Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.7, No.22, 2017

Medicinal and Nutritional Benefits from the Shea Tree- (Vitellaria Paradoxa)

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Abstract
Shea butter is a solid fatty oil extracted from the nuts of shea (Karite) tree also known as Vitellaria paradoxa or V. nilotica. The tree grows naturally in the wild across sub-saharan savannah belt stretching across West and Eastern Africa covering about 20 countries. The tree has enormous socio-cultural and economic importance to peoples living in its geographic catchment area. Its leaves, stems, roots bark are used in various traditional medicine to treat a variety of diseases and injuries including stomach ache, headaches, fever, jaundice among others. The butter extracted from the fruit is used locally as food and as a cosmetic product for the skin and hair. In recent times there has been an increasing commercial and industrial demand of shea products. This is attributed to the discovery of its importance in the cosmetic and confectionary industries. Shea butter is used in cosmetic products and in the food industry where it is used as a cocoa butter substitute in the chocolate industry. In Africa where shea butter is produced it is also used as cooking oil. Shea butter is solid at room temperature but quickly melts at around body temperature. The chemical composition of shea butter includes a saponifiable fraction composed primarily of stearic and oleic acids with lesser amounts of palmitic, linoleic and arachidic acids. It also contains a substantial unsaponifiable fraction composed of bioactive substances that are responsible for Shea butter's medicinal properties. It has sun screening properties and acts as an emollient and skin moisturizer. Shea butter has is also reported to demonstra anti-aging and anti-inflammatory properties. Consumption of Shea butter has hypocholesterolemic effect and reduces serum and organ protein concentrations.
Keywords: Shea Tree, Shea Butter, Fatty Acids, Chemical Composition, Fruit Pulp.

1. .Introduction

Mankind has always depended on plants for food, clothing, shelter and medicine. Medicine from plant sources have been used to cure, treat and prevent sicknesses and injuries to people. For centuries the shea tree and its products has been used for food and medicine in Sub-Saharan Africa.

The shea tree also known as karite tree is classified in the family Sapotaceae and comprises two species known scientifically as Vitellaria paradoxa (formerly as Butyrospermum paradoxa) and Vitellaria parkii. The name Butyrospermum which actually means "butter seed" gives a good description of the seed because butter is obtained from the seed after processing. The shea tree grows naturally in the wild across a 5000km wild belt of savannah in West and East Africa stretching from Senegal in the West to Kenya and Uganda in the East covering the land area of about 20 countries. The shea tree population of East Africa is the subspecies nilotica, which produces the more liquid type of shea fat; this is due to its higher oleic acid content in the kernels (e.g. up to 50 to > 60 % in Uganda) (Carette ve ark., 2009). The sub-species paradoxa is more common in the West Africa region.

The most important product obtained from the shea tree is the shea fruit which contains between 20% to 50% edible fat (Carette ve ark., 2009). The tree is also a very important component of the natural ecological system. It is a deciduous tree which grows wild in the savanna regions. The shea tree can survive on minimal annual rainfall of about 400-500mm, temperatures of about 30 degrees celcius to 45 degrees celcius, and relative humidity of less than 10%. A shea tree has an average height of about 13 metres (Hall ve ark., 1996). This study seeks to examine the medicinal and nutritional benefits of the shea tree.

1.1 Traditional uses of the shea tree

The shea tree has immense economic and social value to the communities in which it grows. All parts of the tree have one or more uses. The leaves of the shea tree contain saponin which makes it lather in water and hence is used in washing. In northern Ghana the leaves are used in medicine for the treatment of stomach ache especially in children. The leaves are also used in a mixture with other leaves in a traditional mixture to produce a vapor which is used to bath persons for the treatment of fevers and headaches. The leaves when soaked in water turns to a soapy and frothy liquid which is used to bath the head of persons suffering from fever. İn cases of eye problems a leaf decoction can be used as treatment (Agyekwena, 2011). In the production of the dawadawa, the most common and widely used local spice in northern Ghana, the leaves of the shea tree are used as a preservative.

The shea fruit is a green oval shaped fruit which ranges in size from 2cm to 5cm in diameter. The shea fruit is made up of a green epicarp, a fleshy pulp or mesocarp and a realtively hard shell or endocarp which encloses a shea kernel or embryo. The fleshy pulp is sweet and is eaten as food. The pulp is also used to make jam.

The pulp of the shea fruit is a rich source of some micro nutrients including ascorbic acid (196.1mg/100g), in comparison with an orange, which contains only 50mg/100g. Shea nuts contain 1.93mg/100g of iron and 36.4mg/100g of calcium. The B group vitamins is also a constituent of the shea fruit pulp. The pulp also contains a high sugar content made up of glucose, fructose and sucrose equally distributed and constitute up about 3 to 6 percent. Even the flowers of the sheanut tree are consumed by some ethnic groups that make them into edible fritters (Agyekwena, 2011).

The roots of the shea tree are used by locals in Northern Nigeria as chewing sticks for cleaning the teeth. The roots are also combined in mixture with the bark in traditional medicine for the treatment of jaundice, diarrhoea and stomach pain. The root bark is boiled and pounded and used for treating chronic sores in horses. The roots are mixed with tobacco to produce poison among the Jukun ethnic tribe in Northern Nigeria. The bark of the shea tree is boiled and taken as a beverage. This beverage is claimed to be able cure diabetes in some communities in Ghana.

In some West African countries including Senegal and Guinea, infusions of the bark which are crushed together with the bark of Ceiba pentandra and salted are used to treat worm infestations in livestock. In Guinea Bissau a range of sicknesses ranging from diarrhea and dysentery to gastric problems and even leprosy have been treated with bark infusions. In the Ivory Coast, child delivery is eased by the use of a bark decoction in baths during labour. This decoction is also believed to boost the flow of milk and hence is drunk by lactating mothers. A bark infusion is used as an eye wash against venom of the spitting cobra because it has the capacity to neutralize the venom. It is used as foot bath to extract jiggers in Ghana.

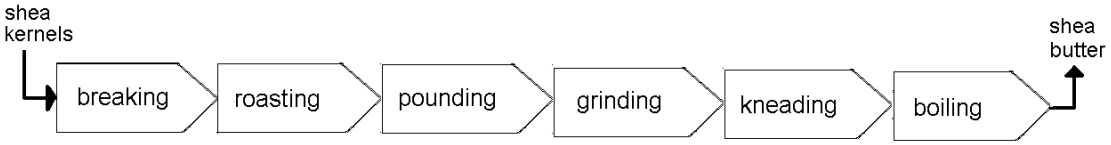
The shea tree produces latex. This latex is used traditionally in a mixture with palm oil to produce glue. Latex from shea nuts contain between 15 to 25 percent carotene which is not appropriate for use in the commercial production of rubber according to present technology.

The shell or husks of the shea nut is used in the purification of water. It has the ability to remove substantial amounts of heavy metal from aqueous solutions. The shell is pounded and made into paste that is used in northern Ghana for plastering traditional mud houses. This treatment serves as decoration whiles promoting the lifespan by making them impervious and reducing their rate of absorption of moisture (Agyekwena, 2011).

1.3 Shea Butter: Extraction

The processing of shea nut into shea butter can be put into a number a categories namely; the traditional method, the semi mechanized method and the fully mechanized method. The traditional method of processing is the most common form of processing among rural, peri urban and even urban processors. This is mainly attributed to the fact that the cost of mechanisation of the processing process is beyond the reach of most small scale shea processors. The traditional method of shea processing produces 100 raw and unrefined shea butter which fetches premium price in the international market.

The traditional and semi-mechanised methods of butter extraction which is fully manual accounts for about 60% of all crude butter produced in the West African sub-region. The extraction rate of the traditional method is approximately 20% (Addaquay, 2004). Generally 1kg of shea nuts produces about 0.4kg of shea butter. The steps involved in the traditional method of extraction is shown as follows:



The semi-mechanised system of processing involves the introduction of new technologies. These technologies are used during the stages of nut crushing and kneading. The use of machines in thses processes increases the extraction rate from 20% to 35-40% (Addaquay, 2004)

The mechanised method of processing involves mechanising all the stages involved in the extraction process. Fully mechanised systems are known to achieve 42%- 50% extraction rate. New technologies being developed involve the use compression exraction or the use pressing machine.

2. Nutrient Content of the Shea Fruit

The shea fruit pulp is a good source of essential nutrients. As an edible fruit it is rich in vitamins, minerals, carbohydrates, crude fibre and proteins (Neuwinger, 1994). The shea fruit pulp ranges in moisture content between 14.90-15.54% (Enaberue ve ark., 2014). Other studies have estimated the moisture content of the shea fruit pulp to range from 67% (Maranz ve ark., 2004) to 80.3% (Mbaiguinam ve ark., 2007). The variation in moisture content of samples is attributed to that the difference in the soil and climatic conditions prevailing locally and the extraction methods used. Moisture content is important in determining the shelf life of fresh fruit. The relatively high moisture content of the shea fruit indicates a short shelf life in preservation.

(Ugese ve ark., 2008) reported the energy value of shea pulp to be 179.5kcal/100g dry weight. The carbohydrate content of shea fruit pulp ranges between 55.35-59.11% (Enaberue ve ark., 2014), and in dry weight

is reported as 8.1g/100g and 37.2g/100g by (Mbaiguinam ve ark., 2007) and (Ugese ve ark., 2008) respectively. It was observed that that the carbohydrate content of the shea fruit pulp decreased at higher latitudes. This phenomenon was attributed to the fact that there is more moisture at the equator leading to improved photosynthesis.

(Maranz ve ark., 2004) observed the presence of sugars, they found that the total soluble sugar content was 13.3g/100 g dw and a glucose content of 1.6 g/100 g dw. Dako ve ark 1974 reported glucose (1–2 g/100 g), fructose (1–1.9 g/100 g), and sucrose (0.7–1.7 g/100 g) in shea pulp from Ghana. (Mbaiguinam ve ark., 2007) observed a crude protein content of 4.4g/100gdw while (Maranz et al., 2004a) reported 5.6g/100gdw. (Ugese ve ark., 2008) found crude lipid and crude fiber content to be 1.3 and 42.2 g/100 g dw, respectively. (Mbaiguinam ve ark., 2007) found the ash content to be 4.7g/100gdw while 5.4 g/100 g dw (Ugese ve ark., 2008) reported the ash content to be 5.4g/100gdw . The carbohydrate content of the shea fruit exceeds the amounts normally required as vital in nutrition and it is also a good source of energy (Anhwange ve ark., 2004). Consumption of the shea fruit pulp is therefore a very good source of energy especially after hard labour, which is very important for farmers in rural areas. The consumption of the shea fruit should therefore be promoted as a good source of energy in these areas.The shea fruit pulp is also rich in minerals particularly potassium and calcium. It also contains good amounts of vitamins and amino acids. The amounts of these nutrients varies widely according to various studies conducted to estimate the nutrient content. Some of the results obtained empirical studies are presented in table below.

Table 1: Nutrient composition of Shea Fruit Pulp, Kernels and Butter

	Pulp			Kernels			Butter		
Macronutrients	**Min.**	**Average**	**Max.**	**Min.**	**Average**	**Max.**	**Min**	**Average**	**Max**
Moisture (%)	67.0	74.2	80.3	5.0	6.8	8.1	0.1	1.4	4.9
Energy (kcal/100gdw)		179.5							
Carbohydrates (g/100g dw)	8.1	22.6	37.2	25.0	30.9	34.8		22.3	
Crude protein(g/100g dw)	4.2	5.2	5.6	6.8	8.1	9.0			
Crude-lipid(g/100g dw)		1.3		17.4	45.2	59.1		75.0	
Crude fibre(g/100g dw)		42.2		3.2	9.1	20.4			
Ash(g/100g dw)	4.7	5.1	5.4	1.8	2.5	3.0	1.6	2.3	3.2

Source: (Fernande ve ark., 2009)

Table 2: Composition of Shea Fruit Pulp, Kernels and Butter

	Pulp			Kernels			Butter		
Minerals(mg/100g dw)	**Min.**	**Average**	**Max.**	**Min.**	**Average**	**Max.**	**Min**	**Average**	**Max**
Ca	2.5	117.3	4260.0	0.1	71.8	215.2	0.2	9.6	34.1
Cu	0	0.1	1.1		0.3		0	0.8	1.5
Fe	0.4	8.5	16.0	0.01	1.6	3.1	0.5	3.6	6.7
K	21.7	830.3	1686.0	0.1	0.1	0.2	0	2.2	4.5
Mg	11.1	57.2	129.0		1426		0	4.5	8.9
Mn	0.3	0.6	0.9	0.1	0.4	0.7	0	0.006	0.14
P	1.0	39.8	71.4		0.04				
Na		19.3		0.9	20.9	73.9	1	4.2	9.6
Zn	0.5	2.1	4.0		0.9		1.9	2.7	3.4
Vitamins(mg/100g)									
B		7.0							
C		196.1							

Source: (Fernande ve ark., 2009).

The amino acid content of the pulp was investigated by (Mbaiguinam ve ark., 2007) and found that the pulp contains asparagine/asparticacid (6.6g/100gprotein), glutamine/glutamic acid (5.6 g/100 g protein), proline (3.9 g/100 g protein), and leucine (3.1 g/100 g protein), and it is limited in cysteine (1.1 g/100 g protein) and methionine (0.1 g/100 g protein). The table below summarises the findings;

Table 3 Amino acids (g/100 g proteins) of Shea Fruit Pulp

Amino acid	Value
Asparagine/aspartic acid	6.6 ±0.3
Threonine	1.7±0.2
Serine	2.1±0.2
Glutamine/glutamic acid	5.6±0.5
Proline	3.9±0.2
Glycine	2.2±0.2
Alanine	2.4±0.1
Valine	2.5±0.2
Cysteine	1.1±0.1
Methionine	0.1±0.0
Isoleucine	2.0±0.1
Leucine	3.1±0.1
Tyrosine	1.7±0.2
Phynylalamine	1.5±0.1
Lysine	1.8±0.1
Histidine	1.2±0.1
Arginine	3.1±0.14

Source: (Mbaiguinam ve ark., 2007)

3. Physical and Chemical Composition of Shea Butter

Shea butter is a triglyceride fat derived mainly from stearic acid and oleic acid with large fraction of unsaponifiable components. It is solid at room temperature but melts around body temperature. Its unsaponifiable fraction iscomposed of bioactive substances that are responsible shea butter's medicinal properties (Esuoso ve ark., 2000). The unsaponifiable fraction of Shea butter is mainly made up of triterpene alcohols. It also contains some hydrocarbons, sterols, and other minor components such as vitamin E (Alander, 2004). The concentration of these components varies from region to region. The saponifiable triglyceride fraction of Shea butter constitutes about 90% by mass of the butter and is composed primarily of stearic and oleic acids with lesser amounts of palmitic, linoleic and arachidic acids (Davrieux ve ark., 2010) . The triacylglyceride fraction is made up of fatty acids (acyl chains) attached to a glycerol backbone (Nelson ve ark., 2008). Since different fatty acids are present in Shea butter, different combinations of fatty acids attached to the glycerol are possible. In Shea butter, the most predominant combination is SOS (S-Stearic, O-oleic) making up to 40% of the total triacylglycerol molecules, followed by SOO (27 %), POS (P-palmitic, 6%) and POP (1%) (Alander, 2004). Shea butter contains relatively high amount of saturated fatty acids compared to other plant-sourced lipids including: grape seed oil (total saturated fatty acids: 10.4-14.3 % of total fatty acids), olive oil (12.7-16.2 %), and canola oil (5.5-7.7 %) which are all, in contrast to shea butter, liquid at room temperature and have saturated fatty acids less than 20 % of total fatty acids (Damodaran ve ark., 2008). Though the fatty acid composition of shea butter vary across the region (Maranz ve ark., 2004) presented ranges and mean values of the fatty acid compositions as shown below:

Table 4: Fatty acid Composition of Shea Butter

Fatty acids	Mean (%)	Min (%)	Max (%)
Palmitic (16:0)	4.0	2.6	8.4
Stearic (18:0)	41.5	25.6	50.2
Oleic (18:1)	46.4	37.1	62.1
Linoleic (17:2)	6.6	0.6	10.8
Arachidic (20:0)	1.3	0.0	3.5

Source: (Maranz ve Wiesman, 2004).

4. Benefits of shea butter

4.1 Healing qualities: Shea butter has great healing properties. It is often used as a base in medicinal ointments due to its anti-inflammatory properties. Due the presence of several fatty acids and plant sterols such oleic, palmitic, stearic and linoleic acids shea butter is known to possess some healing properties. These oil-soluble components do not undergo saponification or convert into soap on coming in contact with alkali. Shea butter is more non-saponifiable than other nut oils and fats, thus imparting it a great healing potential for the skin. Raw, unrefined shea butter is effective in curing skin rashes, skin peeling after tanning, scars, stretch marks, frost bites, burns, athletes foot, insect bites and stings, arthritis, and muscle fatigue. Also due to its high content of vitamin A, it is

effective in promoting healing and disinfection, and soothes skin allergies like poison ivy and insect bites. Shea butter contains Vitamin F which has the ability to act as a rejuvenator for soothing and healing rough and chapped skin (Malachi, 2013).

4.2 Sun-screening Function: Shea butter is a good sun screening agent. Sun-screening agents act by absorbing or reflecting some of the ultraviolet (UV) radiation from the sun and prevnts it from reaching the skin. This helps to protect the skin from sunburn, preventing erythema and also reducing further risk of skin cancer induced by the sun's rays. According to (Velasco ve ark., 2008), photocarcinogenesis is mainly caused by UVB radiation between the ranges of 290 and 320nm. İt interacts with the DNA directly thereby forming cyclobutane pyrimidine. Cinnamate esters of triterpene alcohol are the main constituent of Shea butter's unsaponifiable fraction, these esters have been reported to have strong ability to absorb UV radiation of the wavelength range 250-300 nm. This therefore makes the addition of Shea butter's unsaponifiable components into sunscreens increase the absorption of UVB radiation by providing synergistic sun-protection (Nahm, 2011). During the cold season and summer when the weather is extreme, shea butter is considered as the best skin care during the period because it provides the extra moisture, nutrients and protection needed by the skin.

4.3 Anti-aging Properties: Shea butter has been considered one of the best anti-ageing and moisturising agents for the skin. İt is reported by (Tran, 1986) that Shea butter has UV anti-erythemic activity. This property of shea butter helps to soften the skin and stimulates cell regeneration hence reduce the aging process. He also indicated that shea butter prevents photo-aging. Shea butter has also been known to boost collagen production (Loden ve Andersson, 1996). The major structural proteins that makes the skin tough and provides plumpness and α-amyrin and lupeol are collagen and elastin. These triterpenes are found in the unsaponifiable fraction of Shea butter. The inactivation of proteases such as metalloprotease and serine protease are reported to be affected by these triterpenes. The unsaponifiable componets are also repoted to contribute to anti-aging and collagen-boosting activities (Alander, 2004).

4.4 Anti-inflammatory Properties: Shea butter is reported to show anti-inflammatory properties attributed to the several derivatives of cinnamic acid that it contains. (Verma ve ark., 2012) showed that shea butter has anti-inflamatory properties by inhibiting Inos, Cox-2, and Cytokines through the Nf-Kb pathway in Lps-Activated J774 Macrophage cells. The ability of shea butter to reduce reaction to skin irritations was also demonstrated by (Loden ve Andersson, 1996). (Nahm, 2011) discovered that shea butter's most dominant triterpene in its unsaponifiable fraction was α-amyrin. This triterpene (α-amyrin) when mixed with β-amyrin shows a dose-related antinociceptive effect against visceral pain (Otuki ve ark., 2005a). The application of α-amyrin topicaly shows anti-inflammatory effects, that inhibits skin inflammatory responses such as an increase in tissue IL-1β levels, edema formation, and even the migration of polymorphonuclear leukocyte (Otuki ve ark., 2005b).

4.5 Effect on Cholesterol Metabolism: (Masters ve ark., 2004) reported that shea butter can to lower cholesterol levels when used. They also observed that the usage of shea butter leads to a reduction in low density lipoprotein (LDL) and total cholesterol. The high stearic acid content in shea butter is reported to have anti-hypercholesterolemic effects. İn a different study by (Akinwale ve ark., 2012) on rats they reported that when rats were fed with Shea butter there observed a significant reduction in High density lipoprotein (HDL), Total Cholesterol and Low density lipoprotein (LDL). The presence of saponins in shea butter was said to be responsible for the anti-hypercholesterolemic effect. Saponin as present in the unsaponifiable fraction of Shea butter (Alander, 2004) is said to have the ability to lower the serum cholesterol level by forming mixed micelles with cholesterol and bile acids in the intestine. This process inhibits the absorption of cholsterol and thereby increasing its excretion (Israel, 2014)

4.6 Effect on Protein Metabolism: When shea butter is administered, it is reported to lead to a decline in the overall protein concentrations of the hepatic and renal tissues and also in the serum. This decline has been attributed to the presence of saponin. Saponin has been reported to cause a reduction in protein digestibility by the forming sparingly digestible saponin-protein complexes in the intestine (Malachi, 2013)

4.7 Allergy: According to (Anderberg ve ark., 2002) the Shea nut tree and the Brazil nut tree are distantly related. The Brazil nut cross-reacts with a number of other fruits including walnut, almond, peanut and hazelnut. The shea nut however does not show an allergic reaction resulting from the topical or oral use of Shea butter (Sharma ve ark., 2008). İt has also been reported by (Chawla ve ark., 2011) that there is no IgE-binding soluble proteins and reassures in shea butter. This result indicates that Shea butter is safe to be used by persons with nut allergy. (Weidner, 2004) on the other hand found that medicinal compositions containing at least 5% of Shea butter's triterpenes. Some of these triterpenes include butyrospermol, lupeol, parkeol, germanicol, dammaradienol, 24-

methylene-dammarenol, and α, and β-amyrins and dammareno these can effectively suppresses hypersensitivity reaction such as Immunoglobulin E (IgE)-mediated allergic reactions and autoimmune reactions in mammals.

4.8 As an emollient and skin moisturizer: Shea butter contains vitamins A and E, this makes it a good moisturizer for hair. Also shea butter has semi-solid characteristics and buttery consistency, this make it a good emollient and moisturizer for the scalp and skin as well (Nahm, 2011). When shea butter is fractionated, its olein fraction especially is can be formulated into creams or surfactant based products such as bath products and shampoos. This formulation provides more moisture for the skin, scalp, and hair (Rogers ve O'Lenick Jr, 2009). As indicated by (Malachi, 2013) shea butter is solid at room temperature but melts at body temperature. It acts as a "refatting" agent. İt is easily absorbed into the skin and has good water-binding properties hence it is useful for skin care. Shea butter has the ability to repair dry inflamed skin caused by dermatitis and can be used as a night time moisturizer for hands and feet (Sheperd, 2012). (Science., 2009) showed that shea butter is superior to mineral oil at preventing Trans-Epidermal Water Loss (TEWL). In an experiment he washed the hands of participants in ethanol, the results indicated that the skin totally recovered from TEWL within two hours when treated with Shea butter. In another study by (Belibi ve ark., 2009) showed that shea butter can work as an emollient for eczema. Shea butter is also widely used for curly hair treatments due to its emollient qualities. Shea butter can restore moisture lost in hair due to a number of chemical treatments like straighteners, perms, curlers. These treatments causes the loss of natural moisture from the hair.

4.9 Hair protection and softener: Shea butter has been used widely for hair treatment. It serves as a good source of protection for the hair against the harmful free radicals in the air and water and harsh weather conditions. Shea butter when applied to the hair and absorbed, it coats the hair shaft and hence protects it from a heat. This protective activity is particularly beneficial for hair that have been processed or colored hair. When Shea butter is applied to the hair before swimming it protects the hair against salt and chlorine. For damaged and brittle hair shea butter has a softening and revitalizing ability. Shea butter has a non-greasy texture hence can control and spread the excess oil in the scalp (Naaz, 2016).

5.0 Conclusion

It can be said that the shea tree is socio-economically a very important tree to the people of the regions in which grows. It has also beome a tree of global importance primarily due to the discovery of the wide usage of shea butter in the cosmetic and confectionary industries. The entire shea tree from its leaves and flowers to the roots has found usage both in traditional medicine and rituals and also industrial commercial use in one form or the other. The tree can comfortably be described as a tree of live in the sub-saharan savannah belt of Africa.

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