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Valorization of *Vitellaria paradoxa* butter in cosmetics and agrifood in Africa

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Abstract

Forest species are very abundant in African ecosystems and contribute to the economy of households, through their use in cosmetics, pharmaceuticals and agri-food. Among these species, *Vitellaria paradoxa* (sapotaceae) is a tree that can reach about fifteen meters, which grows exclusively in wooded savannas in Africa. Its area of distribution is Senegal, Mali, Burkina Faso, Guinea Bissau, Guinea, Sierra Leone, Côte d'Ivoire, Ghana, Togo, Benin, Nigeria, Cameroon, Chad and Ethiopia. The purpose of this study was to highlight the forms of valuation of shea butter in the food industry and in cosmetics. To do this, we carried out a literature review. The results revealed that shea butter is a fat extracted from the kernels of the shea fruit. It is obtained by shelling, drying and crushing the nuts. Crushed seeds and then mixed with water. Once immersed in water, the impurities will come out naturally from the butter and thus settle in the bottom of the container. Then, the butter that has remained on the surface is collected, and kneaded, to be cooked for a long time at a very low temperature. The water evaporates, leaving only room for the oil, which will be manually filtered through muslin and then conditioned. Once at room temperature, the butter (melted into oil) regains its solid and melting texture. This butter, for its properties, is on considerable importance in food industry and cosmetics. Thus, shea butter is used in cooking (edible oils), in pastry products, confectionery and in chocolate industry as a substitute for cocoa butter. In cosmetics, it is best known for its moisturizing and softening properties of the skin. It is also used as an excipient in cosmetic formulations such as ointments, shampoos, toilet soaps and in creams.

Keywords: *Vitellaria paradoxa*; Shea butter; Uses; Cosmetics; Food; Africa

1. Introduction

In Africa, agriculture is the main economic activity. Nowadays, the shea sector has significant socio-economic importance in the development of the world's major producers of shea butter. Shea, *Vitellaria paradoxa*, a fruit tree native to the semi-arid and sub-humid savannas of sub-Saharan Africa. It is appreciated in all the regions for its many products and uses, including its edible sweet fruits, protein-rich caterpillars, and edible oil known as shea butter. Shea butter or vegetable butter is an edible substance extracted from the fruits of the shea tree, *Vitellaria Paradoxa* of the sapotaceae family, a tree growing in the wooded savannas of West Africa [1], [2]. The shea tree (*Vitellaria paradoxa*) grows in parks, arid savannas and forests over a strip of about 5,000 kilometers in Africa [3], more specifically in Benin, Burkina Faso, Cameroon, Central African Republic, Côte d'Ivoire, Democratic Republic of Congo, Ethiopia, Gambia, Ghana, Guinea-Bissau, Guinea Conakry, Mali, Niger, Nigeria, Uganda, Senegal, in Sierra Leone, South Sudan, Sudan, Chad

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and Togo [4], [5]. Like most trees in agroforestry parks, the shea tree is managed by farmers on their farmland where it grows in association with annual crops and is protected against bush fires and lawless competition for nutritional elements. The shea tree accounts till to one third of park trees in areas where the average tree density is around 40 trees per hectare [6]. Flesh of shea fruit is widely consumed by local people, sold in local and urban markets in West Africa. It is also used as fodder for animals. The almond is the most economically valuable part of the shea tree as it contains 31-62% dietary fat [7]. In Africa, fruit trees and shrubs, thanks to the multiple non-timber forest products they provide, present food, medicinal and economic interests [8]. *Vitellaria paradoxa*, fruit tree from Sudano-Sahelian region; is an endemic species characteristic of the woody flora of a wooded savannas of Africa, fully exploited [9]. It is also reported as the second on the list of 10 priority food woody species in Benin [8]. International demand is concentrated in the hands of a few food, pharmaceutical and cosmetic companies (95% of almonds are intended for the food industry and 5% for cosmetic and pharmaceutical companies). European Union market for shea butter exceeds that the United States market, especially the regulatory authorities, allow shea butter as an ingredient in food products, in particular in seafood products confectionery such as cookies and chocolates, but also in pastry products, margarine and other products usually containing vegetable fat. Chocolate producers use up to 5% shea butter instead of cocoa butter in their products [10]. It is also used in chocolate, pharmacy and cosmetology for its intrinsic properties linked to its glyceride composition and its high unsaponifiable content [11]. It is well known for its cosmetic properties as a skin moisturizer and softener. Thus, shea produces fruits in which the internal kernel is made up of about 50% butter [12]. The quality of shea butter depends on the processes that led to its production, such as cooking the almond, drying, roasting, frying, smoking and heating [13]. In addition, on the socio-cultural and economic level, shea fruits are the object of intense trade and by-products and derived products, play an important role in life [14]. These properties mean that it is now used in the composition of most cosmetic products. In Burkina Faso, industrialists in the North are increasingly using shea butter for the manufacture of chocolate, pastry confectionery and vegetable margarines and an increasing share that is intended for the cosmetics and pharmaceutical sector [15]. According to [16], approximately 60.000 t to 230.000 t of shea kernels that are not exported are converted into raw shea butter, half of which is exported. Rural grassroots women, using traditional manual methods to process about 60% of all raw butter produced in West Africa (at an extraction rate that is on average 33%). Shea comes from a tree known for centuries, sacred to the people of black Africa who use it. Very appreciated by the cosmetics industry, shea has many virtues known and recognized by all. Its tree, *Vitellaria paradoxa*, produces dark green, medium-sized fruit clusters that contain egg-shaped nuts with four to eight centimeters long. It is a fleshy berry containing one or two hard almonds (comparable to an avocado seed), of a whitish hue surrounded by a thin shell and pulp (55%). Each almond contains fat for about half of its weight. This review revolves around the valorization of shea butter in Africa.

2. Methodology

A bibliographic research was carried out from January 15 to October 7, 2021. The following terms were particularly searched, always in combination with "Shea Butter", "manufacturing process" "cosmetic use", "food use" and "valorization"

3. Results and discussion

3.1. Botanical identification of varieties

Shea (*Vitellaria paradoxa*) presents several morphs both in terms of the size and architecture of trees and the shape of leaves and fruits (Table 1). These different aspects enabled [17] to describe the first variants of shea. More recently, the combination of scientific (researchers) and empirical (farmers) knowledge have led to the identification of ten varieties in Burkina Faso. Thus, the first authors who described two subspecies which are: The paradaxa subspecies and the nilotica subspecies. These two subspecies are endemic each to a given geographical area. Thus the paradoxa subspecies are found in West and Central Africa while the nilotica subspecies are only found in East Africa.

The paradoxa subspecies: V*iteliaria paradoxa C.F. Gaertn*.

Subspparadaxa is the most widespread in Africa and has the highest exploitation and export rate. Its nuts have higher stearic acid content and lower oleic acid content. This results in a more solid shea butter.

3.1.1. Vitellaria paradoxa sbsnilotica (Kotschy) Hepper

The latter subspecies are distinguished from the former by their strong hairiness and larger flowers. Their nuts have lower stearic acid content and higher oleic acid content. The result is a more liquid butter, favored by the cosmetics industry. *Vitellaria paradoxa* sbs nilotica spreads in East Africa.

The tree (*Butyrospermum parkii*), from the Sapotaceae family, is native to the Sudanian zone where it grows spontaneously on deep and well-drained soils. It unfortunately suffers from the attacks of bush fires to which it is very sensitive, so that the densest and most productive stands (100 to 150 trees per hectare) are present where traditional crops exist.

Entry into production occurs at only 20 years of age and full production around 40–50 years. Trees from seedlings show a very great morphological heterogeneity.

The almond contains 45 to 55 percent fat characterized by a high level of unsaponifiable components. Its buttery behavior is due to the presence of glycerides of staggered melting points, in decreasing order 0020 [18].

Table 1 Description of the different parts of the plant

Plant part	Characteristics	References
Tree crown	Ball (spherical appearance, long leaves, narrow and light, small fruits) Parasol (V-shape, large and dark leaves, large fruits) Semi-erect (intermediate)	[19]
Stem	Cylindrical, very slow growth, diameter at 1.30m (> 1m)	[19]
Racine	Swivel (length 0.75-1m), Lateral (about 40m)	[19]
Leaf	Oblong 12 to 25 cm long, deciduous, simple, arrangement in a rosette	[19]
limbo	Oblong, wavy edge, leathery, shiny, rounded apex, dark green adaxial face, light green abaxial face, side veins parallel, alternate (20 to 40 pairs), length (10-30 cm), width (3-7 cm)	[19]
Petiole	Average length (8.85 cm) and varies between 4.93 and 22.20 cm	[19]
Fruits	subglobose berry, ovoid or ellipsoid, 4 to 5 cm long and 4 to 5 cm wide, carried by peduncles varying in length between 1.5 and 3 cm	[19]
Pericarp	thick 4 to 8 cm	[20]
Pulp	Fleshy and sweet	[20]
Seeds	Globose or broadly ellipsoid are characterized by their shiny integument, with a large scar along the axis	[21]
Nuts	contains an almond which represents 60 to 84% of the total weight when dry	[20]
Almond	Contains two thick, fleshy, strongly compressed cotyledons and a non-protruding radicle	[22]

3.2. Manufacturing process of shea butter

Table 2 Artisanal process of shea butter production [23]

N°	Tasks	Operations
1	Collect the fruits and / or nuts of shea	Pick up and pulp the ripe fruit that has fallen down on its own from the tree and sort the good nuts to pick u Display nuts (pulped fruits) in a dry and ventilated place for a maximum of 4 days if they cannot be heat treated immediately (insufficient quantity, lack of time, etc.).
2	Wash the shea nuts	Wash the nuts with clean water and sort out them, then remove the bad nuts (rotten, sprouted, immature nuts) and impurities.
3	Heat treat the nuts	Cook the nuts in boiling water for 100 to 120 minutes. Do not store the nuts for more than 4 days before cooking.
4	Wring out the nuts	Wring out the nuts.
5	Dry the nuts	Spread the nuts out on a clean surface and let dry.
6	Sort the nuts	Sort the dried nuts (the almond makes a sharp sound in the shell when you shake) to separate the good from the bad and keep only the good quality ones in baskets, canaries, jute bags, barrels or attics.
7	Shell the nuts	Break the nut to separate shell and almond.

8	Pre-process the almonds	Clean Sort, Wash / Wring, Dry and sort to separate the good almonds from the poor quality almonds ones (withered, shriveled, etc.). After drying, spread the nuts on a sorting table or in a very clean place to separate those that are rotten, sprouted, immature and punctured.
9	Crush the almonds	Cut the almonds into fragments.
10	Roast the almonds	Roast over low heat without leaving to burn.
11	Grind the almonds	Reduce the roasted almonds to a paste (in the mill or by crushing).
12	Cool the dough	Let the dough cool.
13	Knead and Churn the dough	Mix the dough Stir the dough vigorously by adding cold and hot potable water until a creamy dough is obtained. Add cold water to the dough and mix to bring the fat emulsion to the surface.
14	Wash the emulsion	Separate the emulsion from the residue. Wash the emulsion as many times as necessary, until a sufficiently clear wash water is obtained.
15	Cook the emulsion	Heat the emulsion with a little water at the bottom of the pot until whitish bubbles appear.
16	Cool and decant the liquid butter	Lower the pot from the heat and let stand (1st decantation) Separate the liquid butter from the residues.
17	Dehydrate the liquid butter	Cook the butter a second time to reduce the amount of water.
18	Cool and decant the liquid butter	Lower the pot from the fire and let stand (2nd Decantation).
19	Filtrer le beurre liquide	Filter the liquid butter.
20	Knead the butter	Gently mix the butter for a good homogenization of the butter.
21	Pack / Condition the butter	Put the butter in appropriate clean containers and label.
22	Preserve / Store butter	Place the wrapped butter in a clean, dry place (not very hot) out of direct sunlight.

The production of shea butter goes through several unit operations. The diversity of its operations seems to be linked to the socio-economic and socio-cultural landscape of the regions. The sequential description begins with the shelled walnut taken from the pear-shaped basketwork granaries. The material coming from the freshly harvested walnut undergoes pulping followed by toasting (light roasting), the objective of which is to facilitate the shelling, this is done manually after threshing with a flail. This technique has the advantage of ensuring excellent conservation of the nut, which neither acidifies nor oxidizes as is the case when the nuts are kept in a pit when it is not possible to store them in case. At the time of purchase, the almonds are tooth tested, the firmness and color of the flesh being taken as quality criteria [18]. Shea kernel provides palatable butter when prepared from properly harvested and dried almonds. The table shows the production technology of shea butter.

3.3. Valorization of shea butter

In order to fight against poverty, it is necessary to opt for accelerated development of promising sectors, and in particular the sustainable exploitation of non-timber forest products (NTFPs). The products of shea nuts are butter and olein which are used as raw materials in cooking oils, margarine, cosmetics, soaps, detergents and candles; but also as cocoa butter substitutes in the chocolate and confectionery industries [18].

3.3.1. Valorization of shea butter as food

Shea butter is a fat of vegetable origin used as edible oil for frying and / or added to sauces.
The reported moisture contents of shea butter vary from 0.1% [24] to 4.9% [25]. However, exceptional higher values of 8.4% and 14.5% were mentioned by [26], who evaluated the physicochemical and microbiological characteristics of shea butter sold on markets in Côte d'Ivoire. However, the required moisture contents of shea butter destined for cosmetic and food industries are 0.05% and less than 0.2%, respectively [20]. Carbohydrates and crude lipid contents were reported by [27], who found them to be 22.3 g/100 g dw and 75.0 g/100 g dw, respectively. Some mineral contents

of shea butter were assessed by [26] by atomic absorption spectroscopy and by [28] by neutron activation analysis. Ca value varies from 0.2 to 34.1 mg/100 g dw, Na reported is in the range of 0.7–9.6 mg/100 g dw, Fe level is 0.5–6.7 mg/100 g dw, Mg value is 0–8.9 mg/100 g dw, Mn content range is 0–0.14 mg/100 g dw, Zn level is 1.9–3.4 mg/100 g dw, Cu content is 0–1.5 mg/100 g dw, and K value ranges from 0 to 4.5 mg/100 g dw. Ash content ranges from 1.3 g/100 g dw [27] to 3.2 g/100 g dw [29], with an average of 2.2 g/100 g dw [25].
The values of the five major fatty acids in shea oil: palmitic, stearic, oleic, linoleic and arachidic fatty acids in Uganda ranged between 6.52 and 8.12%, 28.65 and 30.94%, 54.99 and 57.72%, 6.18 and 7.79% and 0.65 and 0.90%, respectively. Although oleic and stearic fatty acids were the dominant fatty acids in the shea oil, there was no significant variation ($P \leq 0.05$) in the values of these fatty acids in the different shea districts of Uganda [30]. Table 3 shows the physicochemical characteristics of shea butter.

Table 3 Physico-chemical profile of shea butter

Chemical compounds	Content (%)	References
Total lipids	59.04	[12]
Crude fat	54.85	[12]
Total nitrogen	1.37	[12]
Crude protein	7.81	[12]
Total ash	2.57	[12]
Sugars	5.45	[12]
Starch	7.59	[12]
Pectic substances	2.93	[12]
Hemicellulase	10.84	[12]
Cellulose	5.95	[12]
Total fibers	20.35	[12]
Oleic acid	40 - 60	[31]
Stearic acid	20 - 50	[31]
Linolenic acid	3 - 11	[31]
Palmitic acid	2 - 9	[31]
Linoleic acid	1	[31]

In Europe and the West in general, shea butter is mainly used in cosmetics thanks to its benefits for the skin. However, shea butter is also a valuable ally for many typically African recipes. Shea butter is produced from the shea oil itself extracted from the shea nuts. In the form of oil or butter, they are found everywhere in African cuisine, whether in certain creamy sauces or for frying courgette flower fritters, for example. It can only be cooked and eaten, but it is still very present in African food.

In the West, African restaurants use it a lot. For many Westerners, it is shea butter and oil that give African cuisine its identity without them even knowing it. If edible shea butter is becoming more and more popular, it is not only because it is so prevalent in African cuisine. Indeed, in recent years, European food companies have fallen in love with this oil. As a result, we find a lot of it in vegetable margarine recipes. It must be said that shea butter is a fatty food, but this fat is essentially benefit for human body. It is high in omega 3s and low in saturated fatty acids. However, as always, it should not be abused.

Shea butter is an important cultural and culinary specialty in many African countries, but it is also a great opportunity for economic development of the continent. Indeed, extracting oil from shea nuts is a rather difficult process that requires developing infrastructure.

With an increasingly important market, shea butter could quite accelerate the economic development of countries like Nigeria which is the first producer of shea nuts in the world with 350,000 tons per year.

Since August 2003, shea butter has been one of the fatty constituents of chocolate vegetable origin. European Union has decreed in its article nº 2000/36 / EC, the authorization of an addition of 5% of vegetable fat to chocolate. The latter,

normally made up of cocoa, sugar and cocoa butter, is now associated with vegetable butter. There are therefore new outlets for shea. In fact, this butter has the same properties as cocoa itself. Hence its presence, however minimal, in chocolate. But in addition, it has the advantage of making the chocolate firmer and slows its melting under heat. If shea butter werre chosen as one of the vegetable fat contents of chocolate, it would be no accident. Its chemical resemblance to cocoa combined with its multiple virtues have made this butter on ideal component [32].

3.3.2. Valorization of shea butter in cosmetics

Shea butter is a key ingredient in cosmetics. Moisturizing and nourishing, it is suitable for both skin and hair. He is an exceptional natural partner. Shea butter is often found among the ingredients of body creams or masks for the face and hair. Rich in moisturizing and nourishing active ingredients, it brings softness and suppleness to the epidermis. It is ideal in winter as in summer, to counter various external aggressions such as wind, sun or cold.

In cosmetics, shea butter is used throughout the year. It is a very complete treatment to maintain healthy skin. It is ideally suited as a mask to relieve very dry areas such as hands or feet. In winter, it is ideal as lip balm. Applied pure or combined with other active ingredients such as *Aloe vera* oils or gel, it deeply nourishes and hydrates the hair fiber. Shea butter is used for the formulation of various galenic forms (Table 4).

Table 4 Different forms of use of shea butter in cosmetics

Galenic forms	Properties	Countries	Reference
Ointment	Excipient	Mali	[33]
	Excipient	Ivory Coast	[34]
	Excipient	Benin	[35]
Soap	Fats	Ghana	[36]
Cream	Fats	Burkina Faso	[37]
Soap	Fats	Algeria	[38]
	Fats	Benin	[39]
Massage oil	fats	Burkina Faso	[40]
Raw shea butter	Skin hydration	Ghana	[41]
	Nutrition for dry and brittle hair	Burkina Faso	[40]
	Anti-aging	Ghana	[41]

3.3.3. Shea butter deeply hydrates

Shea butter is ideal for hydrating all parts of the body. It is a natural moisturizer, suitable for the whole family. Rich in vitamins A, D, E and F, shea butter moisturizes, softens and softens for silky skin in all seasons [42].

3.3.4. Shea butter treats skin problems

Many people experience minor skin problems such as eczema, psoriasis, severe scaling or even cracks during their lifetime. These inconveniences can be treated with treatments based on shea butter. Indeed, this natural ingredient with anti-inflammatory and antimicrobial properties repairs and soothes damaged skin, and leaves the skin beautiful and soft. Shea butter calms irritation, and can even be used on a bug bite. It disinfects wounds and helps in healing the skin, thanks to the resinous esters and vitamin E found in its composition.

In addition to moisturizing and protecting the skin, shea butter provides the elasticity and suppleness that the skin tends to lose over years. Thanks to vitamin F and the fatty acids contained in this natural butter, wrinkles can be reduced and cell renewal promoted. While shea butter helps you prevent the first signs from skin aging, it also maintains and preserves your youthfulness [43-44].

3.3.5. Shea butter calms shaving heat

After shaving, the skin may be sore, reddened or even damaged. Shea butter is a care solution to calm "shaving heat". After shaving your beard, it is ideal to apply a shea product rather than a scented aftershave, which contains alcohol and therefore irritates the skin even more. Shea butter will not only soothe the skin but also hydrate it because shaving tends to dry out the skin [45].

3.3.6. Shea butter has beneficial effects for the hair

Besides healing the body, shea butter is also a great ingredient to beautify your hair. Thanks to the vitamin A it contains, it protects brittle hair. The scalp is softer and dandruff, eliminated in the event of a hair problem. Shea butter also takes care of dull and damaged hair, especially due to heating devices, wind or sun. There are hair care products based on pure shea, often as a mask to be carried out after shampooing, or just for the care of the ends [46].

3.3.7. Shea butter helps fight against pregnancy stretch marks

During pregnancy, the skin is often abused. This is due to the change in hormones during this period, as well as the weight gain which stretches the skin and causes it to lose elasticity. It is advisable to use shea butter during pregnancy, to fight against stretch marks. No need to wait for them to occur, shea butter can be used for prevention. In addition, this natural component will allow the skin to be well hydrated. In cream or oil, thanks to shea butter your skin will regain elasticity and firmness [47].

3.3.8. Shea butter protects the breast during breastfeeding

After using shea butter during pregnancy to combat stretch marks, it can be applied to the body while breastfeeding. This helps prevent "crevices" from appearing on your chest [48].

3.3.9. Shea butter has a beneficial effect on the baby's skin

Shea butter is therefore good for the (future) mother, but also for the baby. In Africa, for decades, this natural component has been used in families to hydrate the skin of toddlers. After the bath, the baby should be gently massaged with shea butter, previously warmed in the hands, to nourish the skin and soothe the baby. Shea butter can also prevent diaper rash, which is quite common from newborns, thanks to the vitamins and fatty acids it contains, which calm redness and irritation. Shea butter acts as a “protective barrier” between baby's skin and his diaper [49].

4. Conclusion

In this review, we have highlighted the manufacturing process as well as the different forms of nutritional and cosmetic valorization of shea butter. The results revealed that the butter is extracted from the oil nut which is dried before being crushed. The butter obtained is rich in fatty acids and also contains micronutrients which justify its use in the food industry. In addition, this butter is used in the formulation of several cosmetic products such as ointments, soaps, creams, massage oil, etc. It follows that the development of shea in Africa could increase rural food production and help diversifying the livelihoods of rural populations in the continent.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors agree no conflict of interest.

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