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# Production process on the artisanal extraction output of Vitellaria paradoxa Gaaerterner butter in the southern part of Chad

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**ABSTRACT:** This work is conducted with women producing shea butter in the regions of Mandoul and Logone Oriental. It aims influence the production processes on the shea butter extraction efficiency. Indeed, these women use two methods to extract shea butter: traditional method that gives butter black and method by manual press that gives butter white. In addition, the traditional method has two variants: use when extracting butter boiled water on the one hand and the water slurry accompanied leaves secondly mango. The butter obtained according to production processes extraction yields are: (44.35 ± 3.513%) for the mechanical press method; (36.11 ± 1.64%) to the traditional method using boiled water and (47.70 ± 0.22) for the traditional method using water boiled over the mango leaves. The values of physico-chemical parameters are analyzed: water content (5.646 ± 0.105%); crude protein (7.2 ± 0.655%); total fat (52.886 ± 1.240%); unsaponifiable (7.25 ± 0.636%); stearic acid (49.526 ± 3.090%); oleic acid (48.716 ± 3.735%); linoleic acid (5.843 ± 0.386%) and linolenic acid (1.653 ± 0.105). The use of mango leaves in the extraction has substantially improved the performance of the butter up to that obtained by the mechanical press. The values of the fatty acids obtained correspond generally to the standards of the Economic and Monetary Union of West Africa (UEMOA) for unrefined shea butter with the exception of the water content is very high compared to the required standards.

**KEYWORDS:** shea production processes, performance butter, southern zone, Chad.

## 1 INTRODUCTION

Food forest species are very abundant in African forest ecosystems, contributing to household economies, enhancing food security, and conserving the biological diversity of forest resources (Van Tomme 1999). Unconventional oilseeds (shea butter) are part of the diets of populations, but the process of extraction leads to products of variable quality and remains unexploited on an industrial scale (Kapseu, 2006). This multipurpose tree (karite) plays an important socio-economic role in rural communities in sub-Saharan Africa (Compaoré, 2000). The priority of the developing countries is the fight against poverty and shea but plays a major role in this regard. Several groups of women produce shea butter, but the quality is unsatisfactory due to lack of financial resources, production, control and knowledge of quality (Bernatchez, 2007).

In Chad, shea oil is a non-negligible energy supply throughout the year in the area concerned, with a population of 4,034,915, 51% of whom are women. Shea nuts are transformed on the spot into kitchen oil, soap, detergent, cream and ointment in small quantities. The country could, with its current potential of about 82,800,000 feet of shea trees, produce a large quantity of butter for the local and external market. Unfortunately, this enormous production potential is poorly organized and has received very little support for its promotion (CEPAGE,1999). Shea is an essential commodity for rural self-sufficiency and the entire production chain remains dominated by women (Faho, 2003). It has been reported that certain steps,

such as heat treatments such as drying, cooking and roasting shea nuts and heating shea butter, if not controlled, not only lead to lower (Hall et al., 1996, Kapseu et al., 2005, womeni et al., 2006), but also to obtain a finished product of exceptional quality. The yield and quality of shea butter are influenced not only by the processing technique of the almonds but also by the origin (tree) (Kapseu, 2006). The purpose of this work is to evaluate the influence of production processes on the artisanal extraction yield of shea butter produced in the southern zone of Chad.

## 2 MATERIAL AND METHODS

### 2.1 PLANT MATERIAL

Vitellaria paradoxa, commonly called shea, contains two subspecies: V. paradoxa subsp. Nilotica Kotschy and V. paradoxa subsp. Paradoxa (C.F. Gaertner) Hepper. V. paradoxa subsp. nilotica grows in areas ranging from Sudan to Uganda to Ethiopia through the Democratic Republic of Congo, while V. paradoxa subsp. paradoxa occurs in West and Central Africa (Hall et al., 1996, Eyog Matig et al., 2000, Ye et al., 2007). In Chad, it is the subspecies Vitellaria paradoxa C.F.Gaertn subsp. Paradoxa that is encountered (Djekota, 2008). The shea tree grows wild and belongs to the Sapotaceae family. It is characterized by the presence of latex in the organs. It is a tree 15 to 20 m high (UNIFEM, 1997), with a diameter of 1 m. Shea has green-dark and deciduous leaves (Pehaut, 1976; Von Maydel, 1983). Shea produces fruits whose inner almond is made up of about 50% butter (Sopade and Koku, 1989; Tano Debrah and Ohta, 1994). The fruit of the shea tree consists of the outside towards the inside of a sweet and edible pericarp, a seed comprising a thin shell and an almond which comprises two cotyledons (Kapseu et al., 1999). The age of production of the shea tree is 15 to 20 years, with large harvests between 50 and 100 years. This irregular production averaged 20 kg of fruit per tree, ie 6 kg of almonds, 4 kg of dried almonds and 1.5 kg of butter (NKouam, 2007).

### 2.2 USES OF SHEA

Almost all of the shea tree (fruits, leaves, bark, roots, dead wood ...) is used in culinary, food, health, pharmaceutical, decorative, and economic fields (Badini et al. ., 2011). The ripe fruits are edible, green in color and rounded in shape. At the socio-cultural and economic level, the fruits of shea are the subject of intense trade (UNIFEM, 1997), and by-products and derived products play an important role in life (pharmacopoeia, customs and customs ) (Asubiojo, Guinn and Okunuga, 1982, Booth and Wickens, 1988). The fruit pulp is consumed by humans and animals. It has a slight laxative action. The leaves are used to increase the extraction yield of the butter. The decoction of young leaves is used, in steam bath, against headache (NKouam, 2007). The meal is used as fuel, fertilizer and feed. The main product of shea is her butter. It is used in the making of sauces and fries. It is used in cosmetic products (NKouam, 2007). It is used in agro-food industries. Indeed, it is used in confectionery, biscuit, pastry and mainly in chocolate. It is used as a substitute for cocoa butter because of its high melting point (UNIFEM, 1997; PAF, 1999). In cosmetics and pharmacology, shea butter enters the manufacture of creams of body milks, hair products, lotions and soaps. This is due to its moisturizing, revitalizing and protective properties, as well as its unsaponifiable and glycerin content. He is employed in the pharmacy to make conditioners and healers (NKouam, 2007).

### 2.3 GEOGRAPHICAL AREA OF SHEA

In Chad, V. paradoxa subsp. Paradoxa grows mainly in 7 of the 23 regions in the country. These are natural stands typical of light dry forests and tree savannas (Djekota, 2008). These are the administrative regions located in the southern zone of the country: Mayo Kebbi East, Mayo Kebbi West, Tandjilé, Logone Occidental, Logone Oriental, Mandoul, Moyen Chari. The 7 regions cover a total area of 98 000 km² with a population estimated at more than 4 million inhabitants (INSED, 2009). Shea in Chad is found in Middle Chari, Oriental Logone, Mayo Kebbi, Logone Occidental and Tandjile in the south of the country, with a higher density in the Middle Chari. The stand is estimated at 82 million feet on an area of 127,000 km² (MEE, 1999). The shea potential in Chad estimated at 92 683130 feet would produce about 556000 tonnes of almonds per year because some authors estimate that, with an average productivity of 15 kg / karité / year of fresh fruit, it is possible to obtain On average 5 kg of dried almonds (Lovett, 2004).

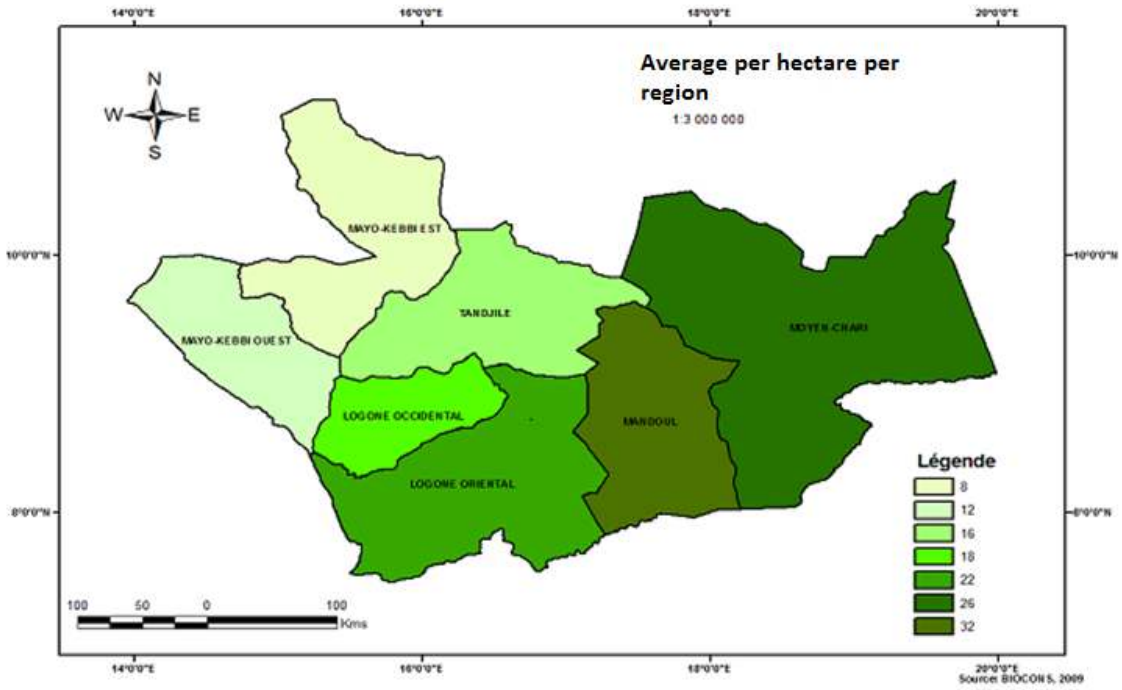


***Fig1. Map of Chad, area of shea stock***

***Table I: Estimation of Shea Potential by Region in Chad***

| Region | Area(ha) | Area under consideration (ha) | Average Density/ha | Number of shea | (%) |
|---|---|---|---|---|---|
| Mayo Kebbi East | 1 822 527 | 364 505 | 0 ± 8 | 2 916 043 | 9 |
| Mayo Kebbi West | 1 283 533 | 256 707 | 0 ± 12 | 3 080 478 | 10 |
| Tandjilé | 1 753 624 | 584 541 | 0 ± 16 | 9 352 661 | 12 |
| Logone Occidental | 884 542 | 294 847 | 1 ± 18 | 5 307 251 | 10 |
| Logone Oriental | 2 364 238 | 788 079 | 2 ± 22 | 17 337 746 | 18 |

### 2.4 HARVEST

In the form of a cluster, the fruits of the shea tree appear five months after flowering. When ripe, the fruit falls to the ground (Badini et al., 2011). Picking properly begins in May. It is done by collecting fallen fruit or by shaking the branches of the tree (Adoum, 1996). The traditional exploitation of shea products (nuts, almonds, butter, ...) was primarily the responsibility of women and children through gathering activities (Djekota et al., 2014). An essentially female activity, it usually takes place early in the morning around 4 am, on the fringe of other rural works. The fruits obtained by shaking the branches produce butter sought after by the cosmetic industries (lower acidity), and those collected at the foot of the tree are rich in butter (UNIFEM, 1997). However, long-ground fruit germinates and yields poor-quality butters (Karo et al., 1988). Formerly, it is the chief of land who announces the campaign to collect shea nuts but nowadays "the love of money has made love of shea by everyone". For "love of money", it is not uncommon to find that collectors are not satisfied only with ripe fruit fallen to the ground but they pluck the fruit on the tree, which is damaging to the tree And which will influence the quality of the butter resulting from it (INADES Formation, 2011).

### 2.5 SHEA SECTOR IN CHAD

The shea sector provides income to women, contributes to the strengthening of social ties between women within their organizations. Women are the main players in the sector (Badini et al., 2011). The shea sector in Chad is informal and unorganized. The exploitation and marketing of shea butter remains essentially local, even national, but has very little

international focus (Rongead, 2014). The country could, with its current potential of about 82,800,000 feet of shea trees, produce a large quantity of butter for the local and external market. Unfortunately, this enormous production potential is poorly organized and has received very little support for its promotion (CEPAGE, 1999). Shea oil is either self-consumed or marketed locally, brought to the other cities of the country, especially at the level of the capital.

This production is natural without any technical input for improvement (INADES Formation., 2011). At the beginning, there is the family unit where women and children collect shea, either for the needs of the family, or to treat and market or both. It is therefore an individual activity, which takes place on the margins of rural labor. Butter production was done in a family setting with informal support from the women in the village or neighborhood. In all regions where the product is found, there are also producers who process the products of the shea tree. They are often organized in groups, or even in union, but often also do the processing and sale of a small amount of oil in parallel. The unions to which these women belong may contain more than 2,000 persons, divided into groups. Several denominations of these groups were born: Co-operative of the women of Mandoul for the promotion of Shea (COFEMAK); Association for the promotion of the shea sector of Mandoul (APROFIKAM); Organization of Development Groups in Chad (OGFDT); Truth to Non-Violence for Development (VNVD); Boat to Combat Poverty (ARCHE) Cooperative; Organizing Committee Women's Autopromotion of Bessada; And the Association of Beekeepers and Breeders (GAEL). Resellers, transporters and consumers of shea are not constant, the sale of the product is often random. Initially, he had some attempts at the structured marketing of nuts and shea butter. For example, the Mutual Society for Rural Development (SMDR) was involved in the marketing of shea butter between 1950 and 1958; Then it was raised by the Development and Rural Development Fund (FDAR), which exported the butter in France, to Rouen, to IRANEX. However, from 1965, the decline in production continued and intensified in 1970 and 1978, leading to an annual export of no more than 300 tonnes of butter (Mbayhoudel, 2002). For the moment, there is no longer any support for the marketing of shea at the state or private level. Nut collectors and processors are organized at their level (Mbayhoudel, 2002). Consumers are women in the region or N'Ndjamena who buy white shea butter for body massage or for cooking. Black shea butter is used only for consumption (Rongead, 2014).

## 3 METHODOLOGY

### 3.1 DETERMINATION OF MORPHOLOGICAL CHARACTERISTICS

The determination of the morphological characteristics is carried out on 100 random almonds. The mass is weighed on à 0.0001 precision electrical balance, the length and diameter are measured with a caliper.

### 3.2 EXTRACTION OF SHEA BUTTER

The methods of extraction of shea butter are numerous and diverse. They vary from one country to another, from one region to another, from one tribe to another (SNV, 1991, Kassamba, 1997). Some local methods in Chad (Adoum, 1996) allow the almonds to be dried in the sun, then to be smoked on the shelves before they are processed. The smoking step thus extends the shelf life and protects against weevils and rodents. The moisture content should be as low as possible to prevent germination of almonds, but also to increase extraction yield (Sopade and Koku, 1989).

The methodology adopted during this scientific research includes treatment and extraction of almond oil with producers of shea butter in real environment according to the artisanal diagram commonly used in the southern regions of Chad. The artistic diagrams selected are those of the Doba producers in Oriental Logone, Peni and Koumra in the region of Mandoul. In general, there are two methods used by women producers to extract shea butter: the traditional method that produces black butter and the mechanical pressing method that produces white butter. The amount of material entering and exiting each extraction method was measured using a precision balance. These measurements made it possible to calculate the yield of the extraction process from the following formula:

$$\boldsymbol{R}\ (\%) = \frac{\boldsymbol{Amont\ of\ butter\ obtained}}{\boldsymbol{Amont\ of\ almonds\ used}}\boldsymbol{x\ 100}$$

The contents of water, unsaponifiables, total lipids, crude protein and stearic, oleic, linoleic and linolenic acids were determined according to AFNOR 1993. The artisanal extraction diagrams used are shown in the following figures:

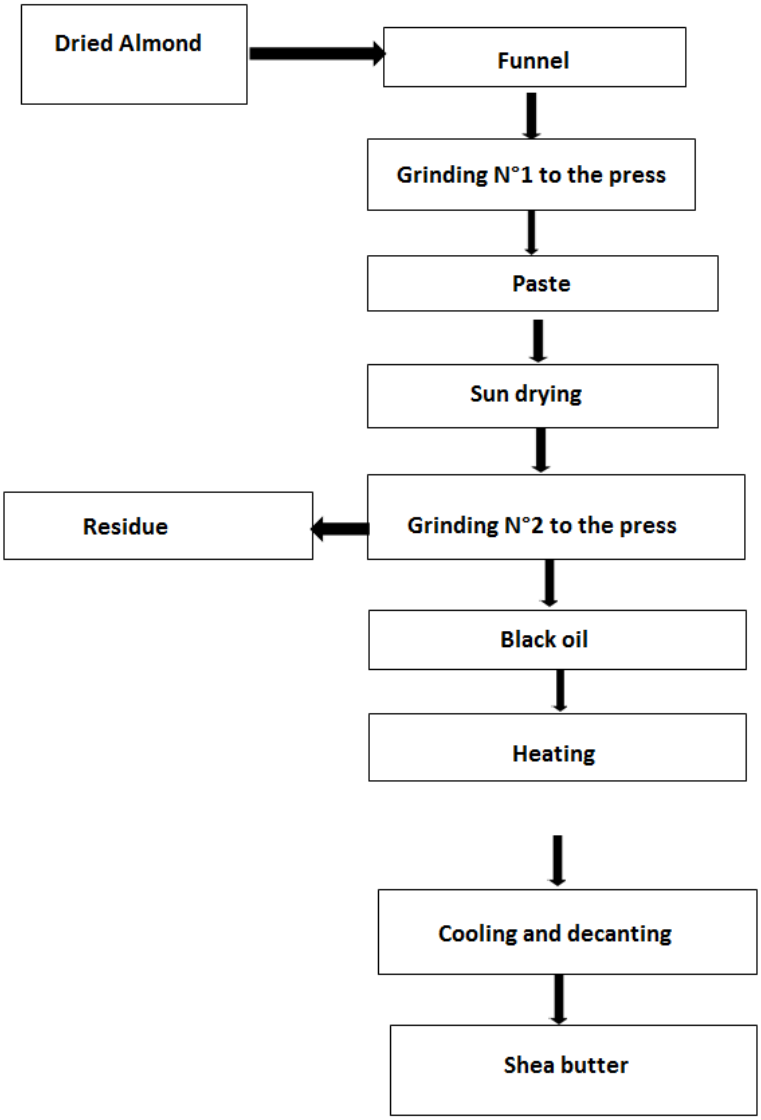


*Fig.2. Technological diagram of the production of shea butter of Koumra.*

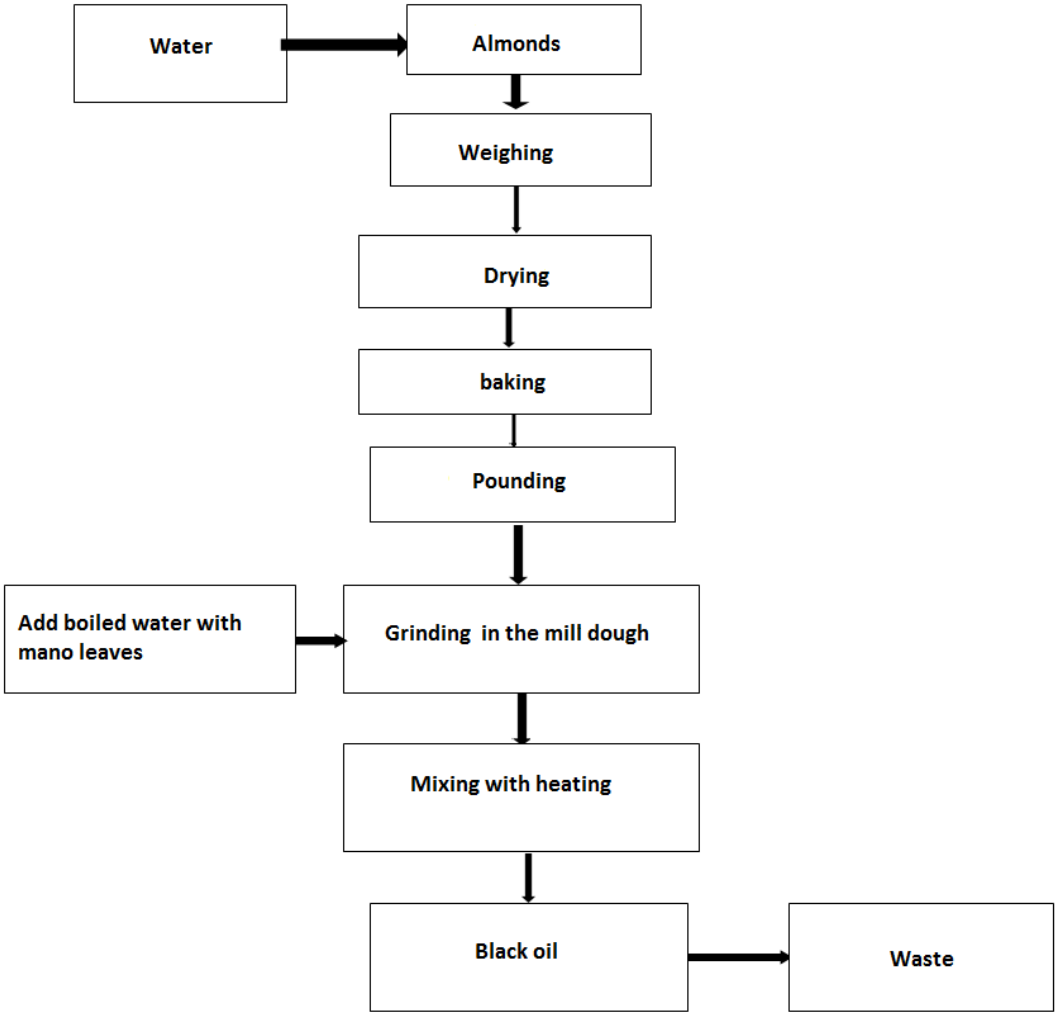


*Fig.3. Technological diagram of the production of shea butter by a family in Doba.*

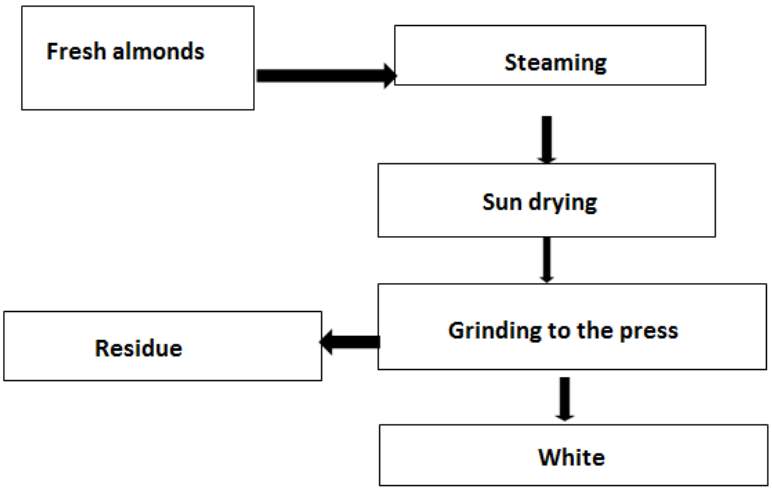


*Fig.4. Technological diagram for manufacturing white shea butter by a group of Mandoul.*

## 4 RESULTS AND DISCUSSIONS

### 4.1 MORPHOLOGICAL CHARACTERISTICS OF SHEA NUTS

The determination of the morphological characteristics of the shea nuts gave an average length of 26.9 ± 1.442 mm and an average diameter of 20.34 ± 0.767 mm for an average mass of 6.36 ± 0.611 g. These dimensions are lower than those obtained by Nkouam, (2007) which showed that the shea nut length of 4.26 cm and diameter of 3.29 cm has an average mass of 21.76 g. It is also possible to find some morphological nuances between the fruits of the same locality. These differences can be explained by geographic variables specific to each locality or region, but also by tree characteristics and shea production depended on rainfall (UNIFEM, 1997).

### 4.2 SHEA BUTTER YIELDS ACCORDING TO EXTRACTION METHODS

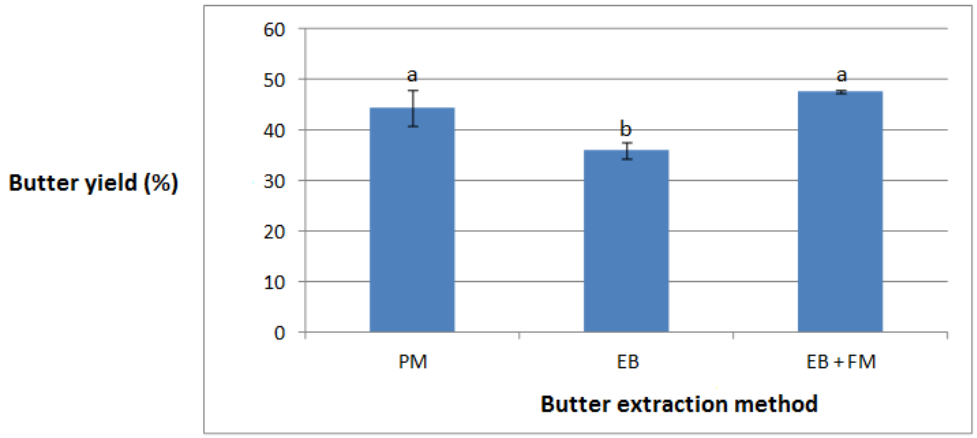


***Fig.5: Variation of yields according to artisanal extraction methods. PM = method by mechanical press, EB = traditional method using boiled water and EB + FM = traditional method using boiled water plus mango leaves.***

he yields of extraction processes range from 36.11 ± 1.64% for the traditional method using boiled water to 47.70 ± 0.22% for the traditional method using boiled water with Mango tree, passing through 44.35 ± 3.513% for the mechanical press. There is no significant difference between the yield of the mechanical press and the traditional method using mango leaves. On the other hand, these yields differ significantly from that of the traditional method with boiled water at the threshold of 0.05% (Figure 5). Press performance is similar to that of (Bernatchez, 2007) which is 32.3%. This is due to the loss of butter in the press bags, since the process is not under vacuum and this modification is costly (Bernatchez, 2007). Based on Mali's experience, the press can process 69-80 kg of seed per day with a yield of 30-35% or even 45% of fat (USAID, 2006). The use of mango leaves in the extraction of shea butter has substantially improved its yield. The leaves of Barkedjé, whose scientific name is Hymenocardia acida, are used in the preparation of cooking waters in the Northern and Far-North Provinces (Cameroon) and in Chad in order to improve the rate of extraction. The same is true for shea leaves to increase the extraction yield of butter (NKouam, 2007). The butters obtained by the traditional processes are not very attractive in terms of food and cosmetics. This is due to their color and odor (Kassamba, 1997, Nianogo et al., 1997, PAF, 1999). Moreover, this manual process is painful and has a low extraction efficiency of 36% (Toe, 2004). The traditional process and storage conditions promote oxidation and hydrolysis, thus increasing the acidity, iodine and saponification index (Bernatchez, 2007). Manual presses produce butter with better physicochemical characteristics, although boiling with water to remove suspended solids raises the moisture content (Nkouam, 2007). In the Chadian markets, shea oil comes in two different forms: the so-called traditional black oil and the white barate oil. Black oil is considered to be of lower quality and therefore cheaper. It is used mainly for cooking at the household level. White oil is considered of better quality and sells more expensive. It is used for cooking but also cosmetic massage oil (Rongead, 2014).

### 4.3 PHYSICO-CHEMICAL CHARACTERISTICS

*Table II: Physico-chemical characteristics of shea butter*

| Parameters | valeurs |
|---|---|
| Water content (%) | 5,646±0,105 |
| Crud protein (%) | 7,2±0,655 |
| Total lipids (%) | 52,886±1,240 |
| Oleic acid (C18.1)% | 49,526±3,090 |
| Linoleic acid (C18: 2)% | 48,716±3,735 |
| Linolenic acid (C18: 3)% | 5,843±0,386 |
| Content of unsaponifiables (%) | 1,653±0,105 |

The water content (5,646 ± 0,105%) is well above the WAEMU value (0,05%) for unrefined shea butter of the first category. The critical quality parameter for shea butter is the moisture content which must be less than 0.05% for the first quality, but this value is very difficult to obtain for unrefined butter (Bernatchez, 2007). The premium unrefined organic shea butter (0.05%) is dedicated to the cosmetic and pharmaceutical industries and also consumed directly; Second quality (0.06-0.2%), it is intended for the food industry (confectionery, chocolate, edible oil or as a basis for margarine); And third quality (0.3-2%) can satisfy the needs of the soap industry (UEMOA, 2011). Low humidity levels are preferred (Bernatchez, 2007).

The values of the fatty acids obtained correspond generally to the UEMOA standards. These values are respectively: stearic acid (49.526 ± 3.090%) for a range of 25-50%; Oleic acid (48.716 ± 3.735%) for 36-62%; Linoleic acid (5.843 ± 0.386%) for 1-11%; And linolenic acid (1.653 ± 0.105%) for 1-11%. Similar fatty acid values were obtained respectively: stearic acid (45.5% and 44.44%) by Terpend, (1981) and Tano Debrah and Ohta, (1994); Oleic acid (42.5% and 42.41%) by Terpend, (1981) and Tano Debrah and Ohta, (1994); Linolenic acid (6.8% and 5.88%) by Terpend, (1981) and Tano Debrah and Ohta, (1994); And linolenic acid (0.1% and 1.66%) by Terpend, (1981) and Tano Debrah and Ohta, (1994). Other similar results are obtained by Mbaiguinam et al. (2007) for oleic acid 53.93% and stearic acid 31.15%.

The WAEMU unsaponifiable content for unrefined shea butter in the first category varies from 1-19%. The unsaponifiable content of our analyzes (7.25 ± 0.636%) is included in the WAEMU range. It falls within the range of 3.5 to 8.5% and 5 to 17% corresponding to the unsaponifiable levels of the shea butter of the Poissoni and Mangifolia varieties. It deviates from that of the Nilotica variety (2.5 to 3%) (Mensier, 1957). The difference between the levels of unsaponifiables is related to the variability of the origins of shea. In addition to variety, the degree of ripeness of fruits is also a factor on which the content of unsaponifiable matter depends (Mensier, 1957). The following levels of unsaponifiables are reported by Terpend, 1981 (3.5 to 17%) respectively; Tano Debrah and Ohta, 1994 (7.48%) and Kepseu et al., 2001 (5.9%). The following levels of unsaponifiables are reported by Terpend, 1981 (3.5 to 17%) respectively; Tano Debrah and Ohta, 1994 (7.48%) and Kepseu et al., 2001 (5.9%).

Crude protein values (7.2 ± 0.655%) and total lipids (52.886 ± 1.240%) are also appreciable. These protein values corroborate those of Duke and Atchley, 1986 (7.30%), Tano Debrah and Ohta, 1994 (7.81%) and Nkouam, 2007 (6.14 ± 0.27%). These authors found the total lipids of (52.60%), (59.04%) and 51.86 ± 0.21%, respectively. Salunkhe and Desai, (1986) found a range of total lipid values ranging from 40 to 55% of shea butter.

## 5 CONCLUSION

Artisanal production of shea butter is one of the main activities and sources of income of women in the southern zone. This resource is available naturally but poorly and exploited with a low level of productivity and little known products. It is clear from this work that the chemical composition of shea butter in Chad is of high quality for cosmetics because of its high levels of unsaturated fatty acids and unsaponifiables. Currently, most of the butter is produced manually by women, which restricts production both qualitatively and quantitatively. The main obstacles to the good functioning of the shea sector in Chad are the difficulty of the tasks due to the craftsmanship of the techniques and the equipment used, the lack of professionalism of the actors and the lack of production credits for the storage of the nut or The supply of necessary equipment. The level of organization and development of the shea industry in the region is an incentive and incentive for operators at all levels. In order to have an impact on rural women, efforts to reduce the hardship of work and poverty must be made for the valorisation of this sector.

**REFERENCES**


[1] AFNOR (French Association for Standardization), 1993. Compendium of French Standards, Oils, Oleaginous Seeds, Derivatives, 5th Edition, AFNOR, Paris, 136-140.

[2] Anonyme, 1997. Shea, the white gold of African women. UNIFEM (United Nations Development Fund for Women), Dakar Regional Office, 41 p.

[3] APROMA, 1995, Study of the shea sector of Burkina Faso, Volume 1: Main report. European Union, Delegation of the European Commission of Burkina Faso, Ouagadougou, 15-19.

[4] Ata J.K.B.A., 1978, The study of the shea kernel in relation to the traditionnal process of shea fat, Ph.D. Thesis, University of Ghana, Legon-Accra.

[5] Aye F.O. & Adomako D., 1987, Processing of shea fruits, rep. Cocoa Research Institute of Ghana. In: Tano-Debrah K. & Ohta Y., 1994. Enzyme-assisted aqueous extraction of fat from kernels of the shea tree, Butyrospermum parkii, J. Am. Soc. Flight. 7, No. 9, 979-983.

[6] 2011. The history of the shea sector in Burkina Faso and the services offered by the technical and financial partners to the actors are presented by Badini Zacharie, Kaboré Moïse, van der Mheen-Sluijer Jennie and Vellema Sietze. WAGENINGENUR. VC4PD Research Paper, No. 11.The effects of unit extraction operations on the yield and quality of the extraction process are discussed. Butter of Pentadesma butyracea produced in traditional environment in Benin. Journal of Applied Biosciences 86: 7976-7989 ISSN 1997-5902

[7] Bailey A.E., 1951, Industrial oils and fats products. In: Tano-Debrah K. & Ohta Y., 1995. Enzyme-assisted aqueous extraction. Soc. Flight. 72, No. 2, 251-256.

[8] Bernatchez C., 2007. Improvement of the product quality and production processes of organic shea butter and logistics of operations in Africa: case of Burkina Faso. Memory in industrial engineering. University of Quebec at Trois-Rivières.

[9] Cabinet for Prospective Studies in Agronomy and Management of the Environment (CEPAGE), 1999. Feasibility study of a project to support the shea sector in the southern zone of Chad, Final Report. Funded by the Agence Française de Développement AFD / Ministry of Water and Environment MEE.

[10] CECI, 1998, Year II-Final report of training courses on improved techniques for the collection and packaging of shea nuts and kernels in the profile of 236 GVF in 16 provinces of Burkina Faso, CECI / PFK.

[11] CECI, 2007. Shea. Technical specifications n ° 16. Developpement@champagne-ardenne.cci.fr

[12] CEPAGE, 1999. Study of the Shea Sector in Chad. Consultation Report, Ministry of Environment and Water (M.E.E.). 68 p.

[13] Food protein: biochemistry, functional properties, nutritional value, chemical modifications, Technique et Documentation, Lavoisier, Paris, 38. Chem. Soc. Flight. 7, 9, 979-983.

[14] Codex Alimentarius, 1992, Joint FAO / WHO Food Standards Program, FAO, Rome, Italy.

[15] Compaoré PN., 2000. Women, development and technology transfer. The case of shea presses in Burkina Faso. Doctoral Thesis, University of Montreal, Department of Sociology, Montreal.

[16] CPCK (Shea Production and Marketing Center), 2006.

[17] Dandjouma A. K. A., Adjia H. Z., Kameni A. and Tchiégang C., 2009. Traditional production processes and marketing circuit for shea butter in North Cameroon TROPICULTURA, 2009, 27, 1, 3-7.

[18] Defez G., 1992, Treatment of shea butter. Stéarinerie Dubois Fils, 2 p. In: Kassamba B., 1997, Synthesis of known techniques of extraction and conditioning of shea butter in Burkina Faso. Final report. Shea sector project of CECI IRSAT. Ouagadougou, 3-9

[19] Derbesy M. et al., 1979, Oilseeds vol. 34, No. 8-9. Pp. 405-409. In: Oils and fats manual, a comprehensive treatise, properties-production-Applications, volume 1. Ed. Karlesking A. & Wolff J.-P. TEC & DOC Lavoisier, Paris, 208-212.

[20] Djekota C., Mouga M., Djimramadji A., Djelassem B., Mbayngone E., Maiga R. D., Rimgoto K. and Noubady D., 2014. Shear potential in Chad (Vitellaria paradoxa C.F. Gaertn. Journal of Animal & Plant Sciences, 2014. Vol.23, Issue 3: 3646-3656.

[21] Djekota C.N., 2008. Macromorphological characterization of Butyrospermum parkii (Vitellaria paradoxa C.F Gaertn, subsp. Paradoxa) in the Mandoul region of Chad. Memory of D.E.A; University Cheikh Anta Diop, Dakar / Senegal.

[22] Dupriez H. & De Leener P., 1987, Gardens and Orchards of Africa. Earth and Life - L'harmattan -Apica - Enda - CTA, 354 p.

[23] Eyog Matig O., Gandé Gaoué O. and Dossou B., 2000. Forest genetic resources program in Africa south of the Sahara. Proceedings of the 1st meeting «Network Species Stratified Food», CNSF Ouagadougou. Ed. IPGRI. 231 p.

[24] Eyog Matig O., Gaoué O. G. and Dossou B., editors. 2002. Network "Species Strains Food". Proceedings of the first Network meeting held 11-13 December 2000 at the CNSF Ouagadougou, Burkina Faso. International Institute of Plant Genetic Resources. ISBN 92-9043-552-6. IPGRI Regional Office for sub-Saharan Africa c / o ICRAF, P.O. Box 30677, Nairobi, Kenya

[25] Faho Cyprien, 2003. Study of a Pilot Project to support the shea sector in Chad, Final Report. Study funded by UN / DESA-New Yo

[26] FAO, 2001, Non-timber forest products in Africa: a regional and national overview. Working Paper FOPW / 01/1 (S. Walter, Ed.), Forestry Department, FAO, 303 p.

[27] Hall J.B., Aebischer D.P., Tomlinson H.F., Osei Amaning E. and Hindle J.R., 1996. Vitellaria paradoxa. A monograph 105 pp. School of Agricultural and Forest Sciences, No. 8, University of Wales, Bangor.
[28] Hall, J.B., Aebischer, D.P., Tomlinson, H.F., Osei-Amaning, E. and Hindle, J.R. 1996.Vitellaria paradoxa. In Monograph. School of Agricultural and Forest Sciences. University of Wales Bangor, United Kingdom, 105 p. Http://www.veillestrategique-champagne-ardenne.fr
[29] INADES Formation, 2011. The Development Organizations of the Southern Zone (Middle Chari, Mandoul, Logone Oriental, Logone Occidentale, Tandjilé, Mayo-Kebbi- Est and Mayo Kebbi Ouest) regions of Chad. 11 p.
[30] INSEED, 2009. Macroeconomic framework note. Forecasts for 2006-2009. Report of the Department of Economic Synthesis and Statistics, 109 pages.
[31] IRAD, 2004, Annual Report 2003-2004, Service Agreement No. 1 / PH1 / ESA-SODECOTON-IRAD, 118 p.
[32] Kapseu C., Womeni HM, Ndjouenkeu R., Tchouanguep MF and Parmentier M., 2005. Influence of almond processing methods on the quality of shea butter: processing of shea kernels This document is extracted from the PBA site: Processes Biological and Food Processes: http://spip.cm.refer.org/pba1/article52.html, © PBA: Biological and Food Processes, 30 May 2005.
[33] KAPSEU C., 2006. Study of processing and preservation processes of shea kernel and palm kernel according to traditional methods and the impact of modern processes on these products, ENSAI (National School of Agro- Processes, Cameroon.
[34] Kouyaté K., 1988, Situation of the shea sector in Burkina Faso. PFK, 71 p.
[35] Lazano Y.F., Dhuique Mayer C., Bannon C. & Gaydou E.M., 1993, Unsaponifiable matter, total sterol and tocopherol contents of avocado oil varieties. J. Am. Oil Chem. Soc. 70, 561-565.
[36] Lovett P. N., 2004. WATH shea butter supply chain analysis: Component one. West Africa Trade Hub, Accra, Ghana.
[37] Mbayhoudel K., 2002. Situation of the shea sector in Chad. ITRAD, N'Djamena. International Workshop on the Treatment, Valorization and Trade of Shea in Africa. 162-166 p.
[38] Mensier P.H., 1957, Dictionary of Vegetable Oils, Edition Paul Chevalier, Paris, 108-110.
[39] Nianogo, A.J., Bougouma, B. and Tapsoba, B. 1997a. Manual shear presses in Burkina Faso. Study report. International Development Research Center; 39 p.
[40] Nianogo, A.J., Bougouma, B. and Tapsoba, B. 1997b. Shea-powered presses in Burkina-Faso. Final report; CECI / Shea Fate Project, 15 p.
[41] NKouam GB. 2007. Conservation of fruits of shea (Vitellaria paradoxa Gaertn.) And of the ale (Canarium schweinfurthii Engl.): Isotherms of water sorption and extraction of fat from stored fruits. Doctoral thesis Ph.D., University of Ngaoundéré, (ENSAI), Ngaoundéré (Cameroon), p. 286.
[42] Nsogning Dongmo S., Womeni H.M., Tchouanguep Mbiapo F., Linder M., Fanni J., Zarnkow M., Becker T. (2014): Cooking and drying process optimization of shea (butyrospermum parkii) butter extraction. Czech J. Food Sci., 32: 578-584.
[43] Perez, R., Ndoyé and Eyébé, A. 1999. The commercialization of non-timber forest products in the rain forest zone of Cameroon. Unasylva, 50 (3): 12-19.
[44] Pseudoblastoma, 1992, Shea nuts, Aproma / Bimonthly Review 27-29, 8. In: Tano-Debrah K. & Ohta Y., 1994, Enzyme-assisted aqueous extraction of kernels of the shea tree, Butyrospermum parkii. J. Am. Oil
[45] United Nations Development Program (UNDP), 2005. Development of Economic Opportunities for Women: The Shea Industry. Partners: Government of Chad, World Vision. 21 p.
[46] Provost S., 1995, Study of the shea industry in Burkina Faso, April 1995.
[47] Rongead, 2014. Vitellaria paradoxa, 21 pages.
[48] SICAREX, 1999: "the shea industry". PAF
[49] Tchobo FP, Natta AK, Barea B, Barouh N, Piombo G, Pina M, Villeneuve P, Soumanou MM, Sohounhloue DCK. 2007. Characterization of Pentadesma butyracea sabine Butters of different production regions in Benin. J. Am. Oil Chem. Soc., 84: 755-760.
[50] Terpend, M. N., 1982: "The shea industry; Product of picking, luxury product. The Faim Développement files, February 1982 ", 91 p.
[51] TOE Ella Innocente, Analysis of physico-chemical parameters of shea butter: comparison of traditional and laboratory extraction processes, Burkina Faso, July 2004.
[52] UEMOA (West African Economic and Monetary Union), 2011. Specifications for non refined shea butter. ICS - 67. 13 p.
[53] IUPAC (International Union of Pure and Applied Chemistry), 1979, Analytical Methods for Fats and Derivatives. 6th ed. Lavoisier Tec and Doc, Paris (France), 190 p.
[54] UNIFEM, 1997: "From local to global, the international market for shea butter"
[55] USAID (US Agency for International Development), 2006. Study on shea collection and processing in Guinea. Project Agricultural Marketing Strengthening Activity (ARCA). USAID / Guinea. Task Order No. 29
[56] Van Tomme P., 1999. "FAO: Activities on Non-Wood Forest Products", OBIT, Tropical Forest Activities, Vol. 7, p. 25-33.

[57] Effect of the cooking and drying of shea nuts (Butyrospermum parkii (G. Don) Kotschy) on the quality of butter (Butyrospermum parkii (G. Don) Kotschy) . TROPICULTURA, 2006, 24, 3, 175-182.
[58] Ye S. F. Lebeau, Wathelet J. P., Leemans V. and Destain M. F., 2007 Study of the mechanical pressing parameters of almonds of Vitellaria paradoxa Gaertn C. F. (shea). Biotechnol. Agron. Soc. About., 11: 267-273.
[59] Zida O.B. & Kolongo S.L., 1991, Seminar on forest statistics in Africa. FAO, Thiès (Senegal).