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Applications of shea butter in new food product formulations

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Abstract
Shea butter, derived from the nuts of the African shea tree (*Vitellaria paradoxa*), is a versatile natural fat with numerous applications in the food industry. Traditionally used in West African cuisine, shea butter serves as a cooking oil, imparting a mild, nutty flavour to dishes, while also being utilized for frying and sautéing. Its stable solid form at room temperature makes it an excellent ingredient in margarine production, providing a rich, creamy texture. Shea butter's use as a cocoa butter substitute in chocolate and confectionery production is particularly significant, offering a cost-effective alternative with similar properties, such as smoothness and melting behaviour. The two main fatty acids in the shea butter samples are stearic and oleic acid. Additionally, shea butter can be found in baked goods, where it enhances the softness and moisture content of products like biscuits, pastries, and bread. Its application extends to spreadable products, where it is used in the formulation of butter and margarine alternatives. Overall, shea butter's high nutritional content, rich fatty acid profile, and versatile textural properties make it an increasingly important component in various food products across the globe.

Keywords: Shea butter, food formulations, fatty acid profile, cocoa butter substitute

Introduction
Shea butter is a natural creamy substance derived from the nuts of the shea tree (Vitellaria paradoxa), which grows in the Savannah regions of West Africa. "Shea" is the English word which comes from si, the name of the tree's is Bambara [1]. There are many local names of shea, such as Lgbo language in the Okwuma, Wolof language of Senegal in the karite, Yoruba language in the ori, Dagbani language in the kpakahili, Twi in nakuto, wali language in the taama, hausa in Kade or Kadanya (Goreja *et al*., 2004) [1]. Moo-yaa is also known as in the Acholi language [3]. It occurs in 21 countries across the African continent, namely Togo, Ivory, coast, Central African Republic, Benin, Eritrea, Chad, Ghana, Mali, Nigeria, Niger, Kenya, South Sudan, Senegal, Cameroon, Burkina Faso, Ethiopia, Guinea Bissau, Democratic Republic of the Congo, Uganda, Sierra Leone. A discovered at the medieval village of Saouga indicates that Shea butter was being produced there as early as the 14th century (Neumann *et al*., 1998) [2].
The shea tree naturally grows in the Southern Sahel and Northern Guinea zone regions. It flourishes in Savannah areas where the oil palm cannot survive due to insufficient rainfall [5]. The crop is shaped like an ellipse and features a white scar on one side. Its Shell in uniformly about 1mm thick (A.M. Olaniyan *et al*., 1999) [4]. Using remote sensing technology in Mali,18 million Shea butter trees were identified along a 20 km stretch (J.M. Fleury *et al*., 2000) [5]. The nuts have a thin shell and encloses an oil-rich Kernel (O.O. Babatunde *et al*., 1997) [6]. In months of June and august shea nuts are generally harvesting and peaking during July. Once extracted, this fat is used locally for a variety of purposes, including frying, cooking, soap making in medicinal applications and even in health care (Hall *et al*., 1996) [7]. outside the production regions, shea butter is primarily used for industrial purposes:95% of the exported butter goes into chocolate and confectionery products, while the remaining 5% is utilized in cosmetics and Pharmaceuticals (Hall *et al*.,1996; Elias & Carney *et al*., 2007) [7, 8].
Shea butter is a natural fat derived from the nuts of the African Mangifolia (Karite) tree. It has a pale yellowish- white color and a distinctive odor. The butter of fat is solid, but because of

its low melting point, it often appears in a liquid form (E. Tessy *et al*., 1992) [9]. Global demand for shea oil is rising, and the FAO has added the to its priority list of African genetic resources [S. Amadou *et al*., 2006] [10]. Shea butter contains a wide range of chemicals responsible for its. Therapeutic benefits. These include antioxidants like water-soluble Catechins and oil soluble tocophenols, as well as triterpenes such as sterols, butyrospermol, phenols and others compound like allantoin and karitene. Its fats are often used in cosmetics, soap making and traditional medicine in many rural areas [14-16]. Shea butter is a type of fat primarily composed of stearic and oleic acids. It is generally edible and in cooking in certain African countries [17]. Shea butter is economically important for its ability to moisturize day skin and treat acne and blemishes. Its healing properties are due to the presence of fatty acids and plant sterols like palmitic, oleic, steric and linoleic acids. It also helps reduce skin imnflamation due to the presence of cinnamic acid, which has anti-inflammatory properties (Israel *et al*., 2014) [16].

Nutritional composition of shea butter

The initial steps of shea butter extraction by rural women, after obtaining the kernel, involves roasting and grinding the kernel into a fine powder or flour, which is then mixed with warm or luke warm water. The semi-solid mixture is then continuously stirred or hand-kneaded until the oily phase separates. The fat-rich liquid is gathered and boiled until it becomes clear. The fat is then strained through a sieve into a basin, where it is allowed to solidify.

Macronutrients in shea butter

The moisture content of shea butter has been reported to range from 0.1% (Olaniyan & Oje *et al*., 2007) [17] to 4.9% (Honfo *et al*., 2011) [18]. Nevertheless, exceptional high value of 8.4% and 14.5% (Megnanou *et al*., 2007) [19], were observed in those who evaluated the microbiological and physicochemical characteristics of shea butter sold on the market cote d'Ivoire. The moisture content required for shea butter intended for the cosmetic industry is 0.05%, while for the food industry it must be below 0.2% (Kassamba *et al*., 1997) [20]. That the carbohydrate content was 22.3g/100g dw, while the crude lipid content was 75.0g/100g dw (Chukwu & adgidzi *et al*., 2008) [21]. Reported ash content ranges from 1.3g/100g dw (Chukwu & adgidzi *et al*., 2008) [21] to 3.2g/100g dw (Adomako *et al*., 1985) [22] with an average of 2.2g/100g dw.
All of the authors used the methods established by the Association of official Analytical chemists to determine the various values.

Minerals in shea butter

The minerals content of shea butter was evaluated using atomic absorption spectroscopy and neutron activation analysis.

Table 1: Minerals contains in shea butter

Minerals (mg/100g dw)	Min	Max	References
Calcium (ca)	0.2	34.1	(Megnanou *et al*., 2007) [19]
Sodium (Na)	0.7	9.6	(Megnanou *et al*., 2007) [19]
Magnesium(mg)	0	8.9	(Megnanou *et al*., 2007) [19]
Iron (Fe)	6.5	6.7	(Megnanou *et al*., 2007) [19]
Copper (cu)	0	1.5	(Megnanou *et al*., 2007) [19]
Zinc (zn)	1.9	3.4	(Megnanou *et al*., 2007) [19]
Manganese(mm)	0	0.14	(Alhassan *et al*., 2011)
Potassium(k)	0	4.5	(Megnanou *et al*., 2007) [19]

Vitamins

There are no published reports on the vitamin content of shea butter, but its tocopherol content has been documented (Maranz & Wiesman *et al*., 2003) [24]. However, due to its yellow color, shea butter is likely to contain some vitamin A.

Composition of genuine coco butter

Cocoa butter is distinguished by its sharp melting point and favourable physicochemical properties, which are attributed to its fatty acid composition (Rao & Lokesh *et al*., 2003) [25]. It contains a high concentration of palmitic, stearic and oleic fatty acids. More than 70% of total TAG consist of desaturated 1(3)-stearoyl-2-oleoyl-3(1)-palmitoyl glycerol (SOP), 1,3-distearoyl -2-oleoyl glycerol (SOS) and 1,3-dipalmitoyl-2-oleoyl glycerol (POP) with oleic acid in sn-2 position of glycerol backbone (Simoneau *et al*., 1999; Liu *et al*., 2007) [26, 27]. The unique fatty acid composition & structure provide cocoa butter with valuable crystallization and melting properties, creating a cooling sensation in the mouth and the characteristic texture that makes it the primary fat used in chocolate and confectionery products (Shukla *et al*., 1995) [28]. The total amount of unsaturated fatty acid present in coco butter about 57-64%. The saturated fatty acid which present in coco butter and lauric acid, stearic acid, palmitic acid, arachidic acid and myristic acid and in unsaturated fatty acids present are in linoleic acid, palmitoleic, oleic acid and α-Linolenic acid where stearic acid, palmitic acid, oleic acid are present in higher amount and myristic acid, lauric acid, palmitoleic acid linoleic acid & arachidic acid in low amount. Cocoa butter triglycerides contain saturated fatty acids at the 1,3-positions, while oleic acid is present at the 2-positions. The main fatty acids include oleic, palmitic, stearic acids (Talbot *et al*., 1999) [29]. In cocoa butter natural antioxidant like vitamin E such as α-Tocopherol, β-Tocopherol, γ-Tocopherol present which helps in preservation, it contains β-Tocopherol in higher amount that followed by γ-Tocopherol and α-Tocopherol (Erickson *et al*., 1983) [30].

Application of shea butter and cocoa butter

Cocoa butter is a key component in the production of chocolate. It's hard, moldable, and brittle at room temperature but fully melts at oral temperature. The cocoa butter equivalent, on the other hand, lowers the cost of chocolate production because it is less expensive than cocoa butter Cocoa Butter Equivalent (CBE) is found in foods like chocolates, ice cream, and bakery items like cakes, biscuits, and bread. Sal fat, mango seed fat, shea butter, and palm oil are examples of CBEs that have undergone various processing procedures such as chemical or enzymatic interesterification, fractionation, and blending.
Seed kernels of trees growing in Borneo, Java, Malaysia, India, and the Philippines are used to make Sal Fat (*Shorea robusta*). It was largely utilized as cooking oil, animal feed, in the pharmaceutical industry, and biodiesel manufacturing. It is believed that 1.5 million tonnes per year are available in India alone. Cocoa butter and shea butter are vegetable fats that are utilized in both food and cosmetics.
The Cocoa Butter Equivalent (CBE) Market is primarily driven by the increase in demand for chocolates and the high price of cocoa butter. Cocoa butter is a key component in the production of chocolate.
They are typically utilized to make compound coatings for use in enrobing bread and confectionery products other than chocolates. Increasing consumer demand for chocolates,

rising cocoa butter prices, an increase in the number of applications in the cosmetics industry, easy availability of products in the market, and an increase in the number of patients suffering from various skin diseases, as well as a growing number of people becoming health conscious and focusing on maintaining healthy skin conditions are some of the major factors that will likely boost the growth.
Shea is in high demand in a variety of industries and markets around the world. Continued rising demand for Cocoa Butter Equivalents (CBEs) due to rising global chocolate consumption, high cocoa costs, and strong demand for natural cosmetics and soaps are the main drivers driving demand.
Shea has a lot of commercial appeals since it may be used as a substitute for cocoa butter (CBE) in the confectionery sector. Shea butter is authorized as a CBE in chocolate up to 5% in the EU, which is driving this demand. India is also a significant market for shea butter in the food sector. The key driver of shea butter demand is the growing need for CBEs as a substitute for cocoa butter in chocolate production. Shea butter is now used in only 10% of cosmetics and medicines, with 90% of the demand coming from chocolate and confectionery items.

Chemical composition
Shea butter's efficacy is attributed to its rich chemical composition, which includes:

Triglycerides: Predominantly composed of stearic and oleic acids, providing moisturizing and emollient properties.

Unsaponifiables: Including vitamins A, E, and F, along with phytosterols and triterpenes, which contribute to its healing and anti-inflammatory effects.

Phenolic compounds: Exhibiting antioxidant properties that protect the skin from oxidative stress and environmental damage.

Health benefits
Shea butter's health benefits are extensive and supported by scientific research:

1. Moisturizing and anti-aging
Shea butter is a superior moisturizer, aiding in the retention of skin moisture and improving skin elasticity. Studies have shown that the application of shea butter can significantly enhance skin hydration and reduce the appearance of wrinkles and fine lines.

2. Anti-inflammatory and healing properties
The anti-inflammatory properties of shea butter make it effective in treating various skin conditions, including eczema, psoriasis, and dermatitis. Its ability to accelerate wound healing and reduce scarring has been demonstrated in clinical trials, highlighting its potential in dermatological applications.

3. Antioxidant protection
Shea butter contains a high concentration of antioxidants, which protect the skin from free radicals and environmental stressors. This property is particularly beneficial in preventing premature aging and maintaining skin health.

4. Hair care
In addition to its skin benefits, shea butter is widely used in hair care products. It provides deep conditioning, reduces scalp irritation, and promotes hair growth. Its emollient properties help in managing dry and brittle hair, making it a popular ingredient in natural hair care formulations.

Modern-day applications
The versatility of shea butter has led to its widespread use in various industries:

1. Cosmetic industry
Shea butter is a key ingredient in many cosmetic products, including lotions, creams, lip balms, and soaps. Its ability to provide deep moisturization and improve skin texture makes it a favored component in skincare formulations. The growing demand for natural and organic cosmetics has further boosted the popularity of shea butter.

2. Pharmaceutical industry
The therapeutic properties of shea butter have been harnessed in the pharmaceutical industry for the formulation of topical treatments for skin conditions. Its anti-inflammatory and healing effects make it suitable for use in ointments and creams for conditions such as burns, rashes, and ulcers.

3. Food industry
In some regions, shea butter is used as an edible fat, particularly in chocolate production as a cocoa butter substitute. Its nutritional profile, rich in essential fatty acids and vitamins, adds value to its use as a food ingredient.

4. Sustainable development
Shea butter production supports sustainable development in West Africa. The industry provides employment opportunities, particularly for women, and promotes environmental conservation through the sustainable harvesting of shea nuts. Efforts to improve the shea value chain have focused on enhancing quality, increasing market access, and ensuring fair trade practices.

Future scope
This study seeks to promote the incorporation of shea butter enriched with different nutraceuticals showing health benefits associated with alleviating constipation and reducing cholesterol levels. The combination of this fat offers a multitude of health benefits, opening up new avenues for scientists to develop a wide range of value-added products. Such research can be valuable in promoting healthier dietary choices and potentially reducing the risk of heart-related issues. We wish its extensive adoption in the food industry, food processing, food formulation, and the advancement of innovative food products in the upcoming years.

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