepts of this research were clarified and a conceptual model was proposed .It include antecedents of brand personality (persuasive advertising and attitude toward the ad), consequences (attitude toward the brand and purchase intention) and moderating variables (brand familiarity and product involvement).
An empirical study was conducted among 1200 individuals representative of Tlemcen city. The results of the data analysis using MANOVA and structural equation modeling confirm our main hypothesis as well as others hypotheses.

KEYWORDS: Brand personality, Persuasive advertising, Brand attitude, Purchase intention, Brand familiarity, Product involvement.

RESUME: La personnalité de la marque est considérée comme l'un des concepts susceptibles d'améliorer la compréhension de la relation marque-consommateur. Une personnalité distincte, désirable et durable est devenue donc un objectif important des brand managers qui doivent définir soigneusement les traits de personnalité de leur marque. Néanmoins peu de recherches se sont focalisées sur les antécédents de ce concept.
Cette recherche s'attache donc à montrer le rôle direct que peuvent avoir les routes de la persuasion publicitaire (centrale, transitoire et périphérique) empruntées par les consommateurs sur leur perception des traits de la personnalité de la marque.
Une revue de la littérature exhaustive a permis de clarifier les concepts fondamentaux de cette recherche et a abouti à un modèle conceptuel intégrant des antécédents de la personnalité de la marque (la publicité persuasive et l'attitude envers l'annonce), ses conséquences (l'attitude envers la marque et l'intention d'achat) et des variables modératrices (la familiarité à la marque et l'implication envers la catégorie du produit).
L'étude empirique a été conduite auprès de 1200 individus représentatifs de la wilaya de Tlemcen. Les résultats de l'analyse de données à l'aide de MANOVA et les modèles d'équations structurelles confirment notre hypothèse principale ainsi que certaines hypothèses proposées.

MOTS-CLEFS: La personnalité de la marque, la publicité persuasive, l'attitude envers la marque, l'intention d'achat, l'implication envers la catégorie du produit.

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1 INTRODUCTION

La personnalité de la marque est l'une des dimensions les plus importantes du capital marque [1]. Elle représente un outil stratégique permettant la mise en place des marques puissantes ([2]; [3]), constitue un facteur de différenciation essentiel pour l'entreprise ([4]; [5]) et l'aide à acquérir un avantage concurrentiel durable [5]. De plus, la personnalité de la marque permet au consommateur de s'identifier à la marque et/ou de valoriser la relation qu'il entretient avec elle et retirer des bénéfices symboliques de sa consommation [6]. L'individu pourra de ce fait développer une vraie relation avec la marque qui peut créer un comportement favorable envers une marque à travers laquelle il peut exprimer qui il est ou veut être [7].
Depuis le travail séminal de [2], ce concept a reçu une attention croissante parmi les chercheurs et les publicitaires ([8] ; [9]; [10]; [11]). Une personnalité distincte, désirable et durable est devenue donc un objectif important dans le cadre du brand management [12]. Les responsables marketing doivent définir soigneusement la personnalité de leur marque et s'assurer ensuite que les consommateurs perçoivent leur marque comme prévu [13]. Selon [14], la personnalité de la marque a deux facettes, «*l'input*» qui correspond à l'ensemble des sentiments et pensées envers la marque que l'entreprise désire communiquer aux consommateurs et «*l'output*» qui correspond aux sentiments réels des consommateurs à l'égard de la marque. Un écart entre ces deux facettes, aura des conséquences importantes sur l'évaluation de la marque. Il est donc important de contrôler les sources d'inférence des traits de la personnalité de la marque. Néanmoins, les antécédents de ce concept sont insuffisamment examinées par les chercheurs [15], encore plus dans le contexte algérien, d'où la nécessité de mener une véritable réflexion autour de cette problématique. Les perceptions des traits de la personnalité de la marque peuvent être influencées par toutes les expériences directes ou indirectes que le consommateur entretient avec la marque ([72] ; [12]). La communication marketing est sans doute l'une des sources d'inférence la plus importante ([14] ; [16]). En effet, dès le début, les études se sont focalisées sur la communication comme source de la personnalité de la marque [17], les publicitaires sont d'ailleurs les premiers à souligner « *qu'une bonne politique de communication doit donner à la marque les attributs d'une personne* » [11]. Certains modèles avancés par des chercheurs ont identifié l'influence indéniable de la publicité ([12]; [18]; [19] ; [20]). Par ailleurs, notre recherche s'attache à montrer le rôle direct que peut avoir les routes de la persuasion publicitaire empruntées consciemment ou inconsciemment par les consommateurs sur leur perception des traits de la personnalité de la marque. La problématique principale de cette recherche peut alors s'articuler autour des questions suivantes :

Quels sont les effets de la publicité persuasive sur la perception des traits de la personnalité de la marque ? En particulier, le traitement de la publicité persuasive est-il une cause d'une perception différente des traits de la personnalité de la marque(BP)?

Nous avons également intégré d'autres variables dans notre modèle conceptuel: l'attitude envers l'annonce (Aad), l'attitude envers la marque(Ab), l'intention d'achat (PI). Des questions secondaires émergent alors :

L'Aad exerce–t-elle une influence sur l'attribution des traits de la personnalité de la marque ?

La personnalité de la marque permet-elle d'expliquer le comportement du consommateur, notamment l'Ab et les intentions d'achat ?

Les objectifs de la recherche

Cette recherche a pour objectifs de :

1. Dresser une image claire de l'état actuel des connaissances sur le concept de la personnalité de la marque et ses antécédents notamment la publicité persuasive.
2. Proposer un modèle des antécédents de la personnalité de la marque ainsi que ses conséquences et le tester dans le contexte algérien.

Pour répondre à nos objectifs, nous reviendrons dans une première partie sur le concept de la personnalité de la marque et les recherches sur ses antécédents en particulier le rôle de la publicité persuasive et nous développerons notre modèle de recherche. Dans la deuxième partie nous présenterons la méthodologie de la recherche, le test des hypothèses et les résultats de l'étude.

2 REVUE DE LA LITTERATURE

Le concept de personnalité de la marque est reconnue tant par les praticiens que par les académiciens depuis les années 50. De nombreux chercheurs en marketing ([21]; [22]; [23], [24]) n'ont pas hésité à personnifier la marque et à la considérer comme un partenaire avec lequel un individu entretient une relation mais il fallait attendre la fin des années 1990 pour que le travail fondateur de [2] voit le jour. En effet, [2] fut la pionnière dans la définition de ce concept et le développement d'une échelle de mesure spécifique.

2.1 DEFINITION DU CONCEPT DE LA PERSONNALITE DE LA MARQUE

Comme pour le cas de la personnalité humaine il n'y a pas de réel consensus sur la définition du concept de la personnalité de la marque. Ainsi, il existe de nombreuses définitions de la personnalité de la marque. En 1997, [2] définissait pour la première fois la personnalité de la marque comme «*L'ensemble des caractéristiques humaines associées à une marque* ». Bien que, cette définition fondatrice a été acceptée dans la plupart des travaux qui ont suivi, elle a fait l'objet de nombreuses critiques. [17] estiment que cette définition est trop large car d'un côté, [2], considère la personnalité de la marque comme un construit à part et global et non pas comme un facette de l'identité ce qui peut provoquer un risque de fusionner plusieurs facettes de l'identité de la marque à l'intérieur de ce construit global dénommé par [2] *« la personnalité de la marque»*. D'un autre côté, certains items de l'inventaire d'Aaker ne relèvent pas domaine de la personnalité. Par exemple « *jolie »*, « *compétente* » ou « *féminine* » puisque les « *caractéristiques humaines* » ne recouvrent pas uniquement les traits de personnalité. D'où les auteurs soulignent la nécessité d'une définition plus stricte. [25] propose la définition suivante : « *l'ensemble des traits de personnalité humaine applicable et pertinents pour les marques*». [4] trouve également que cette définition est trop large et que son échelle comprend des dimensions qui n'existent dans aucune échelle de mesure de la personnalité humaine (sophistication et rudesse) et certains traits représentent plutôt des jugements sociaux tels que provincial, branché ou aristocrate. Elle propose alors la définition suivante: « *La personnalité de la marque est l'ensemble des traits de la personnalité humaine associés aux marques* ».

Contrairement à ces des définitions restrictives de ce concept, d'autres par contre continuent dans la même lignée de [2] par exemple : [16] recommandent l'élargissement du champ de la personnalité de la marque au-delà de la personnalité humaine car des caractéristiques comme l'origine sont importantes dans l'évaluation de la personnalité de la marque.

Dans notre recherche nous adoptant la vision large et souple de la personnalité de la marque car le concept de trait lui-même est vague [26]. En plus certaines caractéristiques humaines associées à la marque peuvent avoir une pertinence managériale comme par exemple le genre ([27]; [28] ; [29] ; etc.).

2.2 LES ANTECEDENTS DE LA PERSONNALITE DE LA MARQUE

Les antécédents de ce concept sont malheureusement peu étudiés par les chercheurs [15]. [24] note que l'ensemble d'inférences de traits construites par le consommateur sur la base d'observations répétées des comportements de la marque réalisés par le responsable marketing constitue la personnalité de la marque. Ainsi, les traits de la personnalité de marque sont en effet créés de différentes manières et avec de nombreux outils [15]. Au début l'accent était mis sur la communication comme étant la source d'inférence principale du fait que l'origine du concept de personnalité de la marque est largement ancré dans les pratiques des publicitaires [17]. Récemment, le champ de recherche sur les antécédents s'est élargie et a inclus toutes les variables du marketing-mix ou encore des variables liées à la stratégie de la marque. Tout contact direct ou indirect que le consommateur a avec la marque est de ce fait une source d'inférence des traits de la personnalité de la marque ([30] ; [14]).

2.2.1 LES SOURCES DIRECTES

[16], indiquent que les consommateurs peuvent associer des traits de personnalité à une marque d'une manière directe par le biais des personnes «associées». Ces personnes peuvent êtres l'utilisateur de la marque, le personnel de l'entreprise, les endosseurs de la marque en particulier les célébrités. On peut rajouter également « *l'expérience directe du consommateur avec la marque* », puisque les traits de personnalité sont des associations à la marque et [31] considère l'expérience directe du consommateur avec la marque comme un antécédent direct des associations à la marque.

2.2.2 LES SOURCES INDIRECTES

Les traits de la personnalité de la marque peuvent être également attribués indirectement à travers les attributs reliés aux produits, les associations faites sur la catégorie de produit, le nom de la marque, du symbole, le logo, le style publicitaire, le prix, le canal de distribution, etc. [16]. D'autres antécédents ont été identifiés dans la littérature par ([14] ; [31]; [32] ; [2] ;etc.) : Les illustrations publicitaires, la mise en page de la publicité, les médias publicitaires, le texte de la publicité, le ton de la publicité, l'âge de la marque, le nom de la marque, les symboles et logos, les techniques photographiques, les couleurs, les associations à la firme, l'image de la firme, le pays d'origine, les symboles culturels, les émotions et sentiments évoqués, la musique, le packaging, les attributs du produit, la forme du produit, les localisations en magasins, la promotion des ventes et la typographie.

Dans notre recherche nous nous intéresserons principalement au rôle de la publicité persuasive

2.3 Le Modele Conceptuel Et Les Hypotheses De Recherche

2.3.1 L'influence directe de la publicité persuasive sur la personnalité de la marque, l'Aad, l'Ab et PI

D'après [33], « Dès lors que la marque communique, elle acquiert un caractère qui lui confère une personnalité ». Il existe en effet « un lien fort entre l'emphase sur quoi est mis par la communication marketing et la perception des consommateurs de la personnalité de la marque » [34]. La personnalité de la marque est donc très influencée par la communication [35]. La publicité est considérée comme l'un des outils de communication les plus efficaces [36] et l'une des sources d'inférence la plus importante pour la personnalité des marques [16]. L'utilisation des célébrités dans les publicités est sans doute la meilleure source d'inférence des traits de la personnalité. Quoique cette pratique est encore populaire [37], toute forme de publicité influe sur la personnalité de la marque et non seulement quand un endosseur est utilisé [20]. Le rôle de la publicité dans la formation des traits de la personnalité de la marque a été prouvé par de nombreux chercheurs (voir tableau 1).

Tableau 1. Les recherches antérieures sur l'impact de la communication marketing sur la personnalité de la marque

Auteurs	Résultats
[38]	Les marques qui utilisent des célébrités dans les publicités sont perçues plus sincères.
[35], [31], [39]	La communication marketing a un effet sur la personnalité qu'octroient les consommateurs aux marques.
[9]	Les marques dont les publicités utilisent des métaphores plutôt que des textes et des images sont perçues sophistiquées, dynamiques mais moins sincères.
[40]	La communication dans les sites Internet influence toutes les dimensions de la personnalité de la marque des écoles de commerce.
[41]	les sites peuvent par leur contenu créer des personnalités audacieuses, analytiques ou amicales.
[42]	Il y a une relation entre les dimensions de la personnalité de la marque et les formes de communications dans un environnement électronique.

Néanmoins, il apparait qu'aucune recherche antérieure ne s'est intéressée à explorer le rôle des routes de la persuasion dans l'attribution des traits de la personnalité de la marque.

La persuasion publicitaire définit par [43], comme « l'ensemble des mécanismes psychologiques initiés par la diffusion de la publicité, relatifs au traitement de celles-ci ou du produit objet de cette publicité et, susceptibles d'engendrer un changement d'attitude vis à vis de la marque communiquée» a fait l'objet de nombreuses études dans plusieurs disciplines à savoir la psychologie sociale, sciences de la communication et le Marketing. La recherche sur ce sujet s'est accrue depuis les années 80s, plusieurs modèles ont ainsi vu le jour et ont tenté d'expliquer la complexité du processus de persuasion publicitaire.

Les modèles de persuasion à routes multiples en particulier le modèle ELM de [44], [45] indiquent que le consommateur choisit la route de persuasion qui correspond à un degré de traitement des informations contenues dans la publicité plus ou moins fort par les personnes [44], [45]. La route centrale où le consommateur est motivé et traite les informations en profondeur, sa réaction est cognitive et analytique; La route périphérique, où celui-ci est faiblement impliqué et forme donc son attitude sur la base des d'éléments périphériques présents dans la publicité, sa réaction est plus affective et un lien affectif se créera entre lui et la marque.

Il est à noter que [44] présentent les routes centrale et périphérique comme deux extrêmes sur un même continuum de probabilité d'élaboration. En général, la route périphérique prépare la route centrale si l'un des indicateurs périphériques, entraînent une capacité et une motivation à traiter le message en profondeur ([46] ; [47]). Par contre, des niveaux modérés d'élaboration, impliquent l'emprunt des deux routes en même temps, ainsi la qualité des arguments et l'attractivité des indicateurs périphériques influencent toutes les deux l'attitude ([48] ; [49]).

Dans la suite de cette recherche, nous ferons référence à trois routes, la centrale, la périphérique et la route transitoire, cette dernière étant le résultat d'une implication modérée. Cette qualification de «transitoire » est justifiée par la référence aux certains auteurs qui ont suggéré qu'on peut considérer les deux routes, dans certaines situations, comme imbriquées ou interdépendantes ([50]; [51]).

Le Tableau 2 synthétise les caractéristiques du processus de persuasion mis à l'œuvre sur chacune des routes utilisées dans notre recherche.

Tableau 2. Les routes de persuasion étudiées dans cette recherche

	Route centrale	Route transitoire	Route périphérique
Processus	-Acquisition et traitement de l'information en profondeur -Elaboration sur les éléments pertinents	-Traitement sélectif de l'information -Elaboration sur les éléments saillants	-Traitement automatique peu coûteux en ressources cognitives
Antécédents	Forte implication	Implication modérée	Faible implication
Nature du processus	La cognition	Cognition+Affect	L'affect

En s'inspirant largement des modèles de persuasion à routes multiples en particulier le modèle ELM, nous proposons l'hypothèse suivante :

H1 : le changement du traitement (périphérique, transitoire ou central) de la publicité persuasive modifie :
H1.1:La perception de la personnalité de la marque ; H1.2: l'Aad ; H1.3: l'Ab ; H1.4: PI.

2.3.2 L'INFLUENCE DE LA PERSONNALITÉ DE LA MARQUE SUR AB ET PI

Dans le cadre de notre recherche, nous nous limitons à deux conséquences de la personnalité de la marque à savoir : l'Ab et PI. Récemment, [52] ; [53] ; [54]; [55]; etc. ont montré un lien positif significatif entre la personnalité de la marque et l'Ab. [33]; [56]; [57] ont de leur côté confirmé que la personnalité de la marque avait également un impact significatif sur leurs intentions de comportement futur. Il parait donc légitime de proposer l'hypothèse suivante :

H2: Il existe un lien de causalité entre la personnalité de la marque et :
H2.1 : L'Ab ; H2.2 : PI.

2.3.3 L'INFLUENCE DE L'AAD SUR LA PERSONNALITÉ DE LA MARQUE, AB ET PI

Plusieurs études ont prouvé l'existence d'un lien causal entre l'Aad publicitaire et l'Ab. Les premiers travaux sur le sujet sont de [58] et [59]. D'autres chercheurs ont montré que PI est une conséquence d'Aad [60]. L'Aad constitue un médiateur (au moins partiel) de l'effet des messages publicitaires sur l'Ab [61] et PI.

En outre aucune recherche à notre connaissance ne s'est attachée à étudier l'influence d'Aad sur la personnalité de la marque. Nous pensons pourtant que cette variable pourrait jouer un rôle important pour déterminer la profondeur de traitement de l'information. Selon [62], une attitude positive envers l'annonce engendrera d'une manière générale un traitement plus profond de la publicité. Ce qui va se répercuter sur la perception des traits de la personnalité de la marque.

De ce fait nous proposons l'hypothèse suivante :

H3 : Il existe un lien de causalité entre l'Aad et :
H3.1 : La personnalité de la marque ; H3.2 : L'Ab ; H3.3 : PI.

2.3.4 L'INFLUENCE DIRECTE DE L'AB SUR PI

Selon [63], les attitudes conduiraient aux intentions qui ensuite mèneraient au comportement réel. En se basant sur ce travail séminal de nombreux chercheurs se sont intéressés à ce lien causal ([33]; [64]). Il ressort qu'il existe une relation positive entre l'Ab et PI. De ce fait nous posons l'hypothèse suivante:

H4 : Il existe un lien de causalité entre Ab et PI.

2.3.5 L'IMPACT MODÉRATEUR DE L'IMPLICATION ENVERS LA CATÉGORIE DU PRODUIT

L'implication envers la catégorie du produit est l'une des variables les plus utilisées dans les recherches sur la persuasion publicitaire. Une situation de forte implication envers la catégorie du produit peut affecter :

- L'effort de compréhension en augmentant les cognitions liés au produit dans le but d'évaluer la pertinence de l'argumentation voire même les contre arguments [58], ce qui pousse le consommateur à emprunter la route centrale pour former ses croyances et jugement sur la marque ([44]; [65]) contrairement à la route périphérique.
- La perception de la nouveauté, les nouveaux stimuli seront compris plus facilement et perçus donc comme moins incongrus par les individus fortement impliqués que faiblement impliqués [66].
- L'achat où le consommateur utilisera plus de critères de choix que pour un produit peu impliquant [67].
- Le nombre de connexions et d'idées activées dans l'esprit du consommateur qui sera naturellement plus grand [68].

C'est donc en cas de faible implication que les consommateurs risquent d'être influencés par des éléments appartenant à des routes « périphériques » selon le modèle ELM [45]. Nous postulons alors que :

H5 : l'implication dans la catégorie de produit modère les relations entre la publicité persuasive et :
H5.1 : l'Aad ; H5.2 : La personnalité de la marque ; H5.3 : l'Ab ; H5.4 :PI.

2.3.6 L'IMPACT MODÉRATEUR DE LA FAMILIARITÉ

La familiarité avec la marque est également apparue dans les recherches antérieures comme susceptible de modérer l'influence de la publicité persuasive sur le comportement du consommateur [69]. Par rapport aux marques peu familières ou inconnues, les marques familières disposent d'un réseau mémoriel plus élaboré et plus complexe dans l'esprit du consommateur ([70] ; [71]) du fait du grand nombre d'expériences directes ou indirectes avec elles [72]. Ce qui implique des croyances fermes sur les marques [73]. La familiarité avec la marque permet l'encodage et la restitution de l'information concernant la marque [74] car lors du traitement des informations, les consommateurs font plus attention aux stimuli qui lui sont familiers [75]. Plusieurs auteurs soulignent que la familiarité augmente la probabilité que la marque entre dans l'ensemble discuté et elle motive les comportements d'achat. D'après [76], la familiarité à la marque impacte toutes les perceptions des consommateurs vis-à-vis de la marque. Ainsi en se basant sur ce qui a été évoqué dans notre recherche nous pouvons déduire que lorsque la marque est familière, la publicité persuasive a une influence moins importante sur la perception des traits de la personnalité de la marque du fait que les consommateurs ont déjà une idée sur la marque et lui ont attribué une personnalité a contrario la perception des traits de personnalité des marques non familières sera basée uniquement sur la publicité et son contenu. Aussi, les individus qui sont familiers avec une marque donnée peuvent accorder plus d'attention à la publicité. Il s'avère que les marques fortes bénéficient d'un avantage indéniable d'encodage et de stockage d'associations dans la mémoire des consommateurs par rapport aux marques inconnues [77]. D'autre part [78] soulignent que Aad influence Ab, notamment lorsqu'il s'agit de marques inconnues. De nombreuses recherches ont également évoqué que les réactions affectives engendrées par les stimuli publicitaires influence de façon significative et plus facile les marques non familières [61]. Cela peut avoir des conséquences différentes sur l'impact de la publicité persuasive sur la personnalité de la marque et l'Aad. Pour vérifier les raisonnements qui viennent d'être développés, l'hypothèse H9 est postulée.

H6: La familiarité à la marque modère les relations entre la publicité persuasive et:
H6.1 : l'Aad ; H6.2 : La personnalité de la marque ; H6.3 : L'Ab ; H6.4 : PI

La figure ci-dessous illustre notre modèle conceptuel.

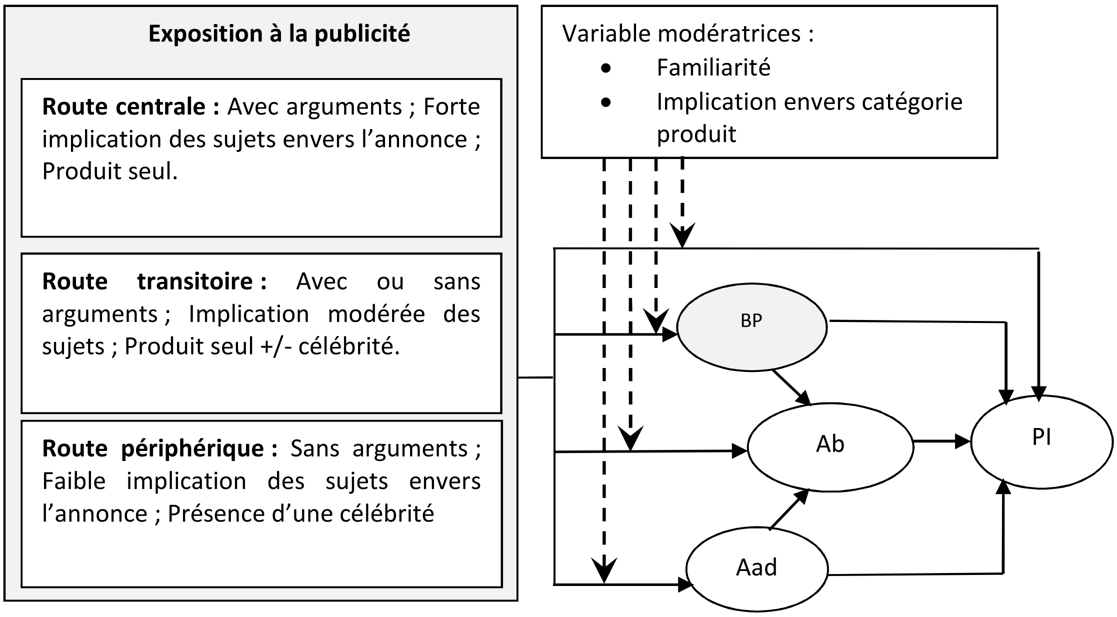


Fig. 1. Le modèle conceptuel

3 L'ETUDE EMPIRIQUE

3.1 METHODOLOGIE DE RECHERCHE

3.1.1 LE CHOIX DES PRODUITS, MARQUES, STIMULI ET DES ÉCHELLES DE MESURE

3.1.1.1 SÉLECTION DES PRODUITS :

Il a été nécessaire de retenir les catégories de produits en fonction du différentiel au niveau de l'implication, car nous avons introduit l'implication envers la catégorie du produit comme variable modératrice dans notre modèle conceptuel. Notre choix final a été fixé sur les boissons gazeuses et le voitures.

3.1.1.2 SÉLECTION DES MARQUES :

Puisque la familiarité à la marque est l'une de nos variables modératrices, il nous fallait des marques connues et d'autres inconnues pour notre cible. Concernant les marques connues, nous nous sommes basés sur les résultats d'un test de notoriété spontanée. Les marques qui se situaient au premier rang de citation ont été sélectionnées. Ainsi pour les boissons gazeuses le choix s'est porté sur la marque Coca Cola, en outre la marque Peugeot a été sélectionnée pour les voitures.

En ce qui concerne les marques inconnues, nous avons opté pour la marque Lorina pour les boissons gazeuses et Maybach pour les voitures. Afin de s'assurer que notre cible ne connait pas ces marques, nous avons testé la familiarité avec ces marques auprès de 40 personnes (20 hommes et 20 femmes), les résultats confirment nos propos et indiquent en effet que Lorina et Maybach sont inconnues en Algérie.

3.1.1.3 SÉLECTION DES CÉLÉBRITÉS :

Notre expérimentation nécessite l'utilisation de célébrité ayant une forte notoriété donc nous avons procéder dans une première étape à un test de notoriété spontanée puis dans une deuxième étape à test de notoriété assistée. Le choix final des célébrités était porté sur l'acteur KivanTutlang (connu par Mohaned) pour les voitures, et Nanci Ajram pour les boissons gazeuses.

3.1.1.4 RÉALISATION DES ANNONCES :

Nous avons utilisé des annonces imprimées. Ainsi, pour chaque marque utilisée, deux annonces ont été créées. Elles varient selon leur caractère informatif (avec ou sans arguments) et la présence versus l'absence de la célébrité. Mise à part une annonce réelle de la marque Coca Cola avec célébrité[1], toutes les autres annonces ont été réalisées avec photoshop 7 (voir annexe 1).

3.1.1.5 L'IMPLICATION VIS-À-VIS DE L'ANNONCE :

Chaque questionnaire commençait par une instruction qui visait à varier le niveau d'implication des sujets vis à vis des annonces publicitaires. La méthode des scénarios semble être une bonne solution. Ainsi pour réaliser notre expérience nous avons créé deux scénarios inspirés de la littérature ([79]; [45]) (voir Tableau 3).

Tableau 3 : les scénarios utilisés

Exemple de scenarios pour la boisson gazeuse	
Scénario à forte implication	Le questionnaire suivant est réalisé dans le cadre d'une recherche doctorale. Il est destiné à évaluer une publicité sur une marque de boisson gazeuse. Nous vous demandons d'être attentifs aux informations communiquées dans la publicité pour pouvoir répondre au questionnaire et ainsi accroître vos chances pour participer à un tirage au sort pour désigner les gagnants d'un montant de 5000 DA
Scénario à faible implication	Le questionnaire suivant est réalisé dans le cadre d'une recherche doctorale. Il est destiné à évaluer une publicité sur une marque de boisson gazeuse. Nous vous remercions par avance de bien vouloir consacrer quelques minutes à le remplir.

3.1.2 LE DESIGN EXPÉRIMENTAL

Nous avons utilisé un plan factoriel 2X2X2 (Quatre facteurs à deux modalités chacun) (voir Tableau 4) qui permet d'obtenir 8 combinaisons possibles.

Tableau 4 : Le design expérimental

	Marques connues		Marques inconnues	
	voiture	Boissons gazeuses	voiture	Boissons gazeuses
Publicité: - avec arguments - produit seul - forte implication des sujets	Peugeot 150	Coca Cola 150	Maybach 150	Lorina 150
Publicité: - sans arguments - célébrité - faible implication des sujets	Peugeot 150	Coca Cola 150	Maybach 150	Lorina 150

[1] *NanciAjram est l'une des célébrités qu'utilise la marque Coca Cola dans ces publicités destinées au monde arabe, de ce fait on a utilisé une annonce réelle de la marque Coca Cola avec Nanci Ajram.*

3.1.3 LA POPULATION CIBLE

Notre étude a été réalisée auprès d'un échantillon représentatif de la wilaya de Tlemcen de 1200 individus âgés de plus de 17 ans. Nous avons utilisé la méthode des quotas pour construire notre échantillon en se basant sur le RGPH 2008. Deux critères principaux sont pris en considération: L'âge (de 17 à 69 ans) et le genre.

3.1.4 ANALYSES, RÉSULTATS ET DISCUSSION

3.1.4.1 SÉLECTION ET ÉPURATION DES ÉCHELLES DE MESURE

La personnalité de la marque : Le BPI d'[2] adapté au contexte algérien par [80] (20 items) ; L'Aad : échelle de [58] (4 items) ; La familiarité de la marque par le répondant : test mono item ; L'Ab : échelle de [81] (3 items) ; L'implication vis-à-vis de la catégorie de produit : échelle de [82] (6 items) ; PI : échelle de [83] (test mono item).

Des analyses exploratoires et confirmatoires ont été réalisées sur l'ensemble des échelles. Des ACP avec rotation promax ont été conduites sur l'échelle de la personnalité de la marque. En outre, la rotation varimax a été appliquée aux autres échelles. Après la suppression de deux items de l'échelle de l'implication envers la catégorie du produit et un item de l'échelle de l'Aad, les résultats mentionnés en annexe 2 indiquent :

- Pour toutes les échelles, les données sont adéquates à la factorisation (tous les KMO sont supérieur à 0,7 et le test de sphéricité de Bartlett est significatif). Le pourcentage de la variance expliquée dépasse 70%. Les communautés et les poids factoriels des items sont également élevés (>0,5).
- L'alpha de Cronbach et le Rhô de Jöreskog sont très satisfaisants.
- Les analyses confirmatoires relèvent une bonne qualité d'ajustement des modèles.

3.1.4.2 TEST DE L'HYPOTHÈSE DE L'INFLUENCE DU CHANGEMENT DU TRAITEMENT DE LA PUBLICITÉ

La vérification de cette hypothèse a été effectuée par le biais de l'analyse de variance MANOVA. Les résultats soutiennent fortement le rôle de la publicité persuasive comme antécédent de la personnalité de la marque. L'effet est significatif sur pratiquement toutes les dimensions de la personnalité de la marque, (sauf pour la dimension compétence de la marque Coca Cola et Peugeot) (voir Tableau 5).

Tableau 5: Influence de la publicité persuasive sur la personnalité de la marque et l'Aad, l'Ab et PI

		Coca Cola		Lorina		Peugeot		Maybach	
Source		F	Sig.	F	Sig.	F	Sig.	F	Sig.
Publicité persuasive	Ab	2,692	0,102	18,81	0,00	7,663	0,006	6,075	0,014
	Aad	19,933	0,00	20,146	0,00	131,982	0,00	0,737	0,039
	DYNAM	10,411	0,023	143,265	0,00	12,961	0,03	16,455	0,00
	SINCER	4,32	0,038	27,968	0,00	13,608	0,00	26,103	0,014
	COMPET	0,371	0,543	35,063	0,00	0,447	0,504	11,734	0,039
	SOPHI	3,645	0,047	7,634	0,047	4,054	0,043	6,943	0,009
	MASCU	16,61	0,00	118,717	0,00	6,398	0,048	21,867	0,00
	PI	0,818	0,366	0,01	0,919	8,645	0,003	3,693	0,045

Légende : Les cellules grisées représentent les liens significatifs

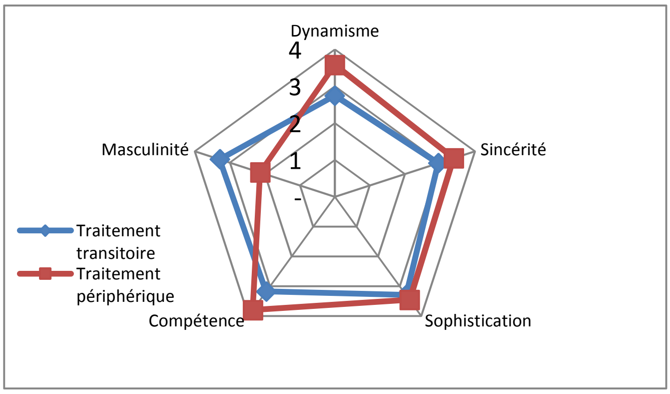
De même, les figures ci-après montrent clairement la différence dans la perception des dimensions de la personnalité des marques étudiées selon le type de traitement de la publicité.

1- La marque Coca Cola : La marque Coca Cola est jugée plus masculine lorsque la route transitoire de la persuasion est empruntée. Par ailleurs dans le cas de la route périphérique, Coca Cola est perçue plus dynamique, sincère est sophistiquée. En ce qui concerne la dimension compétence nous n'observons pas de différence significative.

2- La marque Lorina : Les consommateurs ont jugé la marque Lorina plus dynamique, sincère, compétente est sophistiquée et moins masculine quand ils ont emprunté la route périphérique.

3- La marque Peugeot : Concernant la marque Peugeot, nous constatons que la marque a un profil différent selon les voies de persuasion. Elle est perçue plus dynamique, sincère, et masculine dans le cas d'un traitement central. Par ailleurs aucune différence significative n'est observée pour la dimension compétence.

4- La marque Maybach : La marque Maybach est jugée plus sophistiquée et plus compétente dans un traitement transitoire, en revanche les moyennes observées des autres dimensions sont plus élevés lorsque le traitement est central.



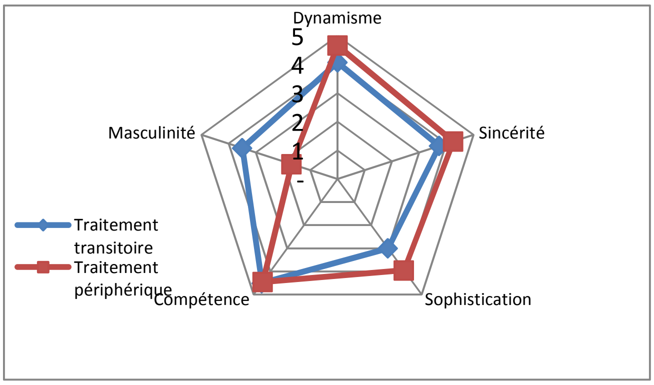
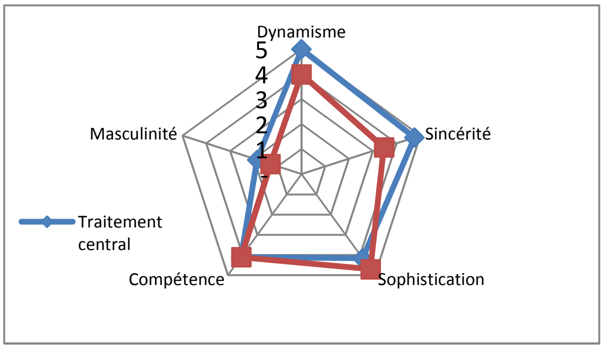


Fig.2. Profil de la marque Coca Cola

Fig.3. Profil de la marque Lorina



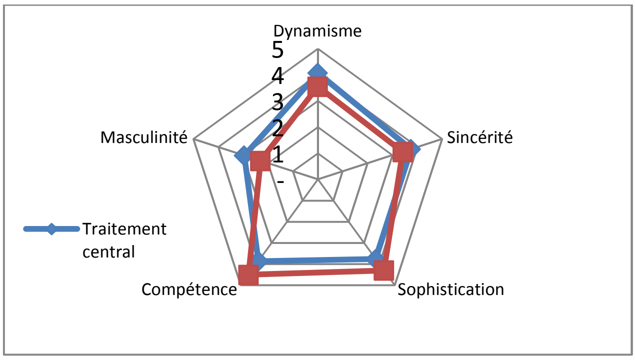


Fig.4. Profil de la marque Peugeot

Fig.5. Profil de la marque Maybach

Ces résultats indiquent que si on souhaite véhiculer certains traits de personnalité la marque on peut agir sur le choix des routes de persuasion publicitaire. Par exemple dans le cas de notre étude le consommateur algérien:

- A jugé les marques plus sophistiquées et moins masculines lorsque le produit est présenté avec une célébrité dans une publicité.
- A perçu les marques de voitures plus dynamiques et sincères en cas de traitement central et les marques de boissons gazeuses en cas de traitement périphérique. Il serait donc nécessaire d'examiner le rôle modérateur de l'implication envers la catégorie du produit.
- Pas de différence significative pour les marques connues sur la dimension compétence. Nous reviendrons donc sur le rôle modérateur de la familiarité à la marque.

Notre première hypothèse postulait également que le changement du traitement de la publicité persuasive a un impact sur l'Aad, Ab et PI. Les résultats présentés dans le tableau 5 confirment:

- L'impact sur Aad dans le cas de toutes les marques.
- L'impact sur Ab pour les marques Lorina, Peugeot et Maybach. En effet nous n'avons pas observé une relation significative dans le cas de la marque Coca Cola. Çà peut être expliqué par le fait que Coca Cola, la marque la plus célèbre au monde a déjà une place privilégiée et établie dans l'esprit des consommateurs.

3.1.4.3 Test des hypothèses du modèle structurel

Les hypothèses testant les relations directes (H2, H3, H4) ont été testées par le biais des équations structurelles avec la méthode maximum de vraisemblance en utilisant le *bootstrap* avec un intervalle de confiance à 95%. Les indices d'ajustement des modèles structurelles obtenus peuvent être considérés comme bons (voir annexe 3), nous pouvons désormais présenter les résultats.

3.1.4.3.1 TEST DE L'HYPOTHÈSE DE L'INFLUENCE DE LA PERSONNALITÉ DE LA MARQUE SUR AB ET PI

Les résultats relatifs à l'impact de la personnalité de la marque mentionnés en annexe 4 supportent les conclusions de plusieurs études antérieures qui ont montré que la personnalité de marque peut être un antécédent important de l'attitude de la marque ([2]; [52]; [53] ; [54] ; [55]). En revanche, nous avons constaté une absence de corrélations entre la personnalité de la marque et PI qui est en contradiction avec la littérature. En effet avec seulement quelques relations significatives (la plus part des résultats ont été validés dans le cas d'un traitement périphérique) nous ne pouvions pas valider l'hypothèse.

- Une première explication de ce résultat inattendu peut être recherchée dans les travaux sur l'endossement par les célébrités. Les sujets ne connaissent pas les marques Mayabach et Lorina et n'ont aucune expérience directe avec elles, et pourtant c'est la dimension compétence qui influence leur intention d'achat mais uniquement dans le cas d'un traitement périphérique. D'après [84], les célébrités utilisées par les entreprises dans leurs compagnes de communication sont souvent perçues comme étant très dynamique et compétentes. Elles vont par la suite transmettre un ensemble d'associations aux produits [85] ce qui va générer des intentions favorables.
- Une deuxième explication peut être attribuée au fait, que notre modèle contient plusieurs variables médiatrices. Les modèles d'équations structurelles analysent simultanément plusieurs variables dans une régression multiple, l'impact de la variable indépendante sur la variable dépendante pourrait être nul si la médiation est totale.
- Enfin nous pouvons expliquer ce résultat par le fait que la collecte de données immédiate limite la validité des intentions d'achat déclarées [47].

3.1.4.3.2 TEST DE L'HYPOTHÈSE DE L'INFLUENCE DE L'AAD SUR LA PERSONNALITÉ DE LA MARQUE, L'AB ET PI

Les résultats du modèle structurel (voir annexe 5) soutiennent fortement le rôle d'Aad comme antécédent de la personnalité de la marque. En effet, l'impact d'Aad est significatif sur les cinq dimensions de la personnalité de la marque, avec des coefficients standardisés positifs (sauf pour la dimension masculinité : plus l'Aad est favorable moins la marque est masculine). De même, Aad a un impact direct, significatif et positif sur l'Ab mais uniquement pour les marques inconnues. Ces résultats confortent les propos de certains auteurs qui stipulent que les individus ont des croyances fermes sur les marques qui leur sont familières ([61]; [73]).

3.1.4.3.3 TEST DE L'HYPOTHÈSE DE L'INFLUENCE DE L'AB SUR PI

Les résultats dans le tableau ci-dessous mettent en évidence que l'Ab exerce une influence sur PI dans le cas de tous les types de traitement pour toutes les marques ($p<0,05$). Ils confirment ainsi nos conclusions quant au rôle direct de l'Ab sur PI et soutiennent la littérature existante.

Tableau.6. Test de l'hypothèse de l'influence de l'Ab sur PI

Marque		***coeff. stand.***	***borne inf.***	***borne sup.***	P
Coca Cola (traitement transitoire)	PI <--- Ab	0,38	0,94	0,549	0,017
Coca Cola (traitement périphérique)	PI <--- Ab	0,314	0,082	0,573	0,024
Lorina (traitement transitoire)	PI <--- Ab	0,218	0,061	0,493	0,015
Lorina(traitement périphérique)	PI <--- Ab	0,68	0,155	0,810	0,023
Peugeot (traitement central)	PI <--- Ab	0,298	0,078	0,340	0,031
Peugeot (traitement transitoire)	PI <--- Ab	0,174	-0,204	0,578	0,044
Maybach (traitement central)	PI <--- Ab	0,374	0,163	0,648	0,012
Maybach(traitement transitoire)	PI <--- Ab	0,714	0,163	0,852	0,032

Légende : Les cellules grisées représentent les liens significatifs

3.1.4.4 LE TEST DES VARIABLES MODÉRATRICES

Pour explorer le rôle modérateur de la familiarité à la marque et l'implication envers la catégorie du produit, nous avons dans un premier temps recodé ces variables en deux groupes séparés par une division à la médiane. Des analyses de variances (MANOVA) ont été réalisées ensuite :

3.1.4.4.1 Test de l'hypothèse de l'impact modérateur de l'implication envers la catégorie du produit sur la relation de la publicité persuasive avec la personnalité à la marque l'Aad, l'Ab et PI

Les résultats illustrés dans le tableau 7 indiquent clairement que l'implication envers la catégorie du produit interagit avec la publicité persuasive pour influencer Ab (F=12,426, p=0,00) et les dimensions dynamisme (F=6,00, p=0,014), sincérité (F=8,331, p=0,024) et compétence (F=8,757, p=0,03) de la personnalité de la marque.

3.1.4.4.2 Test de l'hypothèse de l'impact modérateur de la familiarité sur la relation de la publicité persuasive avec la personnalité à la marque l'Aad, l'Ab et PI

Il apparaît, au travers le tableau 7, que la familiarité à la marque modère uniquement le lien publicité persuasive ➔ personnalité de la marque, il s'agit des dimensions dynamisme (F=9,911, p=0,02), sincérité (F=6,658, p=0,02), compétence (F=3,636, p=0,042) et masculinité (F=15,664, p=0,00).

Tableau.7. Impact modérateur de l'implication envers la catégorie du produit la familiarité sur la relation de la publicité persuasive avec la personnalité à la marque, Aad, Ab et PI.

	Implication * publicité persuasive		Familiarité * publicité persuasive	
	F	**Sig.**	**F**	**Sig.**
MASCULINITÉ	0,436	0,509	15,664	0
PI	0,229	0,632	0,18	0,672
Aad	2,138	0,144	0,15	0,698
Ab	12,426	0	0,006	0,939
DYNAMISME	6	0,014	9,911	0,002
SINCÉRITÉ	8,331	0,0249	6,658	0,01
COMPÉTENCE	8,757	0,003	3,636	0,042
SOPHISTICATION	1,072	0,301	0,099	0,753

Légende : Les cellules grisées représentent les liens significatifs

4 Conclusion Generale

Dès le début de cette recherche nous avons posé un certain nombre de questions sur le rôle direct que pouvait avoir les routes de persuasion empruntées par les consommateurs sur leur perception des traits de la personnalité de la marque. Ces interrogations sont le fondement de notre recherche et font l'originalité de ce travail dans la mesure où la perception des traits de la personnalité de la marque n'a d'après la lecture des recherches précédentes, jusqu'à présent, jamais été abordée sous cet aspect. Comme nous avons déjà souligné, peu de chercheurs en marketing se sont intéressés aux antécédents de la personnalité de la marque. Certains modèles avancés par des chercheurs ont identifié l'influence de la publicité, par ailleurs, notre recherche s'attache à montrer l'impact des modes de traitement des publicités persuasives par les consommateurs.

Les résultats de la recherche montrent effectivement que le changement du traitement de la publicité persuasive modifie la perception de la personnalité de la marque. Ils indiquent que si on souhaite véhiculer certains traits de personnalité de la marque, on peut agir sur le choix des routes de persuasion publicitaire. Dans le cadre de ce papier, nous n'avons pas cherché à démontrer la prééminence de l'une ou l'autre de ces routes. Au contraire nous avons essayé de montrer l'impact de chacune des routes en considérant que toutes les routes ont leur place dans l'attribution des traits de la personnalité de la marque.

Cette étude a également relevé que la familiarité à la marque modère le lien publicité persuasive ➔ personnalité de la marque notamment les dimensions *Dynamisme*, *Sincérité*, *Compétence* et *Masculinité*. En outre l'implication envers la catégor+ie du produit interagit avec la publicité persuasive pour influencer l'Ab et les dimensions dynamisme, sincérité et compétence de la personnalité de la marque. L'intégration, comme variable modératrice, du niveau d'implication envers le produit et de la familiarité à la marque est donc indispensable à la bonne compréhension du rôle des routes de persuasion sur la personnalité de la marque.

Les apports de la recherche

Notre contribution se veut théorique, méthodologique et managériale :

1- Apports théoriques de la recherche **:** Nous avons constaté que les travaux de recherche en marketing sur les antécédents de la personnalité de la marque restent limités. Ceci est encore plus vrai en ce qui concerne le rôle des routes de la persuasion publicitaire. La rareté des contributions dans ce domaine réaffirme de ce fait l'intérêt théorique de la présente recherche.

D'autre part, en s'appuyant sur les modèles de persuasion publicitaire en particulier le modèle ELM, nous avons mis en évidence une troisième route de persuasion « ***la voie transitoire*** » qui est caractérisée par une implication modérée et qui se trouve entre la voie centrale et périphérique. De plus, nous avons analysé l'influence de ces trois routes de persuasion en même temps ce qui permet d'enrichir les connaissances dans ce domaine.

Cette recherche constitue également une contribution empirique supplémentaire sur les antécédents et les conséquences de ce concept. En effet, nous avons proposé un modèle intégrant les antécédents (Aad et publicité persuasive) et les conséquences (Ab et PI) de la personnalité de la marque. Puis nous l'avons testé auprès des consommateurs algériens où notre étude constitue l'une des premières recherches sur ce domaine.

2- Apports méthodologiques : L'adaptation de l'échelle de mesure d'Aaker au contexte algérien constitue un outil intéressant pour les chercheurs car qui souhaitent étudier la personnalité de la marque dans le contexte algérien.

3- Apport managériaux **:** Ces résultats sont susceptibles d'intéresser les managers puisque la personnalité de la marque est un outil de différenciation ([32] ; [2] ; [5]; [16] ; [14] ; etc. Le contrôle des sources des traits de la personnalité de la marque pourrait orienter les managers dans les éléments à prendre en considération dans la stratégie de lancement et de positionnement des marques.

Notre recherche fournit aux responsables marketing un outil de mesure de la personnalité de la marque adaptée au contexte culturel algérien qui pourra les aider à mesurer la personnalité de leurs marques et son évolution dans le temps et la comparer avec d'autres marques.

Ce travail devrait pousser les publicitaires à utiliser la personnalité de la marque comme un élément central dans leurs annonces publicitaires, puisqu'elle a un impact sur la perception des consommateurs.

Limites de la recherche

- Les sous-échantillons par marque sont de tailles réduites (N=150). On n'a pas pu élargir notre échantillon ou le généraliser pour toutes les wilayas de l'Algérie par manque de budget.
- La dichotomisation des variables modératrices qui selon [86] peut entrainer une perte d'informations ou créer des groupes n'existant pas dans la réalité.

Voies de recherche

Ce travail ouvre la voie à un certain nombre de pistes de recherches. Il nous semble intéressant de:

- Explorer le rôle d'autres antécédents de la personnalité de la marque et les tester au contexte algérien afin de combler les lacunes dans ce domaine.
- Prendre en considération d'autres variables modératrices comme le genre et l'âge.
- Valider les résultats sur d'autres catégories de produits puisque l'implication envers la catégorie du produit est une variable modératrice.
- Il serait possible d'établir une comparaison entre la population algérienne urbaine et rurale en termes d'influence et de perception puisque des différences existent entre les deux populations.

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ANNEXE 1 : LES ANNONCES PUBLICITAIRES

ANNEXE 2 : RÉSULTATS DES ANALYSES EXPLORATOIRES ET CONFIRMATOIRES

	Item	Qualité de représentation	Poids factoriel	Variance %	Alpha de Cronbach	KMO	Test de sphéricité de	Valeur propre	Indices de fiabilité
Aad	Aad1	0,67	0,82	73,02	0,79	0,78	p=0,0000	2,19	RMSEA=0,04 GFI=0,912 CFI=0,945 TLI=0,9, χ²/ddl=4,8
	Aad2	0,53	0,73						
	Aad4	0,67	0,82						
Ab	Ab1	0,65	0,81	65,49	0,85	0,73	p=0,0000	2,46	RMSEA=0,06 GFI=0,94 CFI=0,902 TLI=0,965 χ²/ddl=2,7
	Ab2	0,79	0,89						
	Ab3	0,73	0,85						
IMPCPR	IMPCPR1	0,66	0,81	72,41	0,73	0,71	p=0,0000	2,17	RMSEA=0,07 GFI=0,97 CFI=0,961 TLI=0,925 χ²/ddl=2,33
	IMPCPR2	0,73	0,85						
	IMPCPR3	0,57	0,76						
	IMPCPR5	0,69	0,70						
DYNAM	DYNAM1	0,69	0,62	5,53	0,81	0,92	p=0,0000	1,25	RMSEA=0,02 GFI=0,96 CFI=0,933 TLI=0,899 χ²/ddl=3,35
	DYNAM2	0,66	0,66						
	DYNAM3	0,71	0,75						
SINCER	SINCER1	0,77	0,80	7,27	0,89		p=0,0000	2,45	
	SINCER2	0,82	0,81						
	SINCER3	0,80	0,77						
	SINCER4	0,69	0,75						
SOPHI	SOPHI1	0,75	0,74	9,99	0,90		p=0,0000	2,99	
	SOPHI2	0,68	0,73						
	SOPHI3	0,70	0,59						
	SOPHI4	0,53	0,47						
	SOPHI5	0,60	0,65						
COMPET	COMPET1	0,61	0,71	46,15	0,89		p=0,0000	9,23	
	COMPET2	0,66	0,78						
	COMPET3	0,59	0,71						
	COMPET4	0,54	0,72						
	COMPET5	0,67	0,79						
	COMPET6	0,64	0,76						
MASCU	MASCU1	0,90	0,92	4,93	0,95		p=0,0000	1,1	
	MASCU2	0,89	0,89						

ANNEXE 3: LES INDICES D'AJUSTEMENT DU MODÈLE STRUCTUREL

Catégorie d'indices	Indices absolus		Indices incrémentaux		Indices de parcimonie
	RMSEA	GFI	CFI	TLI	χ^2/ddl
Coca Cola (traitement transitoire)	0,06	0,97	0,918	0,905	3,6
Coca Cola (traitement périphérique)	0,075	0,902	0,912	0,905	2,46
Lorina (traitement transitoire)	0,04	0,987	0,919	0,915	2,49
Lorina (traitement périphérique)	0,07	0,7	0,891	0,805	4,6
Peugeot (traitement central)	0,03	0,923	0,978	0,98	2,95
Peugeot (traitement transitoire)	0,945	0,7	0,975	0,965	2,39
Maybach (traitement central)	0,039	0,909	0,958	0,994	1,5
Maybach (traitement transitoire)	0,01	0,968	0,947	0,945	1,98

Annexe 4 : Influence de la personnalité de la marque sur l'Ab et PI

	Coca Cola (traitement transitoire)		Coca Cola (traitement		Lorina (traitement transit
	Coeff. stand. [borne inférieure, borne	P	Coeff. stand. [borne inférieure, borne	P	Coeff. stand. [borne inférieure, borne
Ab<---DYNAM	0,26[-0.07,0.66]	0,008	0,08[-0.27,0.65]	0,148	0,73[0.20,0.96]
Ab<---SINCER	0,43[-0.15,0.85]	0,000	-0,04[-0.35,0.23]	0,587	-0,004[-0.76,0.60]
Ab<---SOPHI	0,27[0.23,0.32]	0,000	0,24[0.01,0.58]	0,000	0,02 [-0.68,0.69]
Ab<---COMPET	0,26[-0.16,0.73]	0,016	0,38[0.03,0.75]	0,000	0,31[0.1,0.80]
Ab<---MASCU	0,05[-0.04,0.25]	0,620	-0,29[-0.73,-0.10]	0,013	-0,42[-0.62,-0.14]
PI<---DYNAM	0,03[-0.22,0.43]	0,889	0,23[0.03,0.46]	0,049	0,54[-0.09,1.42]
PI<---SINCER	0,11[-0.33,0.48]	0,650	0,10[-0.09,0.26]	0,473	0,032[-0.66,1.05]
PI<---SOPHI	-0,19[-0.56,0.27]	0,280	0,19[-0.08,0.48]	0,136	-0,023[-0.70,0.77]
PI<---COMPET	-0,005[-0.40,0.35]	0,980	-0,13[-0.38,0.09]	0,499	-0,17[-1.58.,0.60]
PI<---MASCU	0,086[-0.02,0.20]	0,650	-0,08[-0.30,0.09]	0,751	0,05[-0.185,0.45]

	Peugeot (traitement central)		Peugeot (traitement transitoire)		Maybach (traitement cer
	Coeff. stand. [borne inférieure, borne	P	Coeff. stand. [borne inférieure, borne	P	Coeff. stand. [borne inférieure, borne
Ab<---DYNAM	-0.04[-1.99,1.05]	0,620	0.16[0.03,0.58]	0,040	0.31[0.34,0.96]
Ab<---SINCER	0.15[-0.52,0.89]	0,011	0.17[0.10,0.12]	0,050	0.51[0.21,0.91]
Ab<---SOPHI	-0.21[-0.52.,0.007]	0,000	0.83[0.58,0.88]	0,000	0.15[0.10,0.74]
Ab<---COMPET	0.18[-0.09,0.70]	0,001	0.32[-0.14,0.96]	0,003	0.46[0.27,0.95]
Ab<---MASCU	0.08[-0.12,0.98]	0,494	-0.11[-0.31,0.08]	0,231	-0.08[-0.20,0.03]
PI<---DYNAM	0.35[-0.12,0.45]	0,050	0.34[0.27,0.41]	0,041	-0.01[-0.32,0.26]
PI<---SINCER	0.42[-0.46,0.64]	0,760	0.31[0.06,0.56]	0,048	0.08[-0.15,0.47]
PI<---SOPHI	0.35[0.04,0.68]	0,010	0.09[-0.61,0.32]	0,756	-0.02[-0.32,0.26]
PI<---COMPET	0.04[-0.53,0.37]	0,770	0.06[-0.21,0.35]	0,773	-0.11[-0.45,0.15]
PI<---MASCU	0.12[-0.10,0.64]	0,648	0.04[-0.10,0.18]	0,823	-0.03[-0.80,0.07]

ANNEXE 5 : INFLUENCE DE L'AAD SUR LA PERSONNALITÉ DE LA MARQUE, AAD, AB ET

	Coca Cola (traitement transitoire)		Coca Cola (traitement		Lorina (traitement transi
	Coeff. stand. [borne inférieure, borne	**P**	**Coeff. stand. [borne inférieure, borne**	**P**	**Coeff. stand. [borne inférieure, borne**
DYNAM <---Aad	0,62 [-0.13,0.94]	0,000	0,57 [0.34,0.74]	0,000	0,87 [0.72,0.93]
SINCER <---Aad	0,67 [0.15,0.93]	0,000	0,75 [0.58,0.87]	0,000	0,79 [0.52,0.91]
SOPHI <---Aad	0,23 [-0.05,0.50]	0,050	0,53 [0.37,0.65]	0,000	0,33 [0.07,0.55]
COMPET <---Aad	0,73 [0.06,0.94]	0,000	0,80 [0.58,0.90]	0,000	0,70 [0.46,0.89]
MASCU <---Aad	-0,58 [-0.91,0.44]	0,000	-0,49 [-0.96,-0.69]	0,000	-0,65 [-0.89,0.21]
Ab <---Aad	0,19 [-0.13,0.61]	0,200	0,15 [-0.37,0.51]	0,322	0,53 [-0.02,0.73]
Pi <---Aad	0,32 [-0.07,0.65]	0,299	-0,02 [-0.27,0.23]	0,940	0,22 [-0.46,1.23]

	Peugeot (traitement central)		Peugeot (traitement transitoire)		Maybach (traitement cen
	Coeff. stand. [borne inférieure, borne	**P**	**Coeff. stand. [borne inférieure, borne**	**P**	**Coeff. stand. [borne inférieure, borne**
DYNAM <---Aad	0,73 [0.38,0.94]	0,000	0,54 [0.007,0.91]	0,000	0,59 [0.30,0.83]
SINCER <---Aad	0,55 [0.16,0.86]	0,000	0,53 [-0.04,0.86]	0,000	0,57 [0.31,0.79]
SOPHI <---Aad	0,07 [-0.17,0.33]	0,470	0,30 [-0.07,0.57]	0,031	0,29 [0.06,0.51]
COMPET <---Aad	0,49 [0.06,0.85]	0,000	0,69 [-0.008,0.92]	0,000	0,51 [0.17,0.77]
MASCU <---Aad	-0,87 [-0.98,-0.51]	0,000	-0,54 [-0.09,0.82]	0,000	-0,48 [-0.87,0.25]
Ab <---Aad	0,81 [0.21,0.79]	0,000	0,03 [-0.48,0.40]	0,828	0,43 [0.22,0.78]
Pi <---Aad	0,09 [-0.70,1.18]	0,840	0,49 [0.09,0.77]	0,042	0,50 [0.28,0