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Physico-Chemical Properties of Locally Processed Shea Butter (*Vitellaria paradoxa*) from Parts of Niger State, Nigeria.

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Abstract

The suitability of shea butter as a dietary fat is greatly influenced by its physicochemical parameters as well as fatty acid composition. Thus, the present study was conducted to assess the physicochemical and fatty acid composition of shea butter sampled from three vegetational zones; Zone A (Agaie and Lapai Local Government Areas Coordinates) Zone B (Suleja and Gurara Local Government Areas) Zone C (Kontagora and Magama Local Government Areas in Niger State. The physicochemical parameters which include; colour, moisture, pH, oil yield, acid value, peroxide and saponification were analyzed according to standard methods. Results obtained showed that the colour of the shea butter from the 3 zones were orange/yellow. Moisture content ranged between 2.07±0.21 and 2.40±0.21; pH values ranged between 5.27±0.14 and 5.34±0.14; Oil yield ranged from 52.76±4.27 and 56.12±4.27; Acid values ranged from 2.47±2.61 to 3.77±2.61. Saponification ranged between 183.51±0.09 and 193.57±0.09; Peroxide values ranged between 0.54±0.38 and 1.04±0.38 respectively. There were significant and non-significant differences in the values of all the physicochemical parameters sampled from the 3 zones ($p<0.05$). Fatty acid composition revealed that the values of Oleic, linoleic, palmitic and arachidic ranged between 48.65±1.23 and 52.78±0.74; 7.24±1.21 and 8.30±1.30; 6.43±0.24 and 7.35±1.26; 0.63±0.11 and 0.84±0.08 respectively. The parameters assessed compared favourably with the reports from previous studies, indicating that the shea butter could serve as a source of food to the rural dwellers.

Keywords: Fatty acid, Locally processed, Niger state, Physicochemical parameters, Shea butter

INTRODUCTION

Shea butter is becoming more and more popular worldwide as a cocoa butter substitute in the culinary, cosmetics, and pharmaceutical industries (Okullo *et al*., 2010; Alena *et al*., 2014). In order to meet the high criteria set by industrialized nations in the global shea butter trade, producing nations must create better production guidelines for higher-quality shea butter products. Shea butter which is the fat extracted from the seeds of the shea tree is indigenous to sub-Saharan Africa and grows from Guinea Bissau in West Africa to Ethiopia in the East. The northern region of Nigeria, particularly the states of Bauchi, Niger, Kwara, Adamawa, and Kaduna, is where the tree is most prevalent. It can be found in Oyo, Ibadan, and Abeokuta in Western Nigeria. It is mostly found in Ogoja Province in Eastern Nigeria (Adgidzi, 1999).

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Native Africans have long used shea for a variety of traditional purposes in food, medicine, and personal hygiene items. In recent years, Western businesses and consumers have been more interested in shea. The butter extracted from shea nuts is used to treat a variety of skin diseases, as well as body and hair creams and as a replacement for cocoa butter in confectionary industries. It is also used in traditional medicine to treat conditions related to stomach pains and infections, to aid in childbirth, and to stimulate lactation (Ndukwe *et al*., 2005; Bum *et al*., 2011; Usman *et al*., 2014; Zhang *et al*., 2014).

Shea butter is primarily extracted by the conventional boiling (cold press) technique, which involves roasting, pressing the nuts, churning the liquid with water, boiling, sifting, and then cooling. The physicochemical properties of shea butter have been found to vary depending on how it is processed and packaged (Leakey *et al*., 2005; Womeni *et al*., 2006; Suleiman, 2008). However, the United States Agency for International Development (USAID, 2004) notes that genetic variations and environmental influences also play a role in shea butter variations. Thus, the aim for the present study.

MATERIALS AND METHODS

Sample collection and preparation

The Shea nut was randomly collected from three vegetation zone of Niger state, Zone A (Agaie and Lapai Local Government Areas Coordinates; 9^{o} 02' 60.00'' N 6^{o} 33' 59.99''E). Zone B (Suleja and Gurara Local Government Areas Coordinates; 9^{o} 10' 50.12'' N 7^{o} 10' 45.80'' E). Zone C (Kontagora and Magama Local Government Areas Coordinates; 10^{o} 28' 0.01'' N 5^{o} 02' 60.00'). Five kilograms of shea fruits were randomly collected from under the different shea trees in each district. Ripe fresh shea fruits were handpicked, left to ferment for 3 days at ambient temperature (26 ± 20 ^{o}C) washed, parboiled, sundried, weighed, cracked, winnowed and further dried. The fruits were then stored in a dark cool box at 4 ^{o}C and transported to the laboratory for analysis.

Method of Solvent extraction

Five kilograms of clean, dehusked wet shea kernels were sundried at normal temperature of 37 ^{o}C for five days. The dried shea kernels were handpicked to remove the rotten ones. Thereafter, they were crushed and milled using a mortar and pestle. The milled shea nuts were extracted using hexane (2.5 litres) in a soxhlet apparatus (Konte USA) for 6 hours at 60°C. The oil was obtained after evaporating over water bath at 70^{o}C to remove excess solvent, dried in an oven and cooled in the desiccators and then re-weighed to determine the amount of oil extracted (Warra, 2015; Seweh *et al*., 2016).

Determination of the physicochemical properties of shea butter

Degumming and purification, moisture content determination, pH determination, acid value determination, free fatty acid determination, saponification value determination, peroxide value determination was carried out according to methods described by Akpan *et al*. (2005).

Statistical analysis

Descriptive analyses (mean, standard error) was employed for the analyses. The difference between the means were determined using Least significance difference (LSD). All analysis were carried out using SPSS.

RESULTS

Physico-chemical properties of shea butter sampled from parts of Niger State

The physicochemical properties of shea butter from parts of Niger State is presented in Table 1. The colour of the shea butter were orange/yellow. Moisture content ranged between 2.07±0.21 and 2.40±0.21; pH values ranged between 5.27±0.14 and 5.34±0.14. there were no significant differences in the pH and moisture values in the samples analyzed ($p<0.05$). the oil yield ranged from 52.76±4.27 to 56.12±4.27. There were significant differences in the value of oil yield sampled from the 3 zones. Acid values ranged from 2.47±2.61 to 3.77±2.61. There were significant differences in the values of acid values sampled from zone A compared to zone B and C. however, no significant differences in the values sampled from zone A and C. Saponification values ranged between 183.51±0.09 and 193.57±0.09. significant differences were observed in the saponification values sampled from zone A compared to B and C. However, no significant differences were observed in the value sampled from zone B and C. Peroxide values ranged between 0.54±0.38 and 1.04±0.38. significant differences in the values sampled from zone A compared to zone B and C. however, no significant differences was observed in the values sampled from zone B and C compared to A.

Table 1. Physicochemical properties of shea butter sampled from parts of Niger State

Physicochemical parameters	Zones		
	A	B	C
Colour	Orange/ Yellow	Orange/ Yellow	Orange/ Yellow
Moisture content	2.40±0.21^{a}	2.20±0.21^{a}	2.07±0.21^{a}
pH	5.27±0.14^{a}	5.34±0.14^{a}	5.28±0.14^{a}
Oil yield	52.76±4.27^{c}	53.58±4.27^{b}	56.12±4.27^{a}
Acid values (mgKOH/kg)	3.61±2.61^{b}	2.47±2.61^{a}	3.77±2.61^{b}
Saponification values (mgKOH/g)	193.57±0.09^{a}	183.54±0.09^{b}	183.51±0.09^{b}
Peroxide values (mEq/kg)	1.04±0.38^{a}	0.60±0.38^{b}	0.54±0.38^{b}

Mean with the same superscript along a row are not significantly different ($p<0.05$)
Key: A=Agaie & Lapai; B = Suleja & Izom; C = Kontagora & Magama

The fatty acid composition of shea butter is presented in Table 2. The values of the four fatty acid acid analysed (Oleic, linoleic, palmitic and arachidic) ranged from 48.65±1.23 to 52.78±0.74; 7.24±1.21 to 8.30±1.30; 6.43±0.24 to 7.35±1.26; 0.63±0.11 to 0.84±0.08 respectively. There were significant and non-significant differences in the values of the fatty acid sampled from the 3 zones.

Table 2. Free fatty acid profiles of shea butter sampled from parts of Niger State

Fatty acid (%)	Zones		
	A	B	C
Oleic	48.65±1.23^{a}	52.78±0.74^{b}	50.87±0.97^{c}
Linoleic	8.30±1.30^{a}	7.40±0.94^{b}	7.24±1.21^{b}
Palmitic	6.78±0.15^{a}	7.35±1.26^{b}	6.43±0.24^{a}
Arachidic	0.74±0.13^{a}	0.84±0.08^{b}	0.63±0.11^{c}

Mean with the same superscript along a row are not significantly different ($p<0.05$)
Key: A=Agaie & Lapai; B = Suleja & Izom; C = Kontagora & Magama

DISCUSSION

The most crucial factor to take into account with the developing global shea oil market is its oil yield, or fat content. In Niger State, the oil yield from shea kernels ranged from 56% to

52% depending on the zone. For any zone, a shea oil output content of more than 40% is still considered good. This suggested that shea oil, which can be used as vegetable oil, can be readily produced from the seeds. Di-Vincenzo *et al*. (2005) suggested that environmental influences, geographic location, agronomic factors, and genetic diversity could be responsible for the difference in the shea oil concentration of samples from the different shea zones. The zone C samples' high shea oil concentration may have resulted from their early fruiting during the dry season, which runs from December to February and has temperatures between 31 and 35^{o}C. High shea kernel oil content is also correlated with cold temperatures and high elevations (Maranz and Weisman, 2003).

The amount of potassium hydroxide (MgKOH) needed to neutralize the free acids in one gram of oil or fat is known as the acid value. The study's shea oil acid value is typical of samples taken from a variety of trees. Early germination might raise the amount of free fatty acid in shea oil due to the refractory character of shea fruits. If the acidity of an oil is more than 2 MgKOH g-1 oil, it is deemed acidic (FAO, 1979) The present study reported an acid value of more than 2 MgKOH g-1. Which means that the shea oil reported in this study is acidic. Nonetheless, since groundnut oil, which has an acid value of 4 mg KOH g-1 oil, is widely consumed, shea butter's acidity may not be hazardous to the body.

According to Shahidi (2005), saponification value is a measurement of the alkali-reactive groups found in fats and oils. Its definition is the quantity of potassium hydroxide (mgKOH) in milligrams needed to neutralize the fatty acids in one gram of fat or oil. The shea butter sampled for this investigation has saponification values that are within the necessary range of 180–360 mgKOH/g as reported by Munir *et al* (2012). These results are comparable to those that Saba *et al*. (2018) and Enweremadu and Datti *et al*. (2020) have reported. A high saponification value suggests that the oil is suitable for making soap.

The first byproduct of unsaturated fat oxidation is peroxide; fresh oil has a peroxide value (PV) of less than 10 meq O_2/kg, whereas rancid oil has a PV of 20 to 40 meq O_2/kg. The study's stated peroxide value was less than 10, suggesting that the shea butter oil was still fresh. This also agrees with what Saba *et al.* (2018) found.

When oil and fats hydrolyze due to changes in temperature, moisture content, and time, free fatty acids (FFAs) are created. According to Mahesar *et al*. (2014), FFAs are more prone to oxidation and turning rancid because they are less stable than neutral oil. These are foul-smelling materials that irritate the throat and tongue. Depending on their concentration, they render oil unfit for human consumption. If they happen in small quantities, their impact can go unnoticed. Tight seed harvesting and storage helps maintain low FFA levels in crude oil. The results exceeded the findings of earlier studies by Munir *et al*. (2012) and Animasaun *et al*. (2019), who reported 4.21 and (5.32 - 6.60) respectively. The observed variations can be explained by the fact that the length of storage, type of packaging, processing, moisture content, shea nut fruit germination stage, and overall climate all have an impact on the free fatty acid content of shea butter (Mahesar *et al*., 2014).

The values of oleic acid in the present study fall within the range of values (37% and 55%) reported by (Maranz *et al*., 2004). This is also similar with the findings of previous studies (Okullo *et al*., 2010). Consumption of monounsaturated fatty acids such as oleic acid (>55% in shea oil) is believed to be beneficial in reducing blood levels of low-density lipoprotein (LDL) cholesterol ("bad" cholesterol), hence lowering the risk of coronary heart diseases now on the increase among urban populations in developing countries such as Nigeria.

Linoleic acid is an essential fatty acid that is vital in nutrition because of its un-saturation. The linoleic acid value content of 6-8% makes shea oil a moderate source of essential fatty acids in the human diet. This is in line with the findings of the present study as the values of linoleic acid were within this range. In addition, linoleic acid can be used to synthesize arachidonic acid and other biologically important compounds in most mammals including humans (Diaz *et al*., 2006).

CONCLUSION

The physicochemical properties of shea butter analyzed in this study compared favourably with the reports of previous studies. The results however, revealed significant and non significant differences in the oil yield, acid value, saponification and peroxide values in all samples analyzed. Which requires further investigation as regards to the handling of the shea oil. The fatty acid composition indicates that it could serve as a source of food, soap, cosmetic product as well as essential fatty acid to the rural dwellers.

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