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Studies on the Physico-Chemical Variation of Shea Nuts/Butter

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Abstract: *The present study was aimed at determining the variations in the physico-chemical properties of shea nuts/butter of Ngaski (NA/A), Bosso (NB/B) and Yamaltu-Deba (NC/C) local government areas of Nigeria. The colour of the sheanuts from the present study ranges from dark to dirty brown, with NA having the highest concentration of Cu and Pb elements and NB with the lowest concentration of Pb and Ni with K, Fe and Zn while Ca, Na and Ni were significantly higher in sheanuts NC. Percentage yield of the B is at 35.00%, A at 34.50% and 25.11% for C. The colours of the shea butter ranges between creamy white for A, brown with white patches for B and golden for that of C. There was no significant difference in the moisture contents of the shea butters A and C. The iodine values for the shea butters was between the ranges of 19.13 ± 0.12^{a} mg/g to 56.51 ± 0.29^{c} mg/g with significant difference between all the three samples. The saponification values of the shea butter varied significantly across the study areas with shea butter A having the highest value at 180.28 ± 0.26^{c} mg KOH/g and the lowest 120.84 ± 0.78^{a} mg KOH/g for C. The peroxide values of B and C are at 0.75 ± 0.01^{a} meqO_2/g and 0.80 ± 0.01^{a} meqO_2/g with no significant differences. The variations in the shea nuts and butter can be attributed to the geographical locations and genetic makeup of the plant.*

Keywords: *Vitellaria paradoxa, Shea nuts, Shea butter, Physico-chemical*

INTRODUCTION

Shea tree (*Vitellaria paradoxa* Gaertn.) belongs to the family sapotaceae comprising of two subspecies *Vitellaria paradoxa* found in West Africa and *Vitelleria nilotica* East Africa (Hall *et al.*, 1996). It is a multipurpose plant that serve as food, medicine and source of income especially for the rural population for centuries (Lovett and Haq, 2000; Oluwole *et al.*, 2004). The plant parts are used in traditional medicine to treat ailments associated with stomach pains and infection, to facilitate childbirth and stimulate lactation while the butter extracted from the shea nuts are used for treatments of various skin diseases, as body and hair creams and as substitute for cocoa butter in the confectionary inducstries (Ndukwe *et al.*, 2005; Bum *et al.*, 2011; Usman *et al.*, 2014; Zhang *et al.*, 2014).

The variation in the physico-chemical properties of shea butter have been attributed to the different methods of processing and packaging of the butter (Leakey *et al.*, 2005; Womeni *et al.*, 2006; Suleiman, 2008), but United State Agency for International Development (USAID, 2004) states that variations in shea butter is also attributed to environmental influence and genetic variations. Thus, the aim for the present study.

Materials and Methods

Collection, Identification and Preparation of the Plant Material

The already boiled and air dried shea nuts were collected from the locals between the months of August-September, 2018 from three locations namely; Ngaski (Latitude 11° 14'-12° 39' North; Longitude 5° 18'-18° 20'), Bosso (Latitude 9° 31'-9° 40' North; Longitude 6° 29'-6° 35') and Yamaltu-Deba (Latitude 10° 18'-10° 30' North; Longitude 11° 20'-11° 40'), Nigeria. The plant materials along were transported to the Herbarium unit of the Department of Botany, Ahmadu Bello University, Zaria of which voucher number 900148 was assigned.

Organoleptic and Elemental Analysis of the Shea Nuts

Colour

The nuts each from the three sample areas were examined under diffuse daylight (WHO, 2011).

Size

The length and width of the nuts (100) each from the three sample areas were taken using a vernier caliper (Onyekwelu *et al.*, 2014).

Elemental Analysis of the Shea nuts

The elemental analysis in the Department of Soil Science, Faculty of Agricultural Sciences, Ahmadu Bello University, Zaria. The elements analysed were calcium (Ca), potassium (K), sodium (Na), Iron (Fe), Manganese (Mn), copper (Cu), zinc (Zn), cadmium (Cd), lead (Pb) and nickel (Ni) using Buck scientific model 210VGP Atomic Absorption Spectrophotometer (Kawo *et al.*, 2013).

Physical and Chemical Properties of the Shea Butter

Solvent Extraction of Shea Butter

The dried shea kernel collected was handpicked to remove the rotten ones. Crushing of the kernel to collect the nuts and milling with mortar and pestle was carried out. The milled shea nuts (1600g) 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°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 Physiso-chemical parameters

The percentage yield, sensory characteristics, moisture contents, specific gravity, saponification values, iodine values and peroxide values were determined (AOAC, 2000; Akpan *et al.*, 2006; Warra *et al.*, 2013; Julius *et al.*, 2013).

Statistical Analysis

Means and standard deviation were computed. Duncan multiple range test was used to compare the mean variance with significance level at $P < 0.05$.

Results

The colour of the nuts NA are light to dark brown with the light brown nuts having networks. The shea nuts NB are dirty brown in colour while NC are dark brown with light brown networks (Table 1).

Table 1: Colours and Odours of Sheanuts from the Three Study Areas

S/no.	Sample	Colour	Odour
1	NA	Light to dark brown with networks	Characteristics
2	NB	Dirty brown	Characteristic
3	NC	Dark brown with light brown networks	Characteristic

Key: NA- Sheanuts from Ngaski, NB-Sheanuts from Bosso, NC-Sheanuts from Yamaltu-Deba

NA NB NC

Figure 1: Pictures of NA- Sheanuts from Ngaski, NB-Sheanuts from Bosso, NC-Sheanuts from Yamaltu-Deba

Results of the shea length and width showed that NC with mean length of 3.80 ± 0.69^{c} issignificantly longer in length than NA with mean length of 3.24 ± 1.58^{b}, and the least in length NB with mean length of 2.41 ± 0.58^{a} (Table 2). For the mean width NA had the highest value of 2.04 ± 0.83^{b} although with no significant difference to that of NC with mean length of 1.92 ± 0.56^{b}. Both the sheanuts NA and NC were significantly higher than that of NB with mean width of 1.67 ± 0.42^{a} (Table 2).

Table 2: Length and Width of the Sheanuts from the Three Study Areas

S/no	Sample	Mean Length (cm)	Mean Width (cm)
1	NA	3.24 ± 1.58^{b}	2.04 ± 0.83^{b}
2	NB	2.41 ± 0.58^{a}	1.67 ± 0.42^{a}
3	NC	3.80 ± 0.69^{c}	1.92 ± 0.56^{b}

Key: NA-Sheanuts from Ngaski, NB-Sheanuts from Bosso, NC-Sheanuts from Yamaltu-Deba

The results from the elemental analysis revealed there was variation between the nuts across the study areas. Sheanuts NA had the highest concentration of Cu and Pb which were significantly higher than NB and NC, and also the lowest concentration of Ca, Na, Fe and Zn which were all significantly lower than the contents of the other nuts. Sheanuts NB had the lowest concentration of Pb and Ni with K, Fe and Zn significantly higher than the concentrations of the other nuts. The concentrations of Ca, Na and Ni were significantly higher in sheanuts NC, while K and Cu were significantly lower when compared to the concentration recorded from the other nuts. Mn concentration was not significantly different across the sheanuts while no Cd in all the samples (Table 3).

Percentage yield of the shea butter extracted from the shea nuts of NB had the highest yield at 35.00%. This was followed by the shea butter NA at 34.50% and the least percentage yield was recorded from the sheanuts NC at 25.11% (Table 4). The colours of the shea butter extracted from the three study areas ranges between creamy white for A, brown with white patches for B and golden for that of C. All the shea butters have smooth textures with characteristic smell that was stronger in that of A (Table 4, Figure 2). The moisture contents of the shea butters from the three areas showed no significant difference between the shea butter A and C which were higher at 9.01 ± 0.68^{b} and 9.03 ± 0.2^{b} respectively, having significant difference to the moisture content of B at 5.11 ± 0.24^{a} as in Table 4. The iodine values for the shea butters was between the ranges of 19.13 ± 0.12^{a} mg/g to 56.51 ± 0.29^{c} mg/g with significant difference between all the three samples. Shea butter A had the highest iodine value at 56.51 ± 0.29^{c} mg/g. This was followed by that of B at 28.59 ± 0.37^{b} mg/g and the least is that of C at 19.13 ± 0.12^{a} mg/g (Table 4). The saponification values of the shea butter varied significantly across the study areas with shea butter A having the highest value at 180.28 ± 0.26^{c} mgKOH/g. This was followed by that of B at 139.94 ± 0.78^{b} mgKOH/g and the lowest was that of C at 120.84 ± 0.78^{a} mgKOH/g (Table 4). There was no significant difference between the peroxide values of shea butter B and C at 0.75 ± 0.01^{a} $meqO_2/g$ and 0.80 ± 0.01^{a} $meqO_2/g$ respectively, but they were significantly lower than the peroxide values of the shea butter from A at 0.96 ± 0.07^{b} $meqO_2/g$ (Table 4).

Table 3: Elemental Analysis of the Sheanuts from the Three Study Areas

S/no	Elements	Absorbance (mg/g)
1	Potassium (K)	
	NA	20.07 ± 0.01^{b}
	NB	27.50 ± 0.01^{c}
	NC	11.87 ± 0.01^{a}
2	Calcium (Ca)	
	NA	4.77 ± 0.01^{a}
	NB	5.85 ± 0.05^{b}
	NC	6.77 ± 0.02^{c}
3	Sodium (Na)	
	NA	0.16 ± 0.01^{a}
	NB	0.24 ± 0.01^{b}
	NC	0.65 ± 0.01^{c}
4	Iron (Fe)	
	NA	0.81 ± 0.01^{a}
	NB	1.00 ± 0.01^{c}
	NC	0.94 ± 0.01^{b}
5	Manganese (Mn)	
	NA	0.07 ± 0.01^{a}
	NB	0.07 ± 0.01^{a}
	NC	0.07 ± 0.01^{a}
6	Copper (Cu)	
	NA	0.05 ± 0.01^{c}
	NB	0.04 ± 0.01^{b}
	NC	0.03 ± 0.01^{a}
7	Zinc (Zn)	
	NA	0.07 ± 0.01^{a}
	NB	0.65 ± 0.01^{c}
	NC	0.21 ± 0.01^{b}
8	Lead (Pb)	
	NA	0.17 ± 0.01^{c}
	NB	0.13 ± 0.01^{a}
	NC	0.14 ± 0.01^{b}
9	Nickel (Ni)	
	NA	0.06 ± 0.01^{b}
	NB	0.03 ± 0.01^{a}
	NC	0.13 ± 0.01^{c}

Keys: NA-Sheanuts from Ngaski, NB-Sheanuts from Bosso, NC-Sheanuts from Yamaltu-Deba

Table 4: Physico-Chemical Properties of the Shea Butter from the Three Study Areas

S/no	Physico-Chemical Parameters	A	B	C
1	Colour	Creamy white	Brown with white patches	Golden
2	Texture	Smooth	Smooth	Smooth
3	Odour	Strong characteristic	Characteristic	Characteristic
4	Yield (%)	34.50	35.00	25.11
5	Moisture content (%)	9.03 ± 0.23^{b}	5.11 ± 0.24^{a}	9.01 ± 0.68^{b}
6	Specific gravity	0.98	0.92	0.94
7	Saponification values (mgKOH/g	139.94 ± 0.54^{b}	180.28 ± 0.26^{c}	120.84 ± 0.78^{a}
8	Peroxide values (meqO_2/g)	0.96 ± 0.06^{b}	0.75 ± 0.01^{a}	0.80 ± 0.01^{a}
9	Iodine values (mg/g)	56.51 ± 0.29^{c}	28.59 ± 0.37^{b}	19.13 ± 0.12^{a}

Keywords: A- Shea butter from Ngaski, B-Shea butter from Bosso, C-Shea butter from Yamaltu-Deba

Discussion

Results from the mean length and width of the shea nuts showed that NC is significantly longer in length at 3.76 ± 0.69^{c} cm which conform to the reports of Ugese *et al* (2010) where shea nuts from Yola and Kano that fall within the same sudan savannah as NC had the shea nut length at 3.6 and 3.7 cm respectively. Based on Abedin *et al*., (2015), the shea nuts from NC can be classified as very big nuts, NA big nuts and NB small nuts. The length of NB which falls within the guineas savannah is not in line with the shea nuts from Minna, Lokoja and Kachia that had the lengths of the nuts between 3.1-5.4 cm (Ugese *et al*., 2010).

Sheanuts NA from the elemental analysis had the highest concentration of Cu and Pb at 0.05 ± 0.01c and 0.17 ± 0.01^{c} mg/g. These values are lower than those reported for Cu in Ghana at 0.183 mg/g but higher than the Cu from the sheanuts from Bida, Nigeria. All the nuts had values for K, and Ca higher than those reported for the sheanuts across different shea tree distribution locations (Fasola and Ayoade, 2010; Abdul-Mumeen *et al*., 2013; Honfo *et al*., 2014). The level of Na, Mn, Fe, Cu, Pb and Zn for all the nuts is lower than the level reported in literatures (Abdul-Mumeen *et al*., 2013; Honfo *et al*., 2014; Manikuu and Peker, 2017).

Figure 2: Pictures of Shea Butter from A-(Ngaski), B-(Bosso) and C-(Yamaltu-Deba).

The results of percentage yield of the shea butter extracted from all the shea nuts were lower than those reported literatures, although the percentage yield of the butters A and B falls within the desirable range of 30% suitable for industrial application (Julius *et al*., 2013) with the butter C amongst the least yield reported for shea butter at 25.11%. The colours, textures and odour of the shea butter extracted from the three study areas falls within the colour arrays described for shea butter (Honfo *et al*., 2014). The moisture contents of the shea butters from the present study are higher than the moisture contents for the shea butter reported in Nigeria (Julius *et al*., 2013; Audu and Awulu, 2016) but lower than the sample reported from Ghana at 12.04 ± 1.30 (Quainoo *et al*., 2012).

The iodine values for shea butter A at 56.51 ± 0.29^{c} mg/g indicated it contains higher amount of unsaturated fatty acids when compared with that of B and C at 28.59 ± 0.37^{b} mg/g and 19.13 ± 0.12^{a} mg/g respectively. The saponification values for shea butter A at 180.28 ± 0.26^{c} mg KOH/g is an indication of its suitability in production of soap as in contrast to B at 139.94 ± 0.78^{b} mg KOH/g and C at 120.84 ± 0.78^{a} mg KOH/g. The peroxide values for all the shea butter samples in the present study were lower than those reported in the shea butter from Benue, and Kwara states of Nigeria (Shahidi, 2005; Julius *et al*., 2013; Animasaun *et al*., 2019).

Conclusion

There is variation in the physico-chemical properties of shea nuts and shea butter obtained from the sudan and guinea savannah zones of Nigeria which can be attributed to the geographical and genetic variations of the trees.

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