Title

VALIDATION OF SHEA BUTTER OIL EXTRACTION AND ANALYSIS USING GC-MS AND/OR HPLC

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Abstract

This document is a systematic review focusing preliminarily on Shea Butter (SB)oil; it's processing, extraction, and quality analysis using high performed analytical techniques. It highlights the background and relevance of shea and its widespread utilities, particularly in the cosmetics and beauty industries. Owing to the gradual expansion of the business, different beauty experts are incorporating different blends of other components with shea to produce a value-added market product with adequate consumer interest. This review also casts light on the potential side-effects and risks associated with the products. A considerable section of the review discusses the different extraction methods involved and its sheer benefits. In this regard, the different parameters have also been mentioned. Once the crude product is obtained, it undergoes quality analyses before releasing it into the market as a finished item. This includes organized analytical technologies like mass spectrometry (gas chromatography) (GC-MS) and different variants of high-performance liquid chromatographic techniques commonly abbreviated as HPLC. The current review also provides a detailed overview of the efficiencies and limitations of each analytical technique. This categorically aids other readers to develop a coherent perspective of SB businesses and their future scopes. The review also contains several determinants of this product with the immense potential to dominate the cosmetics world with the eventual flow of time.

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1. Introduction

This document is an elaborate systematic review. The topic of the review is the extraction and corresponding validation of SB oil. This review would categorically reflect the sheer properties of the product to be profoundly used in the beauty and cosmetics businesses all across the globe. However, due to limited information, the review has preliminarily focused on its various aspects of Africa. It casts light on the differential manufacturing procedures, the significance of the steps incorporated, and their respective conditions that help to obtain the best quality sample for marketing. Such extraction and processing have now become a significant earning activity for zillions of people across the globe. However, often owing to adverse environmental effects and its associated potential risks, such methods take its setback. Nearly every part of the shea tree has certain utilities. Shea might aid to soothe different skin conditions due to its immense anti-inflammatory traits (Lin, Zhong & Santiago, 2018). Many beauty experts tend to argue on the better utility of coconut oil over shea, but various investigations have collectively concluded stating the better properties of shea for the presence of more useful nutrients that the skin requires. The abundant presence of multiple oil categories sometimes can cause skin tanning, especially in tropical regions. However, owing to its plethora of uses, the acceptance of shea and the corresponding products have been immensely employed in the cosmetics industries all over. Not only in skin care utilities, but shea also has a plethora of medicinal values as well owing to which the sample has been attaining such a huge market interest to the common mass for over many years now. Shea tree belonging to the Sapotaceae family is mainly indigenous to the Sub-Saharan belt in Africa. And, it is in immense demand in the architecture of the international market. Globally, shea demand is as good as $10 billion with its annual projection estimated to be above $30 billion by this year's end (Allaye Kelly, Poudyal& Bouvet, 2019). Many marketer experts have long been known to inculcate the multi-faceted SB properties in a broad-variety of cosmetics items. Initially, it was not so entirely explored but with the eventual flow of time, this market encountered its eminence and established its profound foothold in different parts of the globe.

Keeping this as the source of the study, this systematic review will cast light on the literature mining of shea, its physical traits, the presence of shea with other ingredients in cosmetics, and finally its extraction techniques and analysis with a focus on the **cosmetic industries**.

1.1 Background

It is important to highlight the origin of shea before focusing on its uses and the processing techniques and their relevance in the beauty industries. This section of the document concentrates mainly on the background of SB and its vast application in diversified marketing aspects. Shea trees are a major characteristic of the semi-arid West African regions. Particularly in Ghana, shea tree is quite a dominant species and is found in abundant numbers in the farmlands and associated areas. Shea tree, formerly known as "Butryospermum Paradoxum," naturally grows in and around the dry belt of Savannah and also around the foothills of the highlands in Ethiopia. (Sarruf et al., 2019). However, according to reports, nearly 19 African countries harbor shea trees. Shea fruit kernels are abundantly rich in oil thereby providing a decent dietary ingredient. The dried kernels are invariably stored or could be instantly processed by an arduous process to produce SB. Therefore, SB is successively regarded as a versatile product owing to its edible nature, anti-microbial properties, pharmaceutical as well as remedial ventures. The broad range of utilization of this is seen in various local as well as global markets. Also, the prodigious demand of the same categorically makes SB production such a significant aspect and earning opportunity for millions of people worldwide. Specifically, for a huge section of the female community on the northern side of Ghana, SB provides them with their only mode of income (Hammond et al., 2019). In other words, historically, it is mostly the women that correspond to the dominating producers of the African SB. They produce the butter with the nut present inside the shea fruit. This grows, particularly on the karate tree. Ideally, the butter used in cosmetics items is chiefly considered to be nut oil, and each item it comprises of is needed to be listed on the final market product label. But, the processing of the same is immensely assiduous and time-consuming. For the producers in West Africa, the collection, storage, and processing methods must be impeccably handled in order to export rich-quality butter to generate adequate revenues. But such processing requires abundant quantities of natural resources. It requires adequate water and fuel wood that needs to be extensively carried from far off distances which is one of the intricacies the producers encounter. Enhancing the value-added just by processing kernels into useful butter is the likely required incentive that remarkably encourages many women to pay more attention to quality (Arendt-Nielsen,

Rosetzsky&Weidner, 2009). However, there are multiple shreds of literature and also practical experiences from the farming land, it is evident that women obtain very minute returns from coherent small-scale processing.

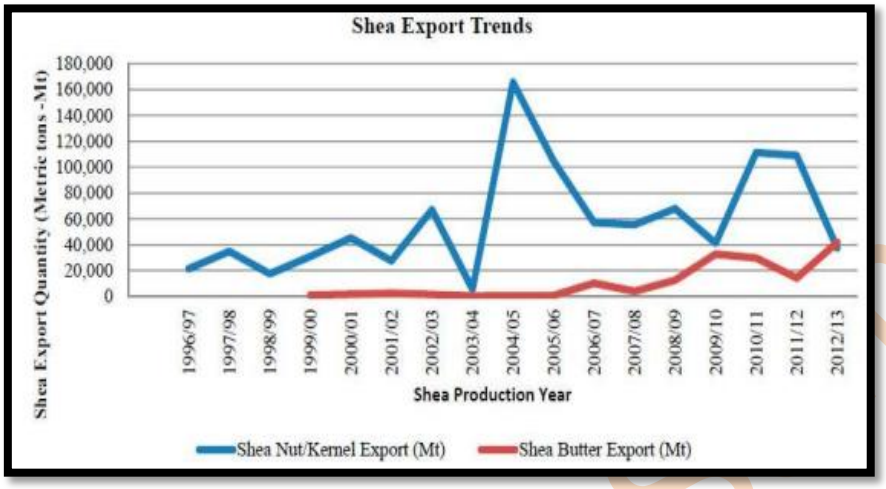

Figure 1: Shea production and trends of export in Ghana

(Source: Hammond et al., 2019).

1.2 SB, its economic values, and quality standards

As mentioned earlier, SB's global demand is approximately projected to be somewhat above $30 billion by the end of 2020. Rich in a wide variety of vitamins, shea has been successfully disseminating in the cosmetics and also pharmaceutical industries generating great annual revenues. Post extraction the residues often serve as good fuel. But for its widespread demand, it is referred to as "women's gold" in various local parts of Africa. It provides great earning source for the female community in supporting food, clothing, and most education. Reports mention that over 18 million females inhabiting the rural communities engage themselves in shea collection and processing into butter for their regular needs. Despite the procedure being physically exhausting, it fetches good income opportunities for such rural families. Worldwide, the annual export of the high-value nut of shea is approximately 350,000 MT having a market value nearing $120 million, particularly to the production countries (Hammond et al., 2019). Hence, its odds shadow the overwhelming attributes that it successively generates among the growing beauty industries all across. However, other groups of thoughts emphasize majorly on the downfalls but the proportion is significantly variable. The emerging recognition for its demand and subsequent traceability corresponds to

its consistent quality. And, this majorly highlights three critical perspectives. Firstly, numerous genetic inconsistencies make the kernels and the processed butter comprise of various fatty acid varieties including certain unsaponifiable profiles. There are beliefs regarding the quality of the resources being used from varied sources. Second of all, not many countries or regions specifically have characteristically imparted the finest of quality control methodologies during the processing. This holds and authentic mainly in the rural setting. With time and repeated investigations, it is highly solicited that these manufacturers enhance their processing understanding by inculcating post-harvest manufacturing of the butter keeping all the basic quality measures stern and intact. A few approved standards have categorically been drafted to regulate and coordinate the production techniques effectively. It invariably follows authentic specifications that include content, ingredients and sources, hygiene aspects and product odor, texture, and taste. These determinants progressively indicate shea's quality classifications and characteristic features. A few approve specs also include the details of some of its applications and the wide range of contaminants that often tend to interfere with the accurate analytical and chromatographic analysis. However, these specifications are very cautiously prepared because it ascertains the reputation of these cosmetics businesses. They are cohesively prepared under the guidance of many trained personnel with a sound comprehension of the extraction principle, steps, and their relative significance in the impending market profile. The primary intent has and would always remain in the overall revenue collection for these marketable value-centric products.

A few critical determinants are essentially needed in its extraction process. Only then the finest shea quality can be preserved for the enormous marketing purposes. Particularly, it will assist the manufacturing countries to ameliorate the existing standards to be able to channelize these products in beauty items in Western countries. Thirdly, many of these manufacturers are still failing to finely maintain decent quality butter simply by adopting improper practices for extraction, packaging, storage, and maintenance. This makes the essence of this systematic literature miningand reviews much easier and comprehensive for its multiple readers and budding market experts aiming to establish their foothold into this business. This will also progressively assist many readers intending to move towards a similar marketing objective.

1.3 Shea composition

It is a seed fat with abundant beauty and personal care benefits. But there lacks decent scientific pieces of evidence to support its uses. The enhanced product demand especially in

the cosmetics industry boosts SB market growth. It functions as an emollient that contains oleic acid, stearic acid(SA), and unsaponifiable like phenols and sterols with great conditioning properties. Other fats include palmitic, arachidic, and linoleic acids. The relative amount of SA and oleic triglycerides impacts the consistency of the butter. And it is majorly the fatty portion of the nut that conditions and deeply nourishes the skin. Its accelerating demand has led to the evaluation of its composition. But different market experts offer shea products with different other ingredients to refine the quality of the blended product. This not only increases the net demand but also aids them to fetch tremendous profit margins from each sale.

This review highlights the macro and micronutrients of shea kernel, nuts, pulps, and butter and also assesses the physicochemical characteristics of the butter. A literature survey reveals that the pulp bears high vitamin C while the kernels have a considerable amount of fat. Its biochemical properties offer brilliant anti-oxidant activities.

Figure 2: Appearances of different parts of shea

(Source: Sarruf et al., 2019)

The following table lists some of the most common characteristic properties of the different components.

Fatty acids	**Role in cosmetics**
Oleic acid	The enriched lipid content makes oleic acid a super moisturizer. Different companies blend it with soaps and lotions to enhance their ability for nourishing the skin.
SA	This is a saturated variety of fatty

	acids used in beauty components like shampoos and shaving creams. Stearic acid is not directly employed in producing soaps but indirectly through triglyceride saponification containing the esters of stearic acid. These esters are often blended with glycol stearate and ethylene glycol to generate a pearl effect in various shampoos and other cosmetics items.
Palmitic acid	This is majorly applied in soaps, release agents, and cosmetics.

The table above would provide the readers with a sustainable opportunity to study the biochemical and physical details of the components without much hassle. And, this would guide them in designing their respective analytical experiments for processing and purifying the product.

1.4 SB properties and its uses in the cosmetics industries

The broad utility of the SB as a beauty product has been very much in vogue particularly for skin and hair care. It works as an immensely useful skin moisturizer. Reports say SB has a more intense absorption rate compared to cocoa butter and hence it is very much suitable for varied skin types. The eventual elaboration of the market is primarily due to its broad range usage as lip glosses, hair conditioners, skin lotions, and many more which constitute some of the most dominant SB applications (Vieira et al., 2020). The most eminent and useful traits of the sample butter spread cautiously rely on the peroxide esteem, free unsaturated fat content, dampness level, and lastly its insoluble polluting impact. Keeping these determinants in mind, this potent systematic investigation will categorically outline the brief overviews of effective procedures such as Soxhlet extraction and cold press techniques.

Owing to its versatility, it is preferred to be employed in other beauty ingredients as well. It helps to keep aging skin supple especially during the cold months. Cosmetics made out of this versatile product often incurs multiple components, stages of processing but are offered at relatively affordable market prices. This coherently increases its overall demand in the

cosmetics industries and personal care. Some research investigations are still in vogue to evaluate its impact on osteoarthritis treatment, especially in older patients. There are innumerable investigations available on the naturally occurring vitamin profile of SB.

The butter readily melts at our usual body temperature thereby making it an extra-ordinary base for items such as ointments particularly in treating itches and other skin inflammation like eczema. This increasing relevance is highly linked to its composite properties that inherently justify the profound range of shea's empiric uses. Its creamy texture, the exotic allure has collectively made it a rapidly sought-after product for routine and natural skin care on today's date. Apart from this, huge varieties of soothing hair nourishing products of shea are also becoming quite prominent with time and demands.

With good overall vitamin and fatty acid content, the product is enormously deemed fit for skin smoothening and moisturizing. The demand and customer interest will be furthermore driven by the introduction of more innovative shea products following extensive R&D initiatives. Hence, its cosmetics application is prodigiously expected to be a mammoth segment over the approximate forecast period.

1.5 SB physicochemical characterization

The item is quite tricky for the producers to work with. Its physical properties and relatively warm storage conditions cause the item to crystallize upon bringing it to normal room temperature. The artisans undertake rigorous screening starting from rapid SB melting and thereafter cooling precisely and whipping simultaneously.Shea oil and its effective characterization is a crucial way of establishing its certification. This characterization is made in different shea zones and by different procedures. But the only point of commonality is the numerous parameters that are accountable. Different traces of review reports have highlighted that the shea oil yield exhibited significant differences in different locations (Vieira et al., 2020). Additionally, the researchers also found immense variations in shea's fatty acid profiles but each of these characterizations is comparable (Animasaun et al., 2019). This fact indicates the sample's suitability as a crucial raw material in different cosmetics items. Hence the characterization seems to be an eminent benchmark that will help monitor the shea oil quality from different producing zones. Such data can be effectively utilized to accelerate and refine SB's local and international business operations and trading collaborations as well (Garti, Agbemafle & Mahunu, 2019).

However, the characterization includes numerous parameters such as:

- Refractive index.
- Colour.
- Viscosity.
- Saponification.
- Tocopherol values.

1.6 Market drivers of shea in the cosmetics business

- The enhancing cost of cocoa butter urges millions of prospective buyers to purchase shea as a potential alternative to the former.
- The rising awareness of its sheer benefits in the beauty industry compels the manufacturers to introduce innovative variants of shea into the market.
- The increasing number of the aging community leads to an accelerated demand for numerous anti-aging skin products containing shea.

1.7 Mixture of shea with other beauty ingredients in the cosmetics market

For some skin lightening purposes, different market experts blend SB with other varieties of ingredients. Shea mixed with tinges of cocoa butter and almond oil serves as a great balsam for skincare. It not only balances the skin tone but also revitalizes the cells. The indigenous fusion of minerals and specific vitamin oil in SB makes it an active component in a plethora of cosmetics products. This component includes different combinations of ingredients and essential nutrients to improve the overall skin texture and quality. Multiple studies have exhibited that the butter with rich vitamin F bears a deep calming effect on acne inflammation and skin sores. This also replenishes the dark scars on the skin. SB blended with mineral oils also has in skin cell regeneration and fastens skin recoveries. Additionally, such combination products greatly reduce skin imperfections. Combined with linoleic acid in SB, vitamin F also reduces the dissemination of sebum. This makes the skin moist and optimally hydrated. It also has a considerable amount of omega 3 and 6 fats making the component one of the most indigenous and healthiest skin remedies.

A combination of the butter with varieties of essential oils of herbal origin is frequently used for different therapeutic and aesthetic purposes. The blends of the butter coupled with essential oils create a specific natural balsam that ameliorates skin misbalances. Many marketers blend lemongrass oil and tinges of turmeric oil with SB. Some marketers prefer adding some sandalwood into the mix to enhance the organic aspect of such shea products (Bawah et al., 2019). This mix acts as a versatile skin balsam with great nutrients. Another

variety includes a mix with baking soda and a few ounces of coconut oil. The blend needs light heating after which some lemon drops are often added. This product is commonly employed for problematic skin or even skin dryness. Also, an initial composition of shea and olive oil blended with extracts of green tea and carrot seed oil nourishes distorted skin and heals it to retain its shine. These products are high in demand and supply. This results in huge revenue generation by the cosmetics industry with each passing day (Sikpaam, Mintah& Fearon,2019).

1.8 Investing in SB processing methods

The initial investment for its nut production is not huge as shea trees are quite an indigenous species occurring in large numbers (Addaquay, 2004). The only challenge is its time-consumption and ardently laborious owing to its scattered state all across the northern boundary of Ghana region. However, its uniqueness remains is in the fact that it prodigiously generates some income for the women by being a traditional female business (Odebia, & Oyekala, 2018). Most female workers organize their processing functions in smaller business cooperatives or simply set their ground-up in specific areas closer to their residences. Also, the fruits are reportedly one of the most common resources available particularly for the homeless poor. A common trait of the African rural households is that they earn their daily living through farming. These small farms categorically contribute nearly 36% of the country's GDP (Kassi et al., 2019). And it also provides some employment opportunities to around 60-65% of the African poor labor-force. Therefore, this investment justifies its importance in the beauty industry (Odebia, & Oyekala, 2018). Also, an approximate number of women inhabiting the northern part of Ghana fairly survive from the income they derive out of the processing of such shea products (Hammond et al., 2019). This implies that the industry successfully provides a stable alternative livelihood for this deprived mass at least in terms of development and education sometimes.

Hence, there is a stern demand for all the processed beauty items made of shea not just within the borders of Ghana but also in the competitive international market architecture. This is why the investment in this business is worth it and is crucial for the selective income-oriented potential of the compound.

1.9 Side effects

Shea is likely a safe component when having any direct mouth contact. Upon its application on skin surfaces, it is considered to be scientifically safe for up to four weeks. But there is

insufficient reliable information to put forward if its continued application at the same affected area is safe for longer than the threshold time (Chen et al., 2019). Also, there is barely an authentic documented case exhibiting SB related allergies. Reports say that users having acute allergies from tree nuts can also safely apply shea on their skins. They also possess much lower possibilities of any reaction on their faces on applying shea (Kassi et al., 2019). Researchers believe that it is solely due to the viable presence of nuts containing nominal tree-nut proteins and hence does not trigger sensitivity or allergies too easily. Besides, the presence of vitamin A and also E, the shea products are also safe onto irritated and sensitive skin. Many clinicians and/or dermatologists also recommend its usage on babies' diaper rashes owing to its immense antifungal properties.

1.10 Problem statement of the review

The existence of the local business of shea corresponds to the female processors. They directly sell their constituents in and around the local market to earn (Sikpaam, Mintah& Fearon,2019).The problem lies with the imperfect packaging, labeling, and also certification before the sale. Mostly, the products are sold in smaller sized bowls throughout Africa. But with the enhanced demands of shea cosmetics as a potent substitute for cocoa butter made it such an accelerated marketing compound. This eventually calls for a steady improvement in its utility and quality checking. And this quality is largely reliable on certain methodologies and processing steps discussed in the subsequent part of this review. Increasingly, owing to the rising corporate functions and the associated responsibilities, different companies have initiated working towards attaining the prodigious quality to channelize the commercial production of shea cosmetics while assisting the rural female communities (Alhassan, 2020). Hence, the emphasis on quality production would likely indicate ameliorating the production and extraction methods to an abundant tonnage thereby meeting the benchmark of shea's quality requirements. This would strongly facilitate the opportunities of supplying a competitively amounted beauty item to the ever-expanding shea industries. The rural women invest considerable time as well as resources to meeting this standard solicited by larger organizations. However, it is imperative to comprehend if all the diligent efforts are worth the capital or resource to manufacture and process quality butter oil.

In this context, this particular review categorically seeks to evaluate the worth, economic aspects, and constraints of processing marketable shea products. Also, owing to its successive demands and interest among the consumers, it would further be appropriate to look for the different methods in detail to study the varied factors influencing this market quality. This

way the prospective marketing and delivery of shea cosmetics will establish its stern foothold throughout the globe and do justice to its broad customer range.

1.11 Aim of the review

As mentioned earlier, the main aim of this research is to assess the validation techniques about SB oil, its extraction procedures, and detailed analysis using different chromatographic techniques and/or Mass spectrometry.

1.12 Objectives of the systematic review

Owing to the enormous demand and customer interest in SB as a widespread beauty ingredient, the sole objectives of the review include the following:

- To study and evaluate the extraction methods of SB.
- To categorically seek the physic-chemical properties of the item.
- To comprehend the overall composition of the butter oil.
- Its' associated blend with other compounds in varied cosmetics.
- To seek for the presence and/or occurrence of any potential allergic issues by SB usage in cosmetic products.
- And finally, to highlight and assess its quality as a beauty compound.

2. Manufacturing procedure

2.1 Material and sample procurement

The sample is obtained from the extraction techniques as narrated earlier. However, most of the compounds and the analytical laboratory reagents involved in this analysis are usually ordered from the Fischer Scientific (USA), Sigma-Aldrich (USA), and IMPAK (USA). Most of these reagents are typically utilized in the purification procedure (Chen et al., 2019). Most of the general consumables are collected from the respective laboratories conducting the analyses.

Before extraction and quality analysis, shea fruit undergoes multiple pre-processes. However, these are not the extraction methods but just a few basic steps that are cohesively performed before employing the shea extraction process. These preliminary steps include:

Fruit collection: The most appropriate time for collecting the ripe fruits is between Aprils to August. It is usually hand-picked from underneath the shea tree.

De-pulping: The next step includes pulp removal by hand. The animals are often fed with the fruits or are fermented.

Boiling of the nuts:

De-pulping is usually followed by boiling the recovered nuts for around 30 minutes in waterusing the most conventional stove system. The main objective is to loosen the kernels to aid in de-shelling.

Sun-drying: The boiled nuts are thereafter dried under the sunlight on drying mats or racks. This aids in loosening the kernel from its shell.

De-shelling and washing:

With the help of a mortar, all the dried nut pieces are then cracked open. Thereafter the kernels are rigorously washed with clear water. Some manufacturers also prefer using specialized washing machines for this purpose.

2.2 Methods

Extraction methods

SB has multiple extraction methods and processed employing specialized chemical and enzymatic methods. The processing technologies include differential methods each of which bears its benefits and challenges. However, there are various chemical-based and enzymatic procedures in shea extraction. In this context, whether these methods have been able to categorically the existing challenges that bedevil the industries of SB particularly in cosmetics are the pivotal area of interest.

But the following 3 are the most commonly applied techniques of extraction:

- Manual method
- Semi-mechanized
- Fully mechanized

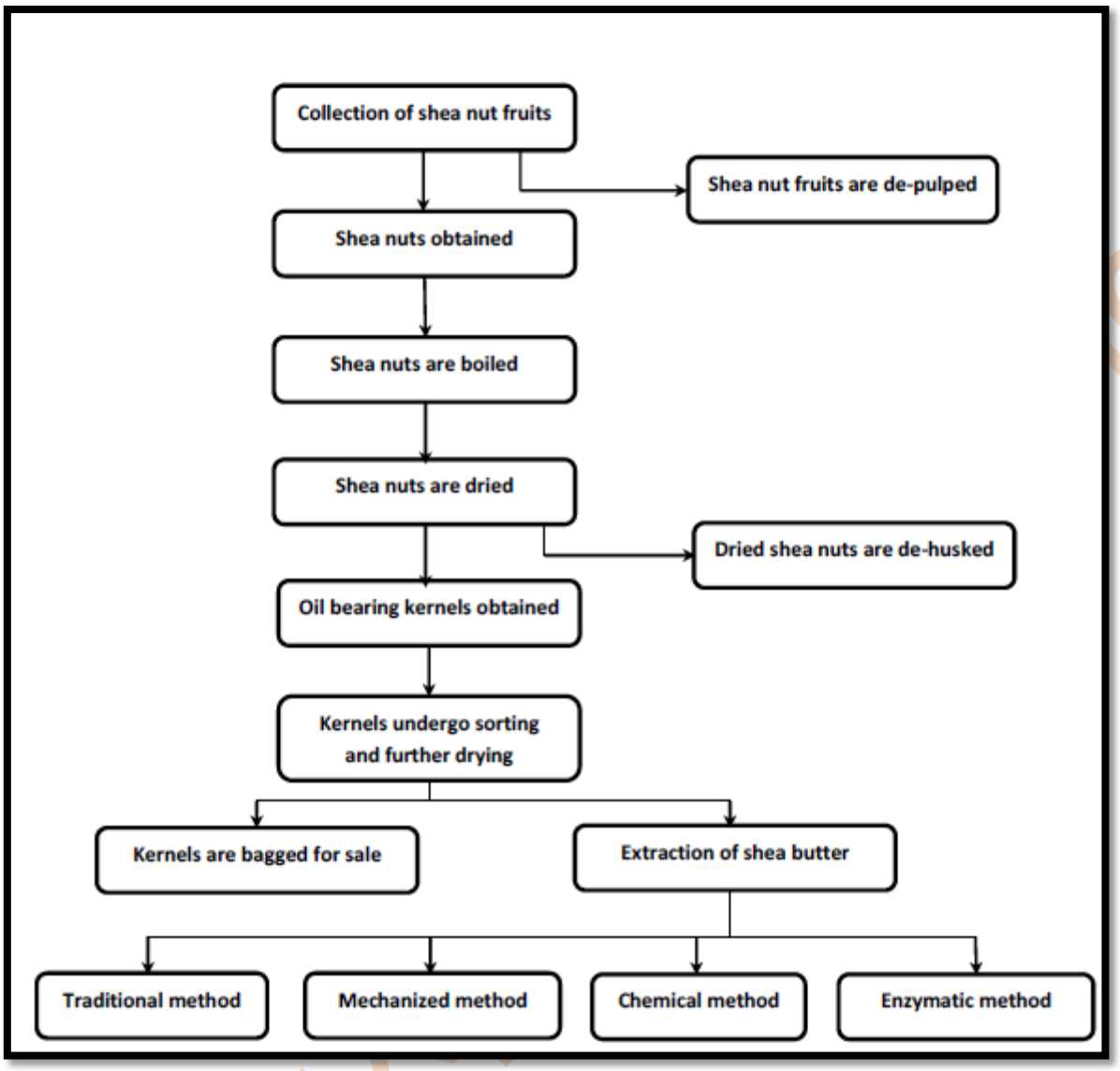

Figure 3: SB extraction flowchart

(Source: Academicjournals.org, 2020)

TRADITIONAL EXTRACTION TECHNOLOGY (Hand Kneading method)

In many parts of the world, manufacturers produce and process SB manually, a technique known as the **wet extraction procedure.** Specifically, in the areas of Ghana, the female community engage themselves in such extraction methods using the conventional/traditional method. As mentioned earlier, this activity has tremendously aided these women to have their individual earning. Reportedly, almost 80-85% of Ghana's SB is made through such traditional processing methods. To produce a considerable portion of the oil, the entire procedure invariably takes from 20 hours and can extend till 30 hours. However, one cycle of

SB processing consumes approximately 5-6 hours. And, the wholesome process of kneading takes 30-40 minutes for the completion of one whole session.

The following table outlines the characteristics of the nut kernel of shea for its extraction potential.

Properties	**Percentage**
Crude fat	54.80
Total lipids	59.04
Carbohydrate	34.77
Crude protein	7.81
Pectic component	2.90
Soluble sugars	5.45
Starch	7.57
Cellulose	5.95
Total fiber	20.35

The traditional process includes **the size reduction** of the kernel followed by the **dehydration** process by roasting (Wei et al., 2019). The steps below exhibit the following method:

- Firstly, the kernel's size needs to be reduced by pounding using the mortar.
- Size reduction precedes dehydration to facilitate oil extraction.
- The roasted parts of the kernel are finely grounded to generate a paste. It is conducted in two distinct ways; either stone is given when the traditional method is applied or if the semi-mechanized way is attempted a grinding mill is applied.
- Size reduction and subsequent milling cohesively enhance the surface area that facilitates effective hydrolysis while performing kneading.

However, researchers have commented in many shreds of literature that various factors tend to impact the overall sample quality during the core preparation (Egbunonu, Ogunjimi & Alabi, 2019). Hydrolysis is articulated during **kneading, heating, separation of oil,** and **cooling.** However, numerous pieces of reports demonstrated that blanching of the shea nuts ameliorated the quality of the butter. Also, some authors have categorically mentioned that the roasting time and SB's sensorial characteristics are interlinked.

The next section includes the differential methods in elaboration.

Kneading

This procedure intends to rupture the oil cells to smoothly ease its extraction. Ideally, one full kneading requires approximately 30 minutes. A few pieces of literature explain any traditional kneading method requires a considerable shea paste quantity and thereafter adding a large quantity of cold water (UMARU et al., 2016). It intermittently requires slow and then rigorous stirringtill the butter rises in its crude milk-like form. However, some suggestion regarding this intends to highlight the application of traditional extractors that have the sheer potency of boiling the water to skim off the oil release (Wei et al., 2019). But there are a few considerate parameters that define a successful kneading. This includes temperature variations, appearance, consistency and this can be impeccably evaluated with time and acquired experience.

Heating, separating oil and cooling

With the completion of the kneading step, the oily portion is to be harvested leaving just the watery layer along with the particulate matter underneath the pan. This oily layer is nothing but the fat emulsion which needs thorough water rinse. The raw fat is obtained by slow pouring or decanting. Thereafter it is cooled to obtain the solidified final product, the SB. Usually, this solidification consumes over six to twelve hours. Such processes tend to bestow an additional aspect of measuring the basic physical features of the ingredients used and its corresponding function in the beauty world (Oseni, Iyasele & Uwadia, 2019).

Importance of the traditional methods in cosmetics

The final butter obtained from this procedure is enchantingly needed abroad especially by cosmetic industries. However, many people still bestow the fact that such conventional extraction methods are generating considerably lower yield and therefore possess uncontrolled aspects in terms of quality variation in the market. In general, nearly 23% of fat remains in the nut cake even after the fulfillment of an entire extraction process. But again, there are certain rigid opinions regarding the efficiencies of such methods arguing to provide almost 35%-45% of the extraction efficiency (Oseni, Iyasele & Uwadia, 2019).

There have been a plethora of initiatives undertaken to enhance the extraction rate. There are attempts to cohesively incorporate proper technology into such traditional steps not just to refine the efficiencies but also the lessen the amount and assiduous labor apart from reducing the associated environmental impact.

The Bridge-press method

A well-developed bridge press which can be operated manually was introduced in the process. This method utilized the **Intermediate Moisture Content** as one of the pivotal

parameters to obtain nearly 65-67% of the extraction efficiencies. This method has been eventually tested and validated by different women communities across the African regions (Komlaga, Oduro& Essel, 2019). The principle concerning this operation includes the following stages:

- Grinding of the dried kernels into a uniform paste using locally designed plate mill.
- At 70°C is put into extraction without any heat treatment employed.
- The moisture content rises to 12% approximately via kneading. This moisturized paste is put into specially designed bags at 60°C and then "bridge pressed" so that it smoothly releases the oil.

Advantages of the IMC method

When compared to the manual/traditional techniques, the IMC one shares some benefits.

- The extraction efficiency is enhanced by as much as 5-6%.
- The regular capacity for production is accelerated by almost 200%.
- It brings about a drastic reduction in the daily consumption of firewood, water usage, and the total steps included in the overall extraction method.
- It also generates a relatively milder shea odor.
- It is immensely eco-friendly due to the limited usage of fuel wood and a lower amount of waste water.

Despite all the positive aspects, the method is not only cumbersome but extensively energy-sapping. However, the returns barely commensurate the overall energy or the economic inputs, and the income opportunities of the women which shows an unstable representation. The reason behind corresponds to poor extraction efficiencies, supposedly low butter quality, and most importantly inconsistency in the production (Egbunonu, Ogunjimi & Alabi, 2019).These existing challenges introduced **semi-mechanization extraction** methods. This technique emerged eventually and became all the more potent with time.

PHYSICAL METHOD: Mechanical Press

Cold Press Extraction Method (CPEM)

The mechanical processing method is most commonly named as the CPEM. The logic behind this nomenclature is rather evident as it barely involves the repeated heating steps as required in the traditional ones. This method has been reportedly referred to as one of the most preliminary research initiatives when it came to shea extraction for decent quality butter (Ajala et al., 2019).

The basic procedure of this one includes a specially designed jack that is capable of exerting almost 30-40 tonnes of force. This allows the butter press to categorically crush over 4 kilograms of the kernels with a quick span of around 20 minutes. This press has the potency of extracting nearly 85% of the designated fat that the kernel possesses in a very simplified manner. This brings the advantage of the specified method. It limits the requirement of too many heating stages and thereby saves an abundant quantity of fuel wood. This also emphasizes its eco-friendly property (Abdul-Hammed, Jaji & Adegboyega, 2020). The gradual emergence and prominence of shea processing to derive good quality butter employing this method came to the zenith of success almost all across Ghana. This was possibly owing to the diligent collaborative labors between the female communities and the development partners including some of the notable NGOs.

The stages are carefully carried out in a specified plan with an appropriate boiler coupled with a mechanical press.

The kernel is heated to approximately 15°C-20°C to obtain the desirable crushed kernel. This employs mechanical pressing applying substantial pressure to the pulverized shea seed to derive abundant SB. Thereafter, they are incorporated into a specific crushing unit in which size reduction happens. This enhances the surface area to generate substantially good butter yield (Ajala et al., 2019). The oil is filtered through the press to get the crude form. The residual cake is poured into an expeller for a second press to obtain additional butter and thereafter allow it to solidify. An additional filter press is also attached. This applies abundant force right onto the pulverized shea seed. This turns more butter out of the entire process. The butter is thereafter transferred to a second chamber wherein it undergoes additional steps for further refinement.

Other methods targeted singular operative units including the following:

- Kneading grinders.

- Solar dryers.
- Mixer.
- Hand press (hydraulic).

However, all these new introductions have collectively widened the extraction efficiencies to as much as 87%. Other sources report approximately 33% of the butter that can be generated from shea nuts using a mechanical expeller (Oyedele et al., 2020). But the combined impact of mechanically coupled with chemical procedures have aggravated the efficiencies to almost 98% thereby highlighting the prodigious relevance of this method in the extraction stages.

The method was categorically refined to ensure it saves sufficient time and ameliorates the processing efficiencies. Once this technique is effectively performed by an expert marketer adequate attention is solicited in areas land/or parameters such as its overall concentration, its consistency, the sample's explicit gravity, and most importantly its specific refractive index. These potentialspreads are effectively analyzed to evaluate how the sample is analytically is formulated majorly in the cosmetic sectors all across the African regions. With the gradual passage of time, it will also aid in disseminating its foothold across the entire global market and generate exclusive revenues out of the sales figures.

But its main intent had been to limit the stress among the processors owingto the labor-intensive steps of the traditional ones. However, just like its benefits, the press method has certain **limitations.** It leaves abundant challenges for the women residing in remote locations to access such a pressing method for production. Apart from the operational activities, affordability, and most likely, its availability remains to be the most pressing problem especially the local females' experience (Seweh et al., 2016). This also makes the local industries suffer a bit.

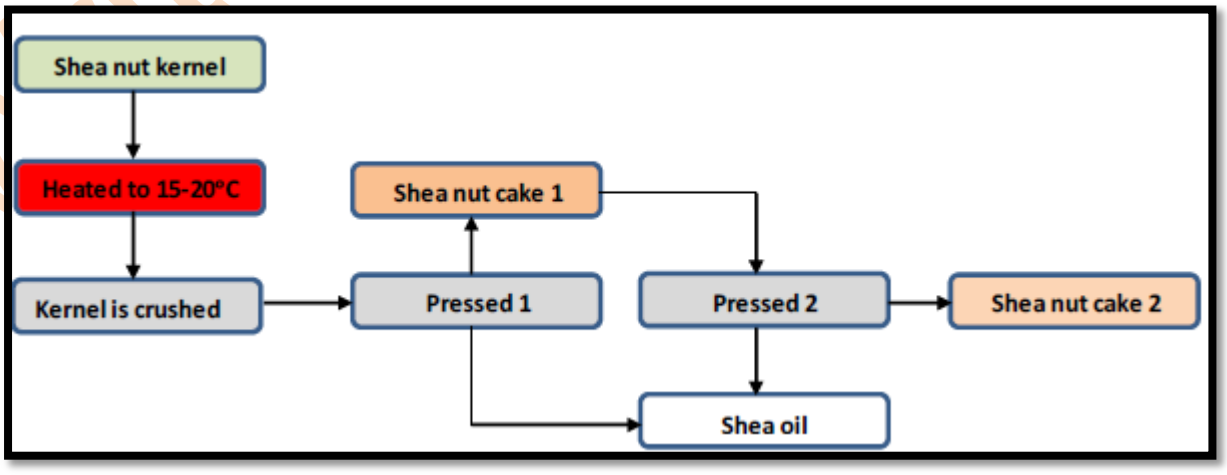

Figure 4: FLOWCHART_MECHANICAL EXTRACTION

(Source: Academicjournals.org, 2020)

THE CENTRIFUGATION METHOD

Among the sheer mechanical techniques, the method involving centrifugation is of immense importance. But different manufacturers observed a relatively lower efficiency (30%) on average. The average efficiency, however, appeared the same as the manual traditional technologies. This method involves oil separation, water, and shea nut cake from an already prepared water-paste emulsion. The extraction device encompasses a movable unit that is driven by an engine or a specialized motor. At a frequency of 1000rpm, it is centrifuged. The entities will be distinctly separated into single layers. In other words, the oil-water-cake will be separated into distinct layers based on their masses. The lighter part (oil) would float and be discharged into two bailing devices. The procedure is to be consistently repeated unless a clear form of oil appears. But owing to the concordance in terms of the extraction potential, this method has never been adequately highlighted into commercial uses.

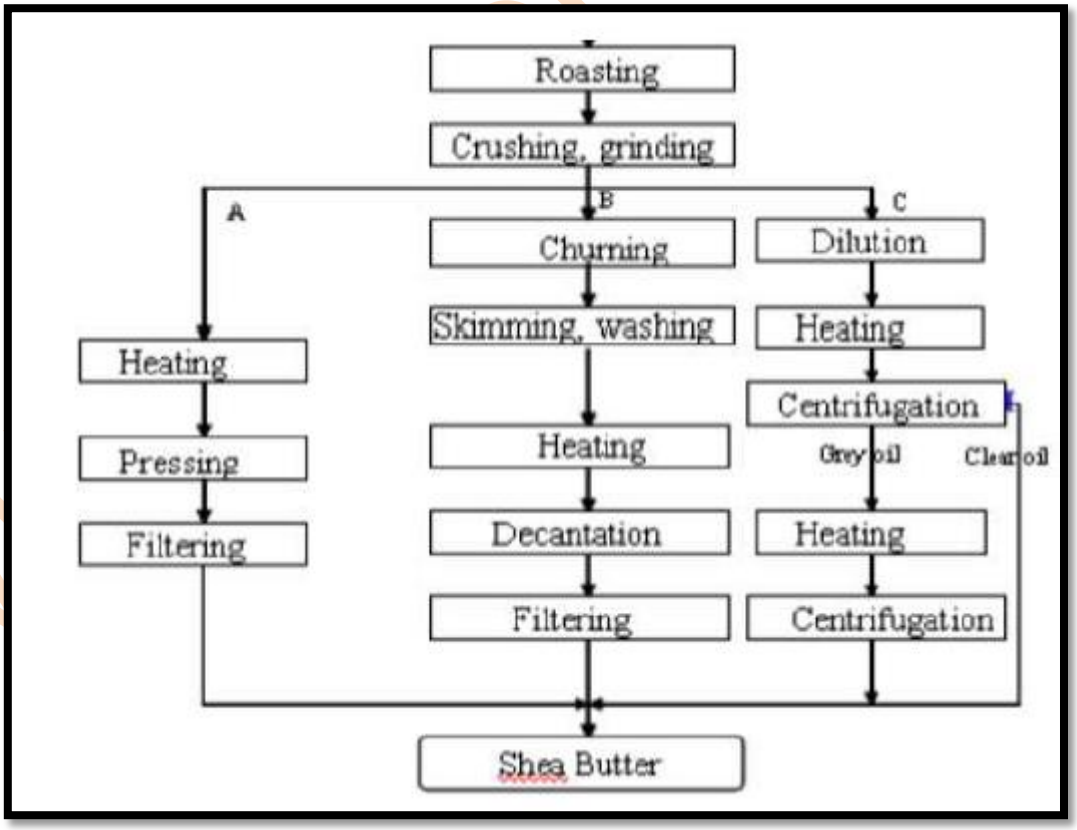

Figure 5: Details of the centrifugation steps

(Source: Academicjournals.org, 2020)

CHEMICAL EXTRACTION METHOD

With the gradual passage of time, the chemical technology evolved into the processing of shea. In this one, the dried kernels are crushed to paste and put into **Soxhlet extractor**. Thereafter organic solvent such as ether and/or n-hexane is added and allowed the mixture to settle for a considerable time (Nde& Foncha, 2020). This is referred to as the **hexane extraction method.** The time allows the oil to get distinctly separated which needs to be decanted thereafter for subsequent solidification. The solvent types tend to strongly impact the quality features of the sample particularly the butter's **peroxide value.** Other solvents can also be given including chloroform and even water. However, researches have exhibited that the most abundant fat quantity is viably obtained from the hexane method (Bawah et al., 2019).

Principally, in this technique, the pulverized shea kernel is blended with hexane. This eventually unlocks the polymers thereby enabling the fatty and oily constituents to get dissolved in it. The final oil-hexane mix is separated from shea seed residues via filtration which is followed by a quick preheating at 68 that vaporizes and recovers the organic solvent to get the raw butter. The hexane has certain other parameters making it the preferred choice in this method (Ladele, Kpoviessi& Assogba, 2017). It includes its physical properties that make decent edibility of the oil after extraction. This, consequently, improves the commercial economics of SB.

Such methods reportedly yield as much as 47.5% of the butter which is relatively higher than the mechanical one (Oyedele et al., 2020). But its potency increases if employed with the latter method combinedly. Furthermore, the introduction of solvent-based methods demonstrates very little or detectable content of peroxides (Abdul-Hammed, Jaji & Adegboyega, 2020).

Unfortunately, its higher yield does not make the method a universally accepted one. Especially, in terms of the **cosmetics industries,** the traditional methods have been uniformly accepted better (Didia, 2018).

BIOLOGICAL (Enzyme Based Extraction Technology)

The enzymatic extraction includes cell wall degradation and the subsequent release of the oil. Water-soluble enzymes are used. Such extraction methods are preferred due to their low temperatures and high specificity (Abdul-Mumeen, Beauty & Adam, 2019). Glucanase,

cellulose, amylase is used to extract oil from their kernels. But cellulase and/or hemicellulose have the best potency to degrade the cell wall. Pectinase, on the other hand, carries out similar functions but are more preferably applicable in the oil industries over cosmetics (Didia& Iddrisu, 2018). Among the other existing methods, this method however is a bit pricey due to the utilization of several enzymes. But the effectiveness of this deserves a special mention in the field of shea processing and validation in the cosmetics market.

Methodology

Reports say that such techniques are abundantly used for the SB extraction specifically in the region of Ghana (Didia & Iddrisu, 2018). The steps are as follows:

- Approximately 50g aliquot of the shea nut is taken in a water-filled 600 mL beaker and stirred repeatedly.
- Some commercial enzymes are mixed at well-optimized conditions.
- The mixture is thereafter incubated at around 62°C for a couple of hours or slightly more. During the incubation, adequate care must be given to ensure that the medium pH condition remains around 5 for different substrates.
- The reaction was ended upon boiled water added after the incubation.
- The resulting emulsion so formed was collected into a fresh separate beaker and boiled until it appears clear. That is when the clear oil is instantly collected.
- After collection, it is poured onto a separate aluminum dish and weighed to obtain the % of the yield.

Advantages

Enzymatic extractions enhance yield and ameliorate the overall quality of the butter. Following such an extraction technique also facilitates the generation of the product with very low fiber content and peroxide (Didia & Iddrisu, 2018). These are some of the most eminent causes that cohesively make enzyme-based extraction processes much more economical particularly in this business.

3.Quality traits from different extraction techniques

Now that all the methods have been elaborated to its detail, it is rational to summarize it all for the easy comprehension of the commoners. The quality traits will help to create an overview of which technique is better suited for a specific intended purpose. Nowadays, multiple business experts are coherently involved to channelize the shea product for its supreme and versatile applications. This review will also cast light on these unnoticed areas

that could predominantly guide a novice producer in fulfilling his market objectives in the cosmetics business with shea nut and oil samples.

Hence, the following section of the review will list the quality characteristics of the obtain SB from all the different methods. This will categorically aid all the readers to acquire a thorough understanding of the various methods and their efficiencies to choose between so many effective options of processing and extraction.

Methods/techniques	**Peroxide values (meq/Kg)**	**FFA (%)**	**Moisture content (%)**	**Method efficiency (%)**	**Insoluble impurity (%)**
Traditional	8-14	5-21.2	5.4-13	Till 40	0.13-0.15
Mechanical	3.55-45	0.6-15	00.2-0.55	30-45	Variable
Chemical	2.20-11.45	Variable	Variable	40-65	Variable
Enzymatic (Biological)	3.67-11.20	Variable	0.17-0.18	45-75	0.02

4.Data analysis and results

The industrial demand and interest of SB reside in the exceptional property, quality, and most importantly potentialities of its exploitation in different products of the cosmetics industry. This section of the review aims to categorically exalt the quality of the extracted butter thereby presenting its broad potencies of utilization. Hence, apart from their common physicochemical characteristics such as unsaponifiable matter, moisture content, and others, its viscosity, specific gravity, and ultraviolet-visible and/or infrared spectra become inevitable parameters for determination. Also, the sample content needs evaluation (Nemeškalová et al., 2020). Above all, the analysis corresponds to various aptitudes of exploitation of shea in the beauty industries to optimize any underlined status of the product individually.

All of the analytical procedures are conducted majorly in triplicates to ensure the reliability of the final data (Abdul-Mumeen, Beauty & Adam, 2019). These triplicates are often derived from distinct batches and the outcomes are documented as mean and/or ±

SD. The results generated from such experimental procedures are coherently analyzed using several in-house custom algorithms. Before any sophisticated analytical techniques, a few of the most common laboratory analyses are categorically performed. These are some of the essential prerequisites for SB assessment and analysis. Such analyses determine the physicochemical features of the butter (Garti, Agbemafle & Mahunu, 2019). But when it comes to the quality analysis of shea, generally two sets of analyses are accounted for which are individually discussed below.

4.1 HPLC analysis

The industrial interest of SB and oil tend to reside in their prodigious quality and corresponds to their exploitation potency in the beauty industry. Hence, it is of supreme importance to get the samples impeccably tested and analyzed qualitatively to ensure a company is releasing its validated product in the competitive market. This process is universally named as **quality control analysis.** To assess the sample quality, it is invariably put through a wide variety of stages, each of which is documented for clear comprehension and audit purposes by the respective companies. For any quality analysis, each company prepares specified manuals consisting of the details of its operating procedures. These manuals are unique to each company. A quality analyst needs to strictly adhere to these operating guidelines while performing a quality check. Any deviation is highly objectionable and leads to negative consequences as far as the company reputation is concerned.

Similarly, the analysis of SB is categorically conducted using HPLC techniques. The sole purpose of this analytical technique is to identify, purify, and quantify the target sample among its mixture components. Principally, it involves partitioning or separating the analytes between two distinct phases: the stationary (solid) phase and the mobile one. Every compound, SB oil in this case would have varied partitioning coefficients. Hence, when inserted into the device, the components will readily be separated on this basis. However, HPLC intends to function on the core principle that certain samples (or molecules) will require longer elution time than others when put through a specialized chromatographic column.

All the essential vitamins are at first to be methodically extracted. Thereafter the different fractions are categorically separated using HPLC techniques. The Acquity Waters are most commonly employed in the quality checking of SB. The steps are as follows:

- Some portion of the diluted sample in hexane is to be blended with methyl alcohol and centrifuged using the in-house specifications.
- Filtration of the supernatant is carried out with a filter pore size of nearly 0.45µm.
- This filtered solution is inserted into the chromatograph for subsequent analysis.

The following details the analysis condition and programmed settings for the above-mentioned analysis.

Type	**Liquid chromatography**
Detector category	Optical TUV system
Column type Column dimension Capturing ability Column temperature	BEH C-18. 150*0.25mm 1.7-micrometer particle size 45°C.
Injection quantity	10µL
Mobile phase	Methanol: Water (98/2: volume/volume).
Wavelength of detection	Varies for different vitamins.
Elution flow rate	1-2mL/minute
Internal standards	Different for individual vitamins. The commonest standard is retinol palmitate.

There are various traces of reports and authentic pieces of literature that collectively mention HPLC techniques to be of substantial potential. The resulting butter oil is not only refined and qualitatively optimized but also reflects conformity with the best shea standard in the existing competitive market. To carry these experimental assessments, HPLC-grade solvents and reagents are solicited to be purchased. These include acetic acid, hexane, sodium thiosulphate, potassium iodide, and soluble starch solution. Other reagents include metaphosphoric acid, chloroform, sodium phosphate, L-ascorbic acid, and also ethylenediaminetetraacetic acid.

While some manufacturing units routinely determine the acid, iodine-peroxide values, and saponification content with standard methods, the alpha-tocopherol content of the sample is

invariably determined by HPLC analyses. A calibration curve is usually generated using a control standard of tocopherol. The procedural steps are as follows:

- 1 mL of the standards in their working concentration is to be pipetted into different conical glass flasks.
- This follows the addition of methyl alcohol, 50% KOH, and nearly 10% ascorbic acid. The contents are to be uniformly shaken and thereafter put for sonication which typically requires 10 minutes. But the sonication program is differently set for different systems.
- Post sonication, the solutions are individually saponified for 120 minutes under reflux in the dark which typically requires a temperature ranging from 45-50°C.
- In ambient temperature, all the saponified contents are cooled up, transferred individually into distinct funnels, and thereafter rinsed with a considerable quantity of distilled water. This helps to derive the core chemical properties of the sample being evaluated.

Many manufacturers extract the saponified solution using petroleum ether. The corresponding ether extract is often made to run through sodium sulphate (anhydrous). This is categorically put for evaporation at around 70°C for dryness in a specially designed heating bath. In this very step, a quality analyst would collect and subsequently dissolve the residue in methanol. After this, around 12-20µl of the sample is to be injected into an HPLC system (Waters or Agilent). These samples are intended to be separated across a specific capillary column using a methanol-water system which forms the mobile phase. Following the same procedure, shea oil type is analyzed using special **C8 analytical HPLC columns**. After the analysis, the alpha-tocopherol value for the standard and the sample primarily are to be evaluated and documented in mg/100grams. Before the analysis is on progress, it is to be carefully ensured that the temperature for the injector and detector are programmed differently. The peaks generated from one chromatographic sample needs to be analytically compared to its respective standard. The components would emit certain output signals which are essentially captured by predefined settings of the HPLC system. All the relevant chromatographic data are sequentially recorded in a computerized system coupled with specified authentic software.

Different formulations are collectively designed by various units to yield substantially decent butter quantity. Besides, there are numerous formulas newly available in the market that aim to exceed the specifications of the cosmetic of the sample in the worldwide market.

4.2 GC-MS analysis

Biochemical analyses (nutritive)

Before analyzing the fatty acid characteristic composition of SB, it is crucial to biochemically determine the overall content of the unsaponifiable matter in the shea sample. To estimate this, the sample is saponified with potassium hydroxide in a methanolic solution for about an hour. The unsaponifiable component is extracted almost thrice with diethyl-ether. This follows the collection, subsequent washing, and then drying with sodium sulphate. Thereafter using a specialized rotary evaporator, the diethyl ether is fully removed and the unsaponifiable mass is recovered for weighing. This preliminary step is needed before the gas chromatographic analysis.

This section highlights the GC-MS analysis. The fats are generally extracted by conventional and soxhlet methods. However, the mass spectrometry interpretation is successively restricted to components identification (Warra, 2015). It includes differential steps listed as follows:

- Conversion of the components into their respective methyl esters.
- Dilution of SB in n-heptane solution followed by the methanolic solution of KOH.
- Vigorous shaking of the solution and allowing it to restore for nearly10 minutes.
- 1 mL of the topmost section is blended with erucic acid or any in-house control standard.
- Injection into the specialized chromatography.

Usually, GC-MS fragments reveal different profiles of fatty acids in shea in the form of a chromatogram. These include:

- Oleic acid ($C_{18}H_{34}O_2$)
- Stearic acid ($C_{18}H_{32}O_2$)
- Palmitic acid ($C_{16}H_{32}O_2$)
- Linoleic acid ($C_{18}H_{32}O_2$)

However, some researchers prefer monitoring the column's performance into the gas chromatograph (Warra, 2015). This is done by taking the corresponding amount of each sample content and recording the same in summation of percentages as indicated:

% Fatty acid= [peak area of each FA/summation of total peak areas]*100.

Although the analyses have certain limiting aspects, the results demonstrate the potency of the traditional and also hexane-based extraction methods in perfumery and cosmetics industries (Warra, 2015).

The fatty acid analyses in SB samples are carried out using GC coupled with the MS-detector system. The most commonly employed instrument is the Shimadzu QP2010 (plus). The instrument has a specific temperature-programmed between 75°C and 280°C (Animasaun et al., 2019). Helium gas is generally used as the carrier. The following parameters are set for the device to perform the subsequent analysis.

4.3 Analysis conditions

Programmed parameter	Settings
Chromatograph	Equipped with an MS.
Column	RTX5 silica-based fused capillary column
Injection volume	2 µL
Injection temperature **The initial temperature of the column**	250°C 100°C
Column flow	1.80 mL/minute
Carrier gas	Helium

The program was chronologically optimized so that the column temperature rises by 4-5°C each minute until the desired temperature of 220°C is attained. At this stage, it is kept and held for about ten minutes before the device takes the first sample injection.

Also, the ACQ scanner mode is set having 1478 speed and the scanner range set between 30-700 amu. The spectral chromatogram is compared with a standard taking as the control sample amongst the entire spectral library.

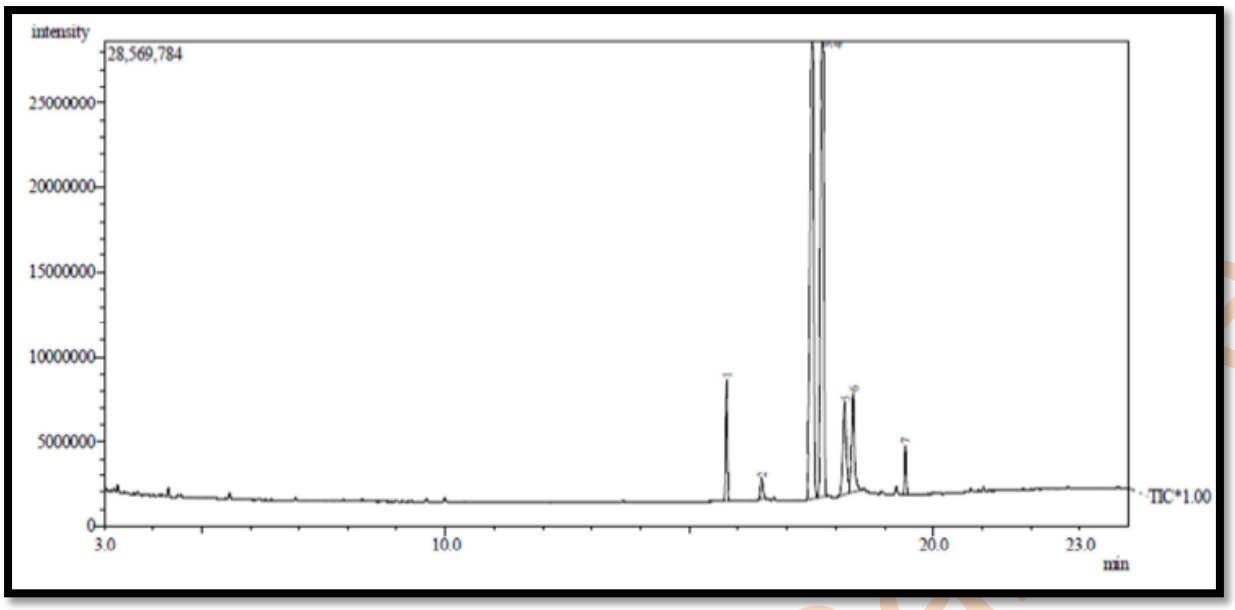

Figure 6: Typical/Standard Total Ionic Chromatogram (TIC) of SB

(Source: Academicjournals.org, 2020)

Profile range of fatty acids of shea samples

Fatty acid	Retention index	Molecular weight	Percentage of similarity index to the target compound
Palmitic acid	1878	270	92
Oleic acid	2175	283	93
Stearic acid	2167	284	88
Tridecene	1821	321	90
Erucic acid	2572	338	89

The fatty acids derived from the mass spectrometric fragments are empirically documented. From the outcomes noted in the GC-MS experimental analyses of shea samples, it can be viably concluded that shea fats have the potentiality to produce excellent revenues in the cosmetics business and facilitate tremendous profit margins to the manufacturers (Animasaun et al., 2019).

Following the analysis, based on certain internal specifications, efficiency, and butter quality is generated. As per the international standards, the general SB quality is categorically assessed based on 4 parameters as follows:

- Moisture content.
- Levels of free fats.
- Peroxide value (PV).
- Insoluble impurities.

PV indicates the stability and deterioration of the product. It also measures all the oxygen's milli-equivalents or the number of total hydro-peroxides.

5. Discussion

5.1 Justification of the current review

On today's date, there have been numerous arguments on the rising demand and insistence of quality shea. But the question lies in if it is economically viable for spending adequate time and the necessary resources in manufacturing marketable shea. Considering how women are at the edge of the benefit of involving in the extraction of SB as a part of their nominal income, the study provides adequate insight on exploring the economical side of the analyses and production of such quality butter. This review document also highlights the potential of such developing business in accelerating SB's market growth specifically in the African countries. It employs almost 3200 households in the northern zone of Ghana generating over four million USD annually (Sikpaam, Mintah& Fearon, 2019).

The existing shreds of literature on the role of shea in the beauty industry have tended to categorically concentrate on the instant gains and profit margins of the sector. And, this is not just for the local traders but also the international marketers. But what is important is to understand that it barely considers the sustainability of such profits that coherently contributes towards the financial well-being of the families that make shea products in the cosmetics world available.

The review is chiefly founded on the stern belief that having a profound understanding of the shea industry will have the potentiality to enhance the economic refinement and limiting poverty across the rural zones of Northern Ghana. Most of the existing details on this topic tend to reflect on the overall gains without emphasizing the sustainability or longevity of such gains. Hence, this elaborated review will adequately help the readers to have a clear insight

on the financial well-being of the people responsible for making shea beauty products available and most importantly possible. Therefore, the prodigious outcome of the review will provide elaborated information on its significance in the market and how essential the chromatographic analyses are for the validation of such products.

6. Conclusions

Worldwide, shea and its corresponding parts are becoming significant ingredients in different fields. This systematic review is chiefly based on the extraction, processing, and validation analysis of SB oil. The commercialization of such samples in the cosmetics industries has taken an immense leap for many years.

For the better comprehension of the readers, the entire document has been categorically segregated into five individual sections under appropriate sub-headings. Starting from the topic's background which highlights the minute details of the origin and application of the product to its marketing dynamics, every narration is cited with proper rationale and necessary shreds of evidence. The literature review section casts light on the vivid aspects of the research topic. It includes the subtle differences between the various extractions techniques commonly employed to obtain crude butter oil for marketing purposes. The study also reveals that such procedures can immensely influence the yield and feature quality of SB being marketed. Each topic has categorically been segmented depending on their relevance over the market enterprise. Despite a few limitations, this review would immensely serve the purpose of aiding millions of producers across the global architecture to formulate their variations and procedure modifications. However, the versatile aspect of the product brought about its relevant uses in pharmaceuticals, food industries, and more areas. Therefore, with time, the world is in dire need of embracing better and more guided techniques to ameliorate the SB business in different other fields as well. That is how a successful marketing expert can expand his initiatives all over and progressively derive a substantial amount of profit and revenue margins. A versatile product will not only entice more consumers but will also dominate a singular channelized domain with all of its potentials. Therein lays the rationale of undertaking this detailed review to penetrate deeper into the existing facts and whereabouts of SB and its potential applications in the beauty aids.

The analysis and results exhibit similar chromatographic trends irrespective of the place and origin. Hence, from this review mining, it can be concluded that the characteristics typified by SB make it such potential and possible raw material to be incorporated in the beauty industries across the world. Such value-oriented features of the component are of immense importance in developing standards for the world's shea oil business. This, with time, leads to the catastrophic improvement and refinement in its commercialization and specifically its global credibility.

7. Recommendations

Substantial variations have been noted particularly in the composition of shea's reported values. Also, considering the existing practices in shea processing and analysis, a series of recommendations can be put forward to ensure better productivity of this business not just locally but also in the global market. These recommendations intend to ameliorate the butter's shelf-life and quality.

i. The first recommendation includes assessing alternative technologies for smaller-scale processing. This would majorly emphasize the technical efficiencies of the methods employed. This might include the potent hydraulic press which is very frequently employed while extracting palm oil. Additionally, it is highly solicited that further investigations are made on the repeated technologies including screw expeller. Any extraction potency ranging between 40%-45% would categorically make such smaller-scale manufacturing profitable in concordance with the existing global prices.
ii. Adequate attention needs to be bestowed to the precision of the analytical techniques used and their accuracy. Appropriate quality analysis is highly solicited to derive much more authentic information on such biological variations.

8. Study limitations

Just how this study has its significant areas of potencies, it carries some of the limitations as well. Besides, systematic volunteering of any practical necessary information is the key to successful systematic research and/or review. But in this regard, clandestine activities of certain processors exerted potential information gap in the literature mining of SB oil, its properties, and extraction techniques in the cosmetics business. Secondly, sometimes due to the ongoing investigations, a few of the information lacked clarity. Also, there are many

online journals with some of the most effective information that charged huge subscriptions. This made the review a bit challenging to accumulate every piece of information and provide insights based on them. So, digging into the intricate details of all the existing shreds of literature has elongated and sharpened the knowledge of the readers but leaves some of the limitations along which requires further search and diligent investigations. However, it is practically quite intricate to dig details on any topic by complete reliance over the available online resources. A research activity would help gain a better comprehension of this state and the production aspects in a better form. Nonetheless, this review has an abundant capacity to coherently guide other communities and manufacturers with the same characteristics for any SB intervention program. So overall, this document review is fruitful in bestowing an adequate piece of information to the viewers.

9. Future scopes and advancements

The structural characterization, validation, and biochemical analysis of SB was the pivotal topic of the current systematic review. The data reflected multifaceted opportunities towards establishing the cosmetic variations of SB more strongly in the beauty industries. Future explorations including more analytical quality control techniques will aid in marking the project effective thereby facilitating huge success. It will also accelerate the potential avenues of offering such cosmetic products in remote areas other than the African bases. Following this, marketing experts can explore more scalable and cost-effective manufacturing strategies to develop and optimize the use of SB with additional components as a wholesome ingredient to multiple variants of beauty items. Systematic research into this product will assist and guide decision-making with all the novel initiatives. Thereafter, this shred of the review is cohesively expected to help in a lot of trial-and-error functions in the cosmetics market with shea and its various parts.

With the gradual passage of time, the traditional extraction methods have proven their respective worth. It assists in generating a decent and quantifiable target product to be used. Hence, it is highly solicited that the researchers and corresponding investigators seek more efficient and consistent optimization to obtain the best yield of the intended product after all the preliminary quality tests are conducted.

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Appendices