Journal of
Chemical Engineering & Process Technology

Saba et al., J Chem Eng Process Technol 2018, 9:3
DOI: 10.4172/2157-7048.1000382

Research Article Open Access

Determination of the Effect of Storage Time and Condition on the Properties of Shea Butter

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Abstract

In effort of raising the market opportunities and values of shea butter, this work seeks to investigate the effect of storage time and condition of storage on the properties of shea butter. This involves the extraction of butter from shea nut, storing at room temperatures and temperature of refrigerator. The shea butter stored were characterized for the iodine value, peroxide value, saponification value and free fatty acid value. The storage was done for the period of eight months and the characterization done monthly. The effect of temperature on the shea butter in respect of iodine value is that the value increases from 4.31 mg/kg to 6.16 mg/kg when stored at room temperatures, while it reduces from 4.3 mg/kg to 3.41 mg/kg when stored in refrigerator. The peroxide value of the shea butter increases at both storage conditions: from 8.80 mg/kg to 10.81 meq/kg for room temperatures, while from 8.80 mg/kg to 9.02 mg/kg for storage in the refrigerator. The saponification value for storage in room temperatures increases from 185.00 mg/kg to 185.96 mg/kg, while for the storage in refrigerator decreases from 185.00 mg/kg to 184.00 mg/kg. The FFA value increases from 3.10 to 4.32 under room temperatures, while it reduces from 3.10 to 3.06 under refrigerator. The result therefore indicate that shea butter can both be stored at room temperature and in a refrigerator but when compared to their storage effect, refrigerated shea butter will last longer.

Keywords: Shea butter; Storage; Temperature; Refrigeration

Introduction

Shea butter is a natural plant extract that comes from the Karite or shea tree. The shea tree formerly *Butryopermum paradoxum* is now called *Vitellaria paradoxa*. It produces its first fruit when it is about 20 years old and reaches its full production when the tree is about 45 years old. It produces nut up to 200 years after reaching maturity [1]. In most part of Africa, destruction of the shea tree is prohibited because of its economic and medicinal values as it is a source of food, medicine and income for the population. It is usually of an average height of about 15 m with profuse branches and a thick waxy and deeply fissured bark that makes it fire resistant. The shea trees grows naturally in the wild in the dry savannah belt of West Africa from Senegal in the West to Sudan in the East, and onto the foothills continent, namely, Benin, Ghana, Chad, Burkina Faso, Cameroon, Central Africa Republic, Ethiopia, Guinea Bissau, Cote D'voire, Mali, Niger, Nigeria, Senegal, Sierra Leone, Sudan, Togo, Uganda, Zaire and guinea [2].

Shea butter is a cream-color fatty substance and sometimes referred to as "Women's gold" in Africa because so many women are employed in the production of shea butter. Shea butter is a particularly effective moisturizer because it contains so many fatty acids, which are needed to retain the skin moisture and elasticity [3]. The high fatty acid content of shea butter also makes it an excellent additive to soap, shampoos, anti-aging creams, cosmetics, lotion and massage oil, its soft butter-like melts readily into the skin and also perfect the skin from both environmental and free radical damage. Shea butter contains vitamin A and vitamin E, and has demonstrated both anti-microbial and anti-inflammatory properties, and nourishes the skin with vitamins A, E and F. Vitamins A and E help maintain the skin and keep it clean and healthy. They are also particularly helpful for sun skin damage, they help prevent premature wrinkles and facial lines. Vitamin F acts as a skin protector and rejuvenator. It soothes rough, dry or chapped skin and help to soften dry or damage hair [4].

Shea butter melts at body temperature and absorbs rapidly into the skin without leaving a greasy feeling. In Africa, it is used for cooking oil, as an ingredient in medicinal ointment. It is also used by maker of traditional African percussion instruments to increase the durability of wood (such as carved djembe shells dried calash gourds, and leather turning straps). It also easily penetrates the skin slowing the skin to breather and not clogging shea butter also has a high level of cinmamic acid, a natural sun screen which provides some degree of protection from sun.

High quality shea butter can be stored at normal room temperature and has a long shelf-life of 12-18 months. The best way to store shea butter is in a air tight container - keep away from sunlight heat and water. Shea butter will have lower quality shelve life of as low as 6 months is due to the contamination of heavy metals, mold, and high moisture content [5].

Shea butter is classified into two namely: Refined and unrefined shea butter. Most noticeably are the scent, color and benefits. Unrefined shea butter maintains its nutty scent, ivory - beige color and all of its healing properties [6]. Refined shea butter has been chemically altered to remove shea butters natural scent, is bleach white in color and retains only a small portion of its natural healing properties [7]. Unrefined shea butter does not spoil, it healing properties are very powerful within the first year and half. After that it is still usable but not as beneficial as the shea butter ages it becomes stiffer but still smooth [8].

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Received April 10, 2018; **Accepted** May 09, 2018; **Published** May 20, 2018

Citation: Saba AM, Tsado DG, Okafor JO (2018) Determination of the Effect of Storage Time and Condition on the Properties of Shea Butter. J Chem Eng Process Technol 9: 382. doi: 10.4172/2157-7048.1000382

The most accurate way to tell would be to do test in a laboratory if the shea butter is no more good. To ensure quality, shea nut should be tested before they are used; the lower the free fatty acid the higher the quality and the higher the free-fatty acid the lower the quality and can no longer good for human use [9].

Shea butter's unparalleled hydrating property is due to natural moisturizers that are chemically similar to those produced by the body's own sebaceous glands. Shea butter also contains healthy fatty acids. It is high in unsaponifiables (a type of fat) containing between 7-12% [10]. This is one of the properties that make Shea butter so valuable in treating the conditions above. Shea butter easily penetrates the skin and will not clog pores. There is a high level of cinnamic acid which makes Shea butter a natural sunscreen. Shea butter has anti-inflammatory properties that make it useful in treating arthritis. Shea butter has powerful moisturizing, anti-aging, protecting and healing benefits to the skin [11]. There are many uses of shea butter and it has been clinically shown to provide relief for various skin conditions. Most seeds oil can be divided into two important fractions: (1) the first fraction is called the saponifiable fraction, which contains most of the moisturizing properties (moisture fraction). The second fraction is called the non-saponifiable fraction, which contain most of the healing properties, (healing fraction). Shea butter apart from other seed oils is it exceptionally large healing fraction [12]. The healing fraction contains important nutrient, vitamins and other valuable phytonutrients required for healing. Depending on the source, the size of the healing fraction may range from 5% and upward. Some report the healing fraction as high as 17%, the larger the healing fraction the better the chances for a good quality shea butter; in other seed oils, the healing fraction is very small, often in the range of 1% or less [13].

This work is aimed at the determination of the effect of storage time and condition of storage on the properties of shea butter. To get this aim achieved, the following objectives were attained. Shea butter was produced; an effective storage method for shea was developed; and effect of storage conditions (refrigerated and unrefrigerated) with time on the properties of shea butter was evaluated.

This study finds its significance in raising the market opportunities and values of shea butter; upgrading the storage time and the condition of shea butter; and encouraging individual and the nation to make shea butter a source of income.

Methodology

The dried sample (shea nut) used for the analysis was obtained from Doko village Bida, Niger state. 100 kg of the dried sample was weigh using a weighing balance of model CAI-304. It was poured into a very large pot of 40 cm diameter where it was batchly roasted for one hour, under the application of an uncontrolled fire supply beneath the pot. The roasted shea nut was poured into a mortar and was pounded with a pestle in order to reduce the size. Further size reduction of the shea nut into powder was achieved through a grinding machine. The powdered nut was poured into the mortal and water was added to it, a proper mixing of the water and powdered nut was carried out for an hour in which a paste was formed. A large foam was obtained at the top after a longtime mixing, the foaming part at the top was packed and poured into a pot which was boiled for complete three hours.

After three hours, the boiled mixture was poured into a large basin and was allowed to cool for an hour. During the cooling, the brownish part which was the waste goes down to the bottom of the basin and shea butter was obtained at the top. One hundred grammes (100 g) of the shea butter was weighed and divided into two separate plastic containers with 50 g each of the shea butter. The first container was stored at room temperature and the second container in a refrigerator of 5°C. The change in the properties of shea butter stored at room temperature and in the refrigerator was determined after every two weeks interval through characterization for iodine value, peroxide value, saponification value and free fatty acid. This analysis was conducted for four months. The characterization was done as follows.

Iodine value test

The iodine value is a measure of the degree of unsaturation of the fatty acid in vegetable oil. This value for oil and fat is defined as the weight of iodine absorbed by 100 part by weight of sample. The glycerides of the unsaturated fatty acid present with a define amount of halogen is a measure of iodine value. The common method used to determine iodine value is Wiji's method.

3.5 g of the butter was accurately measured into beaker of 250 ml capacity. 15 ml of Wiji's solution was added and also 10 ml of chloroform was added to the mixture and the whole of this mixture with 15 ml of potassium iodide was added to the sample. This mixture was observed for 30 minutes and was titrated with theosulphate solution using a starch indicator and an end point of pure yellow obtained. The blank was also carried out.

$$Iodine\ value = \frac{(b-a)\times 1.269}{wt(\mathrm{g})\ \mathrm{of\ sample}}$$

Peroxide value test

The concentration peroxide in an oil or fat, gives an indication of the extent of spoilage. Fat and oil undergo changes during storage which result in production of unpleasant taste or odour, which commonly referred to as Rancidity.

In actual fact peroxide value is used to monitor the development of rancidity through evaluation of the quantity of peroxide generated in the product.

One gramme (1 g) of the butter was accurately weighed into a beaker of 250 ml. 1 g of potassium iodide power and 20 ml of potassium iodide solution was added to the sample that have been subjected into a water bath at 60°C for 5 mins and also 10 ml of chloroform was also added and was titrated with this sulphate (0.002 ml of sodium thiosulphate) using starch as indicator.

$$Peroxide\ value = \frac{S-B(\mathrm{N})}{weight\ of\ sample} = mEq/kg$$

Saponification value test

The saponification value of fat and oil can be defined as the number of milligrams of potassium hydroxide required to neutralized the fatty acids resulting the complete hydrolysis of the sample. Saponification value is usually large when compared with acid value of most edible oil.

Two kilogram (2 kg) of the butter was weighed into a beaker and exactly 25 ml of the alcoholic potassium hydroxide solution was added. This mixture was placed in water (boiled) for 1 hour and rocks attached to a reflux condenser and were shaking frequently. 1 ml of phenolphthalein (1%) solution was added and the mixture was titrated while hot with 0.5 M hydrochloric acid. Also blank was carried out.

$$Saponifcation\ value = \frac{(\mathrm{b-a})28.05}{wt\ of\ sample}$$

Free fatty acid test

The free fatty acid is defined as the number of Mg potassium hydroxide requires to neutralize the free fatty acid in g of the sample. Free fatty acid measures the extent to which glyceride in the oil or fat have been decomposed by lipase action.

Twenty five 25 ml of ethyl ether was mixed with 25 ml of alcohol and 1 ml of phenolphthalein solution (1%) and was carefully neutralized with 0.1 M NaOH to obtain pink colour end point. 2 g of butter was added to the neutralized mixed solution and was finally titrated with aqueous 0.1 M NaOH with a continuous shaking for 15 minutes and a pink colour was obtained. Saponification value is usually larger than free fatty acid value of most edible oil.

$$F.F.A = \frac{Titre\ ml \times 5.61}{weight\ of\ sample\ used}$$

Results

From the whole experiment carried out on the sample to determine the peroxide value, saponification value and free fatty acid value over the range of one-month interval for eight months (8 months) the Table 1 and the charts have been generated.

Discussion

From the experiments carried out to determine the effect of storage time and condition on the property of shea butter stored at room temperature and in refrigerator. The results obtained shows how iodine value, peroxide value saponification value, frees fatty acid value at elevated and depressed temperature response to change.

The results (Figure 1) show that iodine value of shea butter stored at room temperature increases with time. This increase is due to the higher temperature of storage in which the lipases found so favourable to affect this property of the shea butter. This result is similar to a study carried out [14], in which the iodine value of the oils are classify as non-drying oil, since their iodine values are less than 100. A sudden drop in iodine value was observed in the fifth month; from 5.4 mg/kg to 4.92 mg/kg. This sudden change is caused due to change in environmental factor (temperature) below the activating temperature of the lipases. But there was a steady rise in the iodine value from the 6th month through to the 8th month. This increase is due to change in the weather condition (i.e., increase in temperature).

The iodine value of a refrigerated shea butter decreases with time (month) as a result of low temperature within the refrigerator which lipases found unfavourable for their activities. An increase was observed in the 3rd month from 4.2 mg/kg to 4.5 mg/kg. This increment is due to unstable power supply at the moment, as the inverter (the power source) had also run down. This brought about melting of the iced shea butter. This melting process causes an increase in the moisture content (water activity) which promote the lipasic activities whereby affecting the iodine value of the butter. However, the iodine value again dropped steadily due to resolidification of the shea butter from the 4th month through the 8th month without any increase again. In a similar study [15], the higher the iodine numbers, the higher the degree of unsaponification, and the shorter the shelf-life of oil.

Looking at Figure 2, the effect of temperature on the shea butter regarding peroxide value (being the measure of the degree of rancidity) increases with time at room temperature. This is for the reason that thermal hydrolysis of triglycerides which releases peroxide and free fatty acid, and is caused as a result of high temperature. This higher temperature of storage is capable to deactivate the thermal hydrolysis and lipasic activities. The peroxide value again increases from the 6th month through to 8th month.

For the refrigerated storage condition, there was a steady decrease in peroxide value of the shea butter. This due to the application of low temperature found in the refrigerator which is not favourable for the lipasic action or thermal hydrolysis. The peroxide value keeps decreasing until the 5th month where a sudden increment in peroxide value. This increase as a result of power failure which brought about increase in moisture content due to melting of the iced butter and also as a result of temperature zone favourable for lipases action. The peroxide value again the following month and went steadily up to 8th.

During storage, [16] kirk and Sawyer shows that peroxide formation is slow at first during an induction period (which may vary from few weeks to several months) depending storage temperature.

Peroxide are the primary oxidation product and peroxide concentration may fluctuate over time since peroxide turn to other oxidation product with time [17].

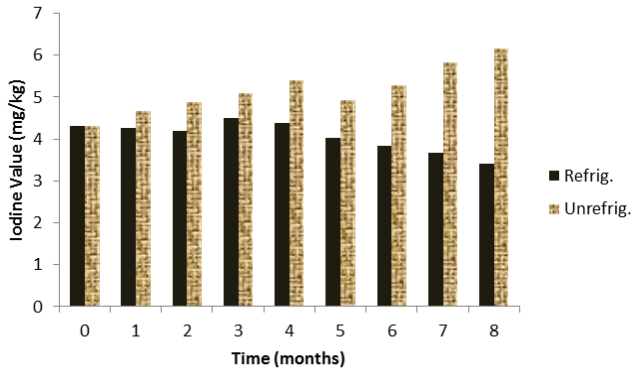

Figure 1: Iodine Value of the Shea Butter (fridge and unfridge).

Month	Iodine Value (mg/kg)		Peroxide Value (meq/kg)		Saponification (mg/kg)		Free Fatty Acid	
	Refrigerated	Unrefrigerated	Refrigerated	Unrefrigerated	Refrigerated	Unrefrigerated	Refrigerated	Unrefrigerated
0	4.31 ± 0.25	4.31 ± 0.86	8.80 ± 0.09	8.80 ± 0.98	185.00 ± 0.65	185.00 ± 0.69	3.10 ± 0.12	3.10 ± 0.63
1	4.26 ± 0.20	4.68 ± 0.49	8.70 ± 0.19	9.03 ± 0.75	184.80 ± 0.45	185.20 ± 0.49	3.10 ± 0.12	3.25 ± 0.48
2	4.20 ± 0.14	4.89 ± 0.28	8.55 ± 0.34	9.80 ± 0.02	184.63 ± 0.28	185.47 ± 0.22	3.08 ± 0.14	3.63 ± 0.10
3	4.50 ± 0.44	5.10 ± 0.07	8.30 ± 0.59	10.05 ± 0.27	184.47 ± 0.12	185.69 ± 0.00	3.00 ± 0.22	3.90 ± 0.17
4	4.38 ± 0.32	5.40 ± 0.23	8.20 ± 0.69	9.70 ± 0.08	184.28 ± 0.07	185.98 ± 0.29	2.93 ± 0.29	3.75 ± 0.02
5	4.02 ± 0.04	4.92 ± 0.25	9.70 ± 0.81	9.30 ± 0.48	184.00 ± 0.35	185.96 ± 0.27	3.85 ± 0.63	3.63 ± 0.10
6	3.84 ± 0.22	5.28 ± 0.11	9.50 ± 0.61	10.00 ± 0.22	184.00 ± 0.35	185.96 ± 0.27	3.53 ± 0.31	3.85 ± 0.12
7	3.66 ± 0.40	5.82 ± 0.65	9.23 ± 0.34	10.50 ± 0.72	184.00 ± 0.35	185.96 ± 0.27	3.37 ± 0.15	4.15 ± 0.42
8	3.41 ± 0.65	6.16 ± 0.99	9.02 ± 0.13	10.81 ± 0.99	184.00 ± 0.35	185.96 ± 0.27	3.06 ± 0.16	4.32 ± 0.59

Table 1: Oil Properties (refrigerated and unrefrigerated) during eight months storage.

With respect to Figure 3, Saponification value been the measure of the amount of potassium hydroxide required to neutralized the fatty acid which result to complete hydrolysis of the sample. This value increases for four months after which it stabilizes for the remaining month at 185.96 mg/kg, when stored at room temperatures. This is opposite to when the oil is refrigerated as the saponification value reduces continuously for four months and stabilizes at 184 mg/kg for the remaining four months. There is a great disparity in the saponification values of shea butter when stored at different temperatures of room and refrigerator. The values observed were lower than those founded in most vegetable oils [18].

From Figure 4, FFA being the measure of the extent at which triglycerides in the oil or fat have been decomposed by lipase action. The free acid value of shea butter stored at room temperature increase with time. This increase is caused due to high temperature (i.e., thermal hydrolysis) to release fatty acid. This increase in the free fatty acid continues until the 3rd month. A decline is noticed in the 4th month which is as a result of low temperature capable of deactivitating the thermal hydrolysis and lipasic activity. The free fatty acid again increases from the 6th month steadily through the 8th month.

From the same Figure 4, the FFA value of the refrigerated shea butter decreases with time due to the presence of low temperature within the refrigerator which is capable of deactivating lipasic activity and also inhibit thermal hydrolysis of the triglyceride [19]. A sharp increase is noticed in the 5th month as a result of instability of power supply which brought about increase in moisture content as a result of melting process of the iced butter and also as a result of the temperature in the refrigerator which is favourable to lipasic activity. The free fatty acid value again decrease from the 6th month continuously through the 8th month without any increase again the lower the acid value of oil, the fewer the fatty acid it contains which makes it less exposed to the phenomenon of rancidity [20-25].

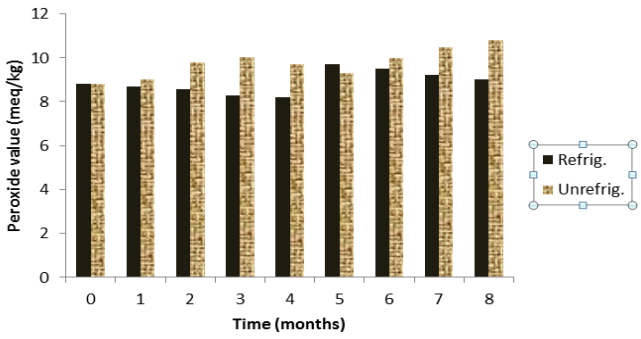

Figure 2: Peroxide Value of the Shea Butter (fridge and unfridge).

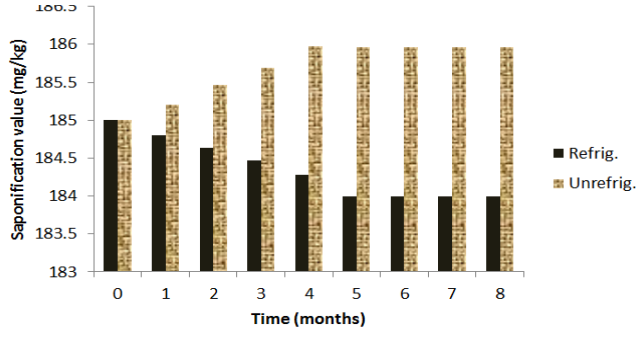

Figure 3: Saponification Value of the Shea Butter (fridge and unfridge).

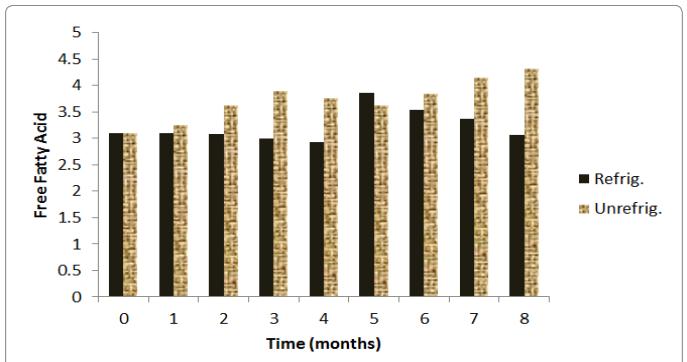

Figure 4: FFA Value of the Shea Butter (fridge and unfridge).

Conclusion

Generally, it can be concluded that the study of effect storage time and condition on the property of shea butter (*Butyospermum parkii*) is of great relevance as it reveals the effect of room temperature and refrigeration on the valuable properties of shea butter such as iodine value, peroxide value, saponification value, and free fatty acid which are of high nutritional and pharmaceutical importance.

From the result obtained, it can be concluded that shea butter stored in the refrigerator is more of advantages than that stored at room temperature. Irrespective of the storage condition of a shea butter, it has a shelf life of one and half year. From the Table 1 of result obtained (Figures 1 and 4), it is clearly indicated that the shea butter stored at room temperature will get rancid on time before the refrigerated shea butter. It can also be deduced that the results free fatty acid has shown that lipase found room temperature so favourable for their daily activities unless there is an environmental temperature change below their temperature. Conclusively, it can be deduced that the shea butter stored under a proper storage condition such as cool area, finds uses in the production of chocolate in place of cocoa butter, pharmaceutical products and soap [26-28].

Recommendation

The following are recommended for the further research work:

- The research work should be carried out in much longer period, and with steady power supply, as most shelf life of oil falls within the period of 18 months.
- Deionized water should be used for the production of high quality shea butter in order to avoid presence of metal and ions which catalyse rate of rancidity.
- Continuous extraction of the shea butter should be carry out in a well sanitary environment in the next research in order to avoid the presence of lipases from the day of extraction caused due to poor sanitary environment.

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