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SHEA BUTTER VS. OLEIN: QUALITY COMPARISON IN IREPODUN LOCAL GOVERNMENT AREA, OYO STATE, NIGERIA

[1]Olubunmi Adeola Adewale and [2]Abdulrasheed Adebayo Lawal
[1]Department of Food Technology, Faculty of Technology, University of Ibadan, Nigeria.
[2]Department of Food Science, Kwara State University, Malete, Kwara State, Nigeria.

Abstract: The shea tree, its biology, and cultivation belt have been extensively studied and documented, along with methods of extraction. In West Africa, particularly in Nigeria, rural women predominantly utilize traditional methods of shea butter extraction, despite the labor-intensive nature, due to its sustained earnings. Unlike Mali and Uganda, where dry extraction methods using hydraulic or screw presses are prevalent, such techniques are rarely employed in Nigerian shea localities. While mechanical devices for drying and size reduction exist, the kneading of shea paste remains unmechanized in Nigeria. This paper explores the prevailing methods of shea butter extraction in Nigeria, highlighting the preference for traditional techniques and the limited adoption of mechanized processes.
Keywords: Shea butter, extraction methods, traditional techniques, mechanization, Nigeria.

INTRODUCTION

The biology and detailed description of shea tree has been reported (Alander, 2004), and belt of cultivation (Chalfin, 2004; Goreja, 2004) and extraction has been properly documented (Ferris et al., 2001). In West Africa, especially in Nigeria, local method of extraction is widely acceptable by rural women over a dry extraction process despite the arduous labour involved because their earnings are sustained (Olaoye and Babatunde, 2001). The dry extraction method of shea butter using hydraulic or screw press is rarely used in the shea localities in Nigeria unlike Mali and Uganda which fully appropriate its usage. There are mechanical devices for drying and size reduction operations, but kneading of shea paste is yet to be mechanized in Nigeria.

In 2004, the United States Agency for International Development (USAID) through West Africa Trade Hub discovered that 80% of shea butter extracted in Nigeria were consumed locally, 20% were exported as nuts and 0% exported as butter (WATH, 2004). The reason being that shea kernels of good grade (20%) that could be extracted as food oil were exported, leaving out kernels of lesser quality to produce poor quality shea butter through an ineffective processing practice (Olaoye, 2012).

Shea butter produced in Nigeria fell into grade three according to the Draft of Regional Technical Standard on Shea butter, 2006. Nahm (2011) observed significant variations in the quality characteristics of shea butter samples purchased from marketplace and the one

industrially extracted in West African countries. Variation in shea butter quality extracted from shea kernels obtained from the same region in Mandoul country is as a result of processing practices being reported by Mbaiguinam et al. (2007).

Moreover, the need to improve the local processing method is important if the problem of poor shea butter quality will be addressed. Aside this, extending process line of shea butter in Nigeria to yield two products (shea stearin and olein) instead of one product (shea butter) will increase foreign earnings and at the same time provide a product (olein) having potentials to be used as a starting material in the vegetable industry. Hence, this

investigation was aimed at comparing the quality of shea butter and olein obtained from the local method of extraction with improved of extraction method.

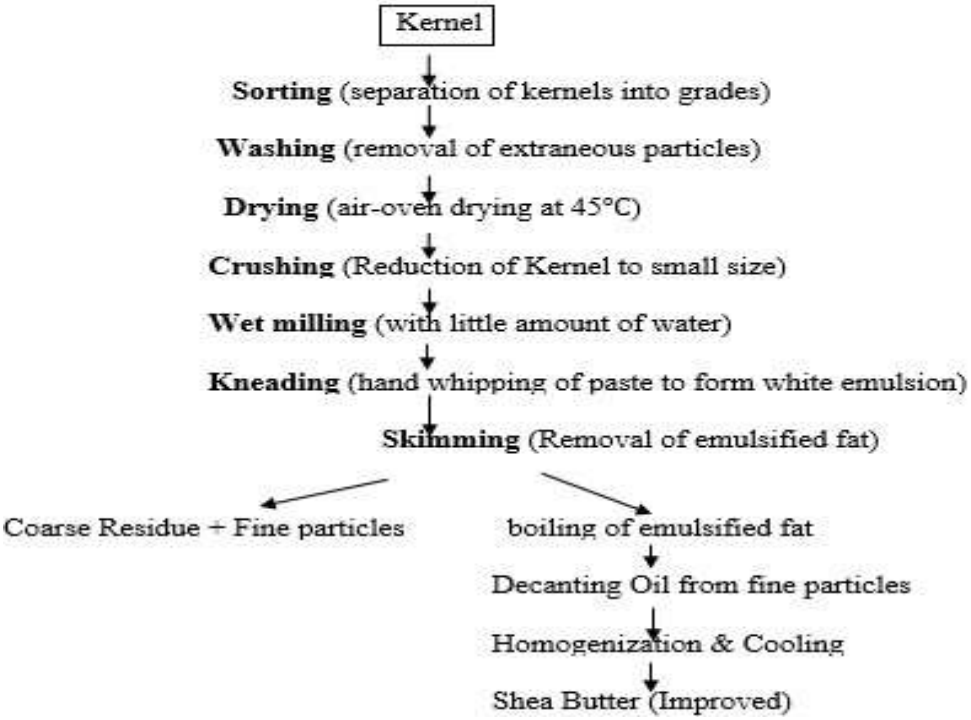

Figure 1. Improved method of Extraction of shea butter (Source: ARSO, 2011).

MATERIALS AND METHODS

Materials

About 2 kg of locally made shea butter (LSB) was purchased from shea butter producer in Kishi, Oyo State. Shea kernels (6.58 kg) were obtained as well from a farmland in Kishi town in Oyo State of Nigeria and processed with improved method to produce shea butter (ISB). The moisture content of the shea kernels purchased was 7.02%. This was sorted, washed and dried in a hot-air oven to moisture content of 3.15% to produce ISB (2.10 kg). All reagents used are laboratory grade. The process flow for the improved traditional method is as described in flow chart 1 (Figures 1 and 2).

Analyses

Specific gravity

Clean, dry pycnometer was filled with 25 mL recently boiled and cooled water to 40°C in a water bath for 30 min. The pycnometer with the content was removed from water bath wiped dried and weighed (W1). The pycnometer was emptied, rinsed several times with alcohol, and allowed to dry completely and weighed (W2). In the same way, 25 mL of the sample was introduced into the pycnometer and the temperature was adjusted to 40°C in the water bath for 30 min (AOAC, 2000). The pycnometer was removed from the bath and wiped dried and weighed (W3):

$$\text{Specific gravity} = \frac{W3-W2}{W1-W2}$$

W3 - W2 is weight of 25 mL sample and W1 - W2 is the weight of 25 mL boiled water.

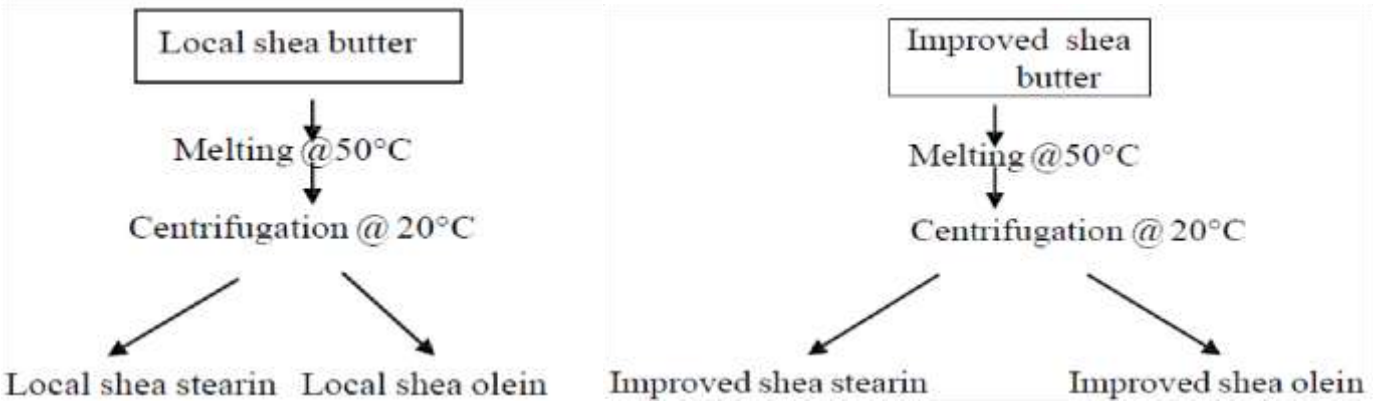

Figure 2. Flow chart for fractionation of shea butter into olein and stearin. Source: Addaquay (2004).

Refractive Index

Two drops of the sample were placed on the surface of lower prism of the refractometer (Fisher Scientific, model 334620). The prism was closed and adjusted until sharpest reading was obtained. This was carried out in triplicates and the angle of refraction obtained was then converted to refractive index (AOAC, 2000).

Moisture content

The sample was melted and stirred thoroughly before sampling. Five grams of prepared sample was weighed into a moisture dish with a tight-fit slip-over cover. It was then dried to constant weight in vacuum oven at uniform temperature of 125°C at working pressure of less than 100 mmHg for 1 h and cooled in desiccators. Loss in weight was reported as percentage moisture and volatile matter (AOAC, 2000).

Insoluble impurities

The sample was melted at 70°C, mixed thoroughly and cooled. About 20 g (M0) of the melted sample was weighed into 250 mL conical flask. Whatman Filter paper, and a vessel with its lid was dried at 103°C in the oven, allowed to cool in the desiccator and the weight of the filter paper, vessel with lid was taken (M1). N-hexane, 200 mL was added to the flask containing the sample, stoppered and shaken well. The content was left to stand at 20°C for 30 min. After 30 min, the content was filtered through filter paper in a Buchner funnel using a vacuum pump. Small amount of n-hexane was poured through the filter paper to wash it in order to dissolve any solidified fat retained on the filter. The filter paper was then removed from the funnel and placed in the vessel to allow the solvent remaining in the filter paper to evaporate in air, and the evaporation completed in the oven at 103°C for 30 min. The vessel containing filter paper from the oven was removed and covered with its lid, cool in the desiccator and weigh (M2) (ISO, 2000). The insoluble impurities were expressed as a percentage by mass:

$$\omega = \frac{M2-M1}{M0} X\ 100\%$$

Where, M_0 is the mass of the sample in grams; M_1 is the mass of the vessel with its lid and filter paper in grams and M2 is the mass of the vessel with its lid and filter paper containing the dry residue in grams.

Free fatty acid in crude oil

To 50 mL of absolute alcohol in a dry 250 mL conical flask, 2 mL of phenolphthalein indicator was added and neutralized with 0.1M sodium hydroxide. The neutralized alcohol was transferred into a conical flask containing

7.05 g oil sample and was titrated with 0.25 M sodium hydroxide. The percentage free fatty acids in the oil were equivalent to the mL of 0.25M sodium hydroxide used in the titration (AOAC, 2000). Acid value was calculated as mL of 0.25M sodium hydroxide multiplied by 1.99 in mg KOH/g.

Peroxide value

Exactly 5 g of oil was weighed into a conical flask and dissolved with 30 mL mixture of acetic acid-chloroform (2:1). Saturated potassium iodide (0.5 mL) was added to the mixture, shaken and allowed to stand for 1 minute. After which 30 mL of distilled water, and 0.5 mL starch indicator was added, the content was titrated against 0.01 N sodium thiosulphate (AOAC, 2000). The blank test was conducted and peroxide value was calculated as mL equivalent of active oxygen/kg of sample:

Peroxide value = $\frac{S\ X\ N\ X\ 1000}{Sample\ weight}$

S = Titre value of sample - Titre value of blank and N = molarity of the thiosulphate.

Iodine value

About 0.5 g of the sample was weighed into 500 mL conical flask and dissolved in 10 mL chloroform. Hanus iodine solution (25 mL) was added and the solution allowed standing 30 min in the dark, shaking occasionally. After 30 min, 10 mL of 15% potassium iodide solution and 100 mL freshly boiled and cooled water was added and shaken thoroughly. The content of the flask was titrated against 0.1 M sodium thiosulphate gradually and with constant shaking until the yellow solution turned almost colourless then, few drops of starch indicator was added and titration continued until blue colour entirely disappeared. A blank determination was conducted alongside with the determination of sample. Number of mL of 0.1 M $Na_2S_2O_3$ required by the blank (B) minus mL used in determination (S) gives $Na_2S_2O_3$ equivalent of iodine absorbed by the fat (AOAC, 2000).

Iodine number was calculated as follows:

$$\frac{[(B-S)X\ N\ X\ 12.69]}{Sample\ (g)}$$

B = mL of 0.1 M $Na_2S_2O_3$ required by the blank, S = mL of 0.1 M $Na_2S_2O_3$ required by the sample and N = molarity of the thiosulphate.

Saponification value

About 5 g of sample was weighed into 250 mL flask. Alcoholic potassium hydroxide solution (50 mL) was measured into a conical flask. The flask was connected with condenser and refluxed for 30 min. The flask was cooled and titrated against 0.5 M HCl using phenolphthalein. A blank titration was conducted along with the sample (AOAC, 2000). Saponification number was calculated as:

$$\frac{28.05\ (B-S)}{Sample\ (g)}$$

Where, B = mL of 0.5 M HCl required by the blank and S = mL of 0.5 M HCl required for sample.

Alpha tocopherol

Sample preparation

Sample (200 mg) was weighed into HPLC vial, 0.8 mL of mobile phase was added and vortex to mix. This was manually injected into the High-Performance Liquid Chromatography and analyzed (Hashim et al., 1993). Mobile phase was 1% 2-Propanol (HPLC grade) in Hexane. About 600 mL of hexane (Analytical grade) was added to 1000 mL graduated cylinder. 10 mL of 2-propanol was added and diluted to 1000 mL mark with hexane. The mixture was filtered and degassed by sonication. Stock solution of alpha tocopherol was prepared from a standard

alpha tocopherol (CAS 5902-9) from Sigma-Aldrich (USA). A drop of the alpha tocopherol standard (viscous dark orange) was transferred into a screw capped test tube. 10 ml of hexane was added and vortex to mix. The absorbance of this was measured at 294 nm against pure hexane. Using Beer's Law, (A= εCl) the concentration of this solution was calculated taking the extinction coefficient of alpha tocopherol to be equal to 71 g/100 mL at 294 nm (Hashim et al., 1993). The stock solution was diluted to prepare series of concentrations between 20 to 100 part per million. This was used to establish a standard calibration curve.

Fatty acid composition

Fatty acids methyl esters (FAMEs) were prepared as previously described by Ozcan, 2009. FAMEs were analyzed on Capillary Column (RT-2560, 50 m × 0.25 mm I.D, 0.25-micron dry film) in an HP 6890 series gas chromatograph equipped with a flame ionization detector and a manual injector (Agilent, Wilmington, DE). Samples were injected at an initial oven temperature of 40°C held for 2 min.

Then the column temperature was increased at a rate of 20°C/min to 125°C and held for 5 min. It was further raised to 190 for 2 min at 1°C /min and finally raised to 233°C at 4/min held for 2 min. The injector and the flame ionization detector (FID) temperatures were set to 250°C. Nitrogen was used as the carrier gas.

Peak identification was performed by comparison of retention times of sample solutions to that of individual fatty acid standards

(FAME 37 mix). Fatty acids were expressed as % of total fatty acids.

$$\% \text{ fatty acid} = \frac{Fatty\ acid\ peak\ area}{\sum total\ fatty\ acid\ peak\ areas} \times 100$$

Statistical analysis

Data were subjected to descriptive statistics and analysis using SPSS package (SPSS, version 22) and means were separated using Duncan Multiple range test of the same software at α0.05.

RESULTS AND DISCUSSION

Specific gravity

The specific gravity of locally made shea butter (LSB) and improved shea butter (ISB) are shown in Table 1. The specific gravity was statistically the same ($p>0.05$) 0.95 (ISB) and 0.96 (LSB). It provides information on identity and helps in detection of adulteration of shea butter of which density may increase or decrease (Nahm, 2011). The Regional Technical Standard for specific gravity of shea butter ranged from 0.91-0.98 g/mL at 40°C. The values in this study agreed with the reported relative density of 0.97 (Njoku et al., 2000) but higher than 0.91 documented (Nahm, 2011) for shea butter samples from Ghana.

The specific gravity of the two shea olein samples is shown in Table 1. The specific gravity of local shea olein LSO was 0.95 and that of the improved shea olein ISO was 0.94. The specific gravity of the two shea olein samples were the same ($p>0.05$). These results agreed with the specific gravity of 0.94 reported by Ren (2010) for crude sunflower oil. The codex standard set value for crude palm olein ranged from 0.90 to 0.92 which were much (slightly) lower when compared to the values obtained from this study.

Refractive index

The refractive index of the improved and local shea butter samples are shown in Table 1. The refractive index of the two samples was not significantly different ($p>0.05$). The value obtained was 1.47. The value was within the limit of 1.46 - 1.47 set by the Africa Regional Standard for improved and local shea butter which also conformed

to reported values of 1.46 - 1.47 by Nahm (2011) for seven shea butter samples from Ghana. The value was lower, when compared to 1.67 and 1.69 reported for Uganda shea butter (Omujal, 2009). Refractive index is the ratio of the speed of light in a vacuum to that in the oil under examination which is related to the degree of saturation and the ratio of cis/trans double bonds, and provides hint on oxidative damage (Hamilton and Rosell, 1986). This result suggests that the degree of thickness of the two crude shea butter samples would be same at room temperature (Nkafamiya et al., 2010).

The refractive index of the local and modified shea olein samples are shown in Table 1. The obtained values were not significantly different ($p>0.05$). The refractive index of the two shea olein was 1.47 showing no difference ($P\leq0.05$) was observed. The result agreed with 1.476 reported (Ren, 2010) for crude sunflower oil. There was no significant difference in the refractive index of all the oils shown in the Table which suggests similarity in the degree of flow or thickness of the two olein samples at room temperature as earlier indicated (Nkafamiya et al., 2010).

Table 1. Physico-chemical composition of shea butter and olein from Kishi town, Oyo state.

Sample	Free fatty acid (%)	Peroxide value (mEq/kg)	Iodine value (g/100g)	Saponification value (mgKOH/g)	Moisture content (%)	Insoluble impurities (%)	Spe gravi
LSO	2.73^{a} ±0.03	4.64^{a}±0.05	54.36^{b}±0.23	151.48^{b}±0.48	0.20^{a}±0.11	0..00±0.00	0.95
ISO	2.01^{b} ±0.01	2.71^{b}±0.01	59.32^{a}±1.11	136.68^{d}±0.20	0.20^{a}±0.01	0.00±0.00	0.94
LSB	2.80^{a} ±0.17	1.88^{c}±0.04	53.19^{b}±2.81	165.53^{a}±0.25	0.40^{a}±0.10	0.40^{a}±0.02	0.96
ISB	2.06^{b} ±0.03	1.02^{d}±0.03	56.41^{ab}±2.07	150.82^{c}±0.10	0.20^{a}±0.05	0.20^{a}±0.01	0.95
SEM	0.06	1.87	1.13	0.17	0.02	0.01	2.

Values with the same superscripts in the same column are not significantly different (P<0.05). LSO, Local shea olein; ISO, improved shea olein; LSB, Local shea butter; LSB, Local shea olein;

SEM, Standard error of mean.

Moisture content

Moisture contents of local and improved shea butter samples obtained ranged from 0.20 to 0.40 % as shown in Table 1. There were no significant differences (P<0.05) in moisture content of ISB and LSB samples. The moisture content for grade 3 shea butter under the Regional Technical Committee Standard for shea butter (RTC, 2006) was 0.2 - 2.0%. Therefore, LSB and ISB were found to be of the same quality in terms of moisture. The moisture content of the improved shea olein is shown in Table 1. The moisture content of the local shea olein LSO and improved shea olein ISO were not significantly different (P≤ 0.05). According to the codex standard (Codex, 1999) for crude vegetable oil, moisture content is 0.2% at maximum. Therefore, the moisture of the two shea butter olein samples, being 0.2% signifies that the values were within the acceptable limit and hence may be a good starting material for vegetable oil.

Insoluble impurities

In this study, the observed insoluble impurities of ISB and LSB ranged from 0.20 -0.40% as shown in Table 1. The ISB had 0.2±0.00% LSB contained 0.4±0.00%. The moisture content and insoluble impurities were consistent in the ISB and LSB samples. With these results, the LSB was in grade 3 category while the ISB grade 2 of the Regional Technical standards, 2006.

The value range of 0.2 - 0.4% obtained was higher than 0.12 - 0.15% reported by Nahm (2011) for seven shea butter samples from Ghana. Insoluble impurities include dirt and other foreign materials (Hamilton and Rosell, 1986). Some of these impurities could arise from machinery involved in the processing of shea butter as well as from physical contact with the soil and packaging materials. Along with moisture content, the amount of insoluble impurities is another important quality parameter which determines deterioration of shea butter since metals (particularly iron) could accelerate oxidation of shea butter thereby decreasing its market value (Nahm, 2011).

The moisture content of the improved shea olein is shown in Table 1. The ISO and LSO had 0.2%. The moisture content of the Local shea olein LSO and improved shea olein ISO were not significantly different (P> 0.05). A maximum moisture content of 0.2% is considered appropriate by the codex standard (1999) for crude vegetable

oil. Therefore, the moisture of the two shea butter olein samples, being 0.2% signifies that the values were within the acceptable limit and could therefore be a good starting material for vegetable oil.

Free fatty acids

The free fatty acid content of two shea butter samples is shown in Table 1. The improved shea butter ISB had 2.06% while 2.80% was obtained from the local shea butter LSB. The amounts of free fatty acids were found to vary significantly among the samples ($P<0.05$). The obtained values indicated that the shea kernels used in producing LSB were not well dried, which resulted in higher free fatty acid and this could probably lead to poor quality of the butter (Laurssen, 2002)

The higher moisture content could promote greater hydrolysis leading to the formation of free fatty acid (Nahm, 2011).

Free fatty acid content of both local and improved shea olein were reported in Table 1. The free fatty acid of the local shea olein LSO was 2.73±0.03% and that of the improved shea olein was 2.01±0.01%. The values were significantly different ($P<0.05$) as shown in Table 1. The free fatty acid content of LSO was higher than ISO. Aluyor et al. (2009) observed an equivalent value of 2.82% in crude groundnut oil. Earlier report by Nkafamiya et al., 2010, recorded values between 1.55 -3.95% for free fatty acid in crude oil from different species of groundnut. This suggests that the starting material for the production of LSO contained higher impurities which could cause hydrolysis of ester linkage thereby increasing the free fatty acid level.

Peroxide value

The peroxide value of shea butter and olein is shown in Table 1. The ISB contained 1.02 mEqO2/kg while LSB had 1.88 $mEqO_2/kg$. The peroxide value of ISB (1.02±0.03 mEqO2/kg) was significantly lowered ($p<0.05$) compared with LSB (1.88±0.04 $mEqO_2/kg$). The peroxide values observed for both LSB and ISB were lower than reported 2.15 - 15.32 $mEqO_2/kg$ (Nahm, 2011). The Regional Technical Committee Standard for shea butter samples established 0 - 10.0 for grade one; >10 -15 for grade two and >15.0 - 50.0 for grade three. The peroxide value of the two samples were within grade one by Regional Technical Committee Standard (RTC, 2006).

The peroxide values obtained for ISO and LSO is shown in Table 1. The peroxide value of the improved shea olein was 2.71±0.01 mEq/kg and that of the local shea olein was 4.64±0.05 mEq/kg. The peroxide value of LSO was higher than that of the ISO. However, the values were still within the permissible level recorded in Codex Alimentarious specification of ≤10 for crude edible vegetable oil (Codex, 1999). These values revealed that the rate of peroxidation was higher in LSO than ISO.

Iodine value

The iodine value of the test shea butter and shea olein samples are shown in Table 1. The iodine value of the LSB was 53.19±2.81 g/100 g and that of the ISB was 56.40±2.07 g/100 g. The iodine values of the two samples were similar ($P>0.05$). The values agreed with the standard specified 50-60 g/100 g for shea butter in Nigeria, Ghana and Benin in the regional standard for shea butter (RTC, 2006). Hence the two shea butter samples were of good quality in terms of iodine value. Asuquo et al. (2010) observed a higher value of 63.45 g/100 g from shea butter on Kano state. Omujal (2010) reported a lower value of 36.60-41.37 g/100 g in Ugandan shea butter oil. The low iodine value for shea butter oil indicates that the oil is rich in saturated fatty acids, which ensures stability against oxidation and rancidification of foods prepared with the oil (Goh, 1994).

The iodine value of local shea olein LSO was 54.36±0.23 mg/100 g while that of the improved shea olein ISO was 59.32±1.11 mg/100 g. The iodine values of the two shea olein were not significantly different ($P>0.05$). Achinewhu and Akpapunam (1985) observed a lower iodine value (37.15 mg/100 g) in bread fruit seed oil. A reported value of 46.88 - 97.13 mg/100 g was obtained from crude oil of different species of groundnut (Nkafamiya et al., 2010). The codex standard was ≥56 for crude palm olein used as a starting material for refined

bleached deodorized palm olein. Therefore, the improved shea olein with iodine value of 59.32 g/100 g met this standard judging from the results.

Saponification value

The saponification values of both the Local and improved shea butter and olein are shown in Table 1. The saponification values (mg KOH/g) of local shea butter, LSB (165.53±0.25) and ISB (150.82±0.10) were significantly different ($p<0.05$). A range of 160.35-190.15 mg KOH/g was documented for shea samples (Omujal, 2009). This was lower than the set value (170-190 mg KOH/g) in the regional standard for shea butter (RTC, 2006). Mbaiguinam et al. (2007) observed a range of value (175.51-184.89) that is within this standard when assessing the physical and chemical characteristic of shea butter obtained by improved traditional processing method from Mandoul region of Southern Chad The higher saponification value observed in local shea butter was indicative of the levels of rancidity (Nkafamiya et al., 2010).

The saponification value of local and improved shea olein were significantly different ($P<0.05$). The saponification value of improved shea olein ISO was 136.68 mg KOH/g and that of the local shea olein was 151.48 mg KOH/g. These values were within the range of 125.33-151.33 mg KOH/g obtained by Babalola and Apata (2011) for shea butter oil, palm oil, soybean oil and sunflower oil. Ren (2010) obtained a higher saponification value of 193.65 mg KOH/g) in crude sunflower oil, while a range of 178-247 mg KOH/g was obtained by Onwuliri et al. (2011) in crude olive seed oil and coconut oil. The results obtained were within the permissible level set by codex standard for crude vegetable oil.

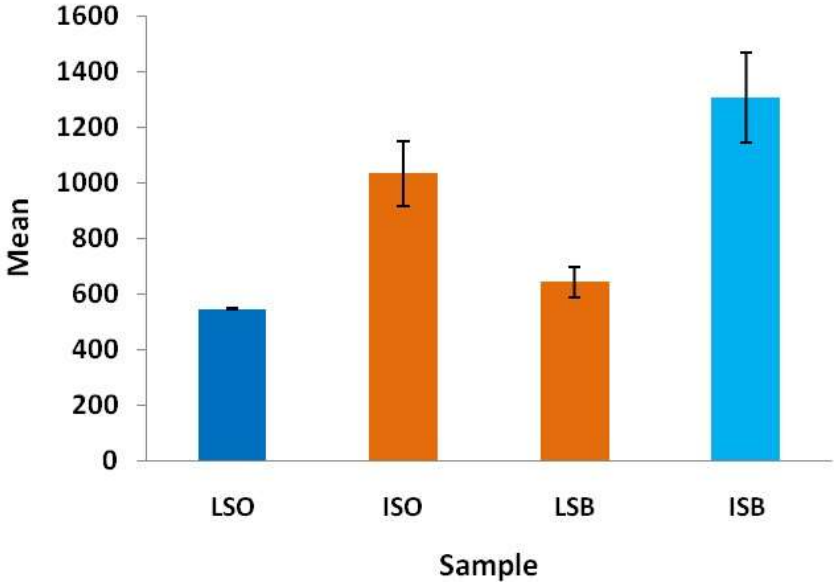

Figure 3. Mean tocopherol content of local and improved shea butter and olein.LSB, local shea butter; ISB, mproved shea butter, LSO, local shea olein; ISO, improved shea olein.

α-Tocopherol

The α-tocopherol composition of the local and improved shea butter and olein is shown in Figure 1. The α-tocopherol content of the improved and local shea butter varied significantly ($P<0.05$). The improved shea butter contained 1,306.73 mg/kg while the local shea butter had 642.34 mg/kg. Maranz et al. (2004) reported α-tocopherol as the dominant (64%) form tocopherol present in the improved and local shea butter. The observed

difference may be due to genetic influence as reported (Maranz et al., 2004) as one of varying factors of α-tocopherol content.

The result of the α-tocopherol content of lSO and LSO is shown in Figure 3. The improved shea olein ISO contained 1,033.95 mg/kg while local shea olein had 545.29 mg/kg. The α- tocopherol of the improved and local shea olein were significantly different ($P<0.05$). This result showed that larger percentage of the α-tocopherol in shea butter was resident in shea olein. Okullo et al. (2010) reported a low value (263-444 mg/kg) for shea oil obtained from Pader and katakwi districts in Uganda. The α-tocopherol content of palm olein used for the production of vegetable oil ranged between 30 to 280 mg/kg according to CODEX (1999). This showed that the two shea olein samples had higher α-tocopherol content than palm olein and shea oil from Uganda in East Africa. It was discovered that tocopherol always increases with temperature during seed maturation and also drought (Kornsteiner et al., 2005). Hence, high values of tocopherol obtained in the two olein samples could be as a result of high temperature that is predominant in Nigeria.

α-Tocopherol can be responsible for reducing degenerative diseases and also for mopping up free radicals responsible for oxidative damage of cell membrane (Kornsteiner et al., 2005). In view of these facts, α-tocopherol plays vital role in human diets, nutrition and in health.

Fatty acid composition

The fatty acids composition of the local and improved shea butter and olein is shown in Table 2. The fatty acid methyl esters (FAMEs) in triacylglycerides of improved and local crude shea butter were not significantly different ($p>0.05$). The improved shea butter contained 48.22% saturated fatty acids; 43.93% monounsaturated fatty acids and 7.96% polyunsaturated fatty acids of which 7.84% was omega-6 fatty acid and 0.13% omega-3 fatty acids. LSB contained 48.22% saturated fatty acids; 43.88% monounsaturated fatty acids; 7.57 polyunsaturated fatty acids of which 7.45% was omega 6 and 0.11% omega 3. This result was similar to those documented for shea butter by regional Technical Committee (RTC, 2006) and similar observation in seven shea butter samples from West Africa (Nahm, 2011).

As shown in Table 2, fatty acid methyl esters found in local and improved shea olein were not significantly different ($p>0.05$). The saturated fatty acids in ISO were 47.56%, 44.47% of monounsaturated fatty acids and 8.06% of polyunsaturated fatty acids of which 7.69% was omega 6 fatty acid and 0.37 was omega 3 fatty acids. Local shea olein contained 49.93% saturated fatty acid; 42.93% monounsaturated fatty acids and 7.51% polyunsaturated fatty acids of which 7.20% was omega 6 fatty acids and 0.31% was omega 3.

As shown in Table 2, the fatty acid profile of the two shea olein samples indicated they were similar to palm olein. According to codex standard (CODEX, 1999), the percentage saturated fatty acids of palm olein ranges from 42.10 to 51.30%; 39.37 to 47.70% for monounsaturated fatty acids and 10 to 14.10% for polyunsaturated fatty acids. The difference in the fatty acid composition of the local and improved shea olein compared to palm olein was with respect to polyunsaturated fatty acids. The polyunsaturated fatty acids especially, linoleic acid (C18:2) ranged from 5.32% in local shea olein to 5.87% in improved shea olein, while palm olein had 10.0 to 13.50%. This showed that linoleic acid of palm olein doubled that of both shea olein samples. This content of fatty acid also revealed the physical state of oils at room temperature (Lin, 2002). Therefore, they tend to solidify on prolong standing at room temperature.

Table 2. Fatty acid composition of local and improved shea butter and olein from Kishi, Oyo state.

Fatty acids	LSB	ISB	LSO	ISO
Saturated				
C16:0	3.17^{a}±0.25	3.23^{a}±0.01	3.28^{a}±0.04	3.14^{a}±0.05
C18:0	43.60^{a}±0.75	42.99^{a}±0.43	42.52^{a}±0.29	39.03^{b}±1.32
C20:0	ND	0.08^{a}±0.01	0.40^{b}±0.02	0.20^{a}±0.00
C22:0	1.46^{a}±0.54	1.93^{a}±0.16	3.73^{b}±0.03	5.19^{a}±0.07
Monounsaturated				
C18:1	43.72^{a}±0.10	43.54^{a}±0.16	42.59^{a}±0.54	43.87^{a}±0.93
C22:1	0.12^{a}±0.01	0.22^{a}±0.05	0.22^{a}±0.04	0.18^{a}±0.03
C24:1	0.09^{a}±0.15	0.13^{a}±0.03	0.13^{a}±0.01	0.39^{a}±0.15
Polyunsaturated				
C18:2n6c	5.61^{a}±0.10	5.92^{a}±0.53	5.32^{a}±0.19	5.87^{a}±0.22
C18:3n6	1.84^{a}±0.03	1.92^{a}±0.06	1.87^{a}±0.05	1.82^{a}±0.03
C20:5n3	0.12^{a}±0.12	0.13^{a}±0.06	0.31^{a}±0.02	0.37^{a}±0.10
Total Saturated	48.22^{a}±0.17	48.23.^{a}±0.24	49.93^{a}±0.18	47.56^{a}±0.20
TotalMonounsaturated	43.93^{a}±0.17	43.88^{a}±0.24	42.93^{a}±0.07	44..47^{a}±0.18
Total Polyunsaturated	7.57^{ab}±0.15	7.96^{a}±0.06	7.51^{a}±0.13	8.06^{a}±0.02

Values with the same superscripts in the same row are not significantly different (P>0.05). N.D, Not detectable; LSB, local shea butter; ISB, improved shea butter, LSO, local shea olein; ISO, improved shea olein.

Conclusion

In conclusion, improved shea butter and olein were of relatively higher quality compared with the corresponding local shea butter and olein. This reveals the need to improve the traditional method of processing shea butter by aligning with the code of practice of shea kernel and shea butter as suggested by the African Organization for Standards.

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interest.

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