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Comparative Study of the Proximate Analysis of Shea Butter Seed (*Vitellaria paradoxa*) Across three Different Locations in the Savanna Region of Nigeria

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Abstract: *his study investigates the nutritional composition of shea butter seeds (Vitellaria paradoxa) from three different locations in Nigeria: Oke-Ogun, Ilorin, and Gbako-kasarawa. Shea butter, derived from the seed, is a valuable resource with diverse applications, including food, cosmetics, and traditional medicine. The proximate analysis involved determining moisture content, ash content, lipid content (fat), crude protein, crude fiber, and carbohydrates. Samples were collected, prepared, and analyzed using standard methods. The results indicate variations in the nutritional composition across the locations, with Ilorin exhibiting the highest moisture, protein, and fiber content, and Minna showing the highest carbohydrate content. However, no significant differences were observed in mean values across the locations. The study underscores the nutritional significance of shea butter seeds, emphasizing their potential as a source of essential nutrients and energy. These findings provide valuable insights for promoting the consumption of shea fruit and its products, contributing to food security and economic development. Moreover, they highlight the need for further research on shea butter seeds and the conservation of Vitellaria paradoxa for sustainable utilization.*

Keywords: *Comparative study, proximate analysis, Shea butter, Savanna region*

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1.0 Introduction

In developing countries, there is a tremendous increase in the number of under-nourished people (UNSSCN, 2004). Moreover, up to 25% of the African population has been reported to be suffering from chronic food insecurity and receiving less than 80% of recommended calorie intake (FAO, 2007). To eliminate food insecurity, hunger and malnutrition in developing countries, alternative sources of nutritious food in these areas need to be identified. One such indigenous fruit tree is the shea butter tree. The shea tree (*Vitellaria paradoxa*) is an indigenous fruit tree with enormous nutritional benefits (Maranz and Weisman, 2003). The fruit has been reported to be vital for supporting livelihoods (Hall *et al.*, 1996; Okullo *et al*., 2004). It is also valued as a source of food for other animals such as elephants, sheep, pigs, bats and birds in addition to being sold in local markets (USAID, 2004).

Vitellaria paradoxa (formerly *Butyrospermum parkii*), commonly known as shea tree or vitellaria, is a tree of the Sapotaceae family. It is the only species in genus *Vitellaria* (Byakagaba, 2011) and is indigenous to Africa. The shea fruit consists of a thin, tart, nutritious pulp that surrounds a relatively large, oil-rich seed from which shea butter is extracted. The shea tree is a traditional African food plant. It has been claimed to have the potential to

improve nutrition, boost food supply in the "annual hungry season" (Masters *et al*, 2010) foster rural development, and support sustainable land care (NRC, 2006). The shea tree 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 of the Ethiopian highlands. It occurs in 19 countries across the African continent, namely Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Ethiopia, Ghana, Guinea Bissau, Ivory Coast, Mali, Niger, Nigeria, Senegal, Sierra Leone, South Sudan, Sudan, Togo, Uganda, Democratic Republic of the Congo, and Guinea (MUIENR,1998). In Nigeria, the Shea tree grows in the following states: Niger, Kwara, Kebbi, Kaduna and Oyo (Warra, 2011).

The fat obtained from the shea kernel is referred to as shea butter and it is the most valued product from the shea tree (Warra *et al*. 2014). Shea butter is frequently used for local domestic purposes such as cooking, lighting, soap manufacture or a skin moisturizer as well as in traditional medicine (Sorro *et al*., 2011). Shea butter is also valued medicinally for several uses – to relieve rheumatic and joint pains, applied to open wounds to quicken healing times and prevent infection. It is also widely used to treat skin problems such as dryness, sunburn, burns, ulcers, and dermatitis (Sorro *et al*., 2011). Traditionally, shea butter is rubbed on pregnant women during childbirth newborn babies and adolescents because of its soothing properties (Moore, 2008). The fruit of *Vitellaria paradoxa* is consumed for its sweet pulp while the seed is discarded; otherwise, the seed is crushed and extracted for the fat (oil). Its dietary importance at the local level is derived from the fat extract which is used for cooking as well as the fruit pulp which is consumed by humans and livestock (ICRAF, 2000). The nutritional and economic importance of shea oil has been emphasized over that of the shea fruit. The fleshy shea fruit pulp is sometimes fermented, given to animals or left to rot and is discarded in favour of the shea nuts for shea oil production.

Research on the shea fruit has remained neglected with limited nutritional information. Earlier studies have reported the existence of important nutrients in the shea fruit pulp, normally consumed by the local population to supplement the diet from staple foods (Mbaiguinam *et al.,* 2007). This research work is being carried out in order to establish the proximate value and the nutritional status of shea butter across the three locations under study. It is justifiable that identifying and determining the proximate and nutritional composition of this all-important plant goes a long way in appreciating its nutritive and medicinal value

The present is aimed at the provision of analytical information on the nutritional status of shea butter seed in Nigeria. The specific objectives include the determination of the nutritional status of shea butter and to to evaluate the proximate contents of the shea butter in different different locations in Nigeria.

2.0 Materials and Methods

2.1 Study Area

The seeds of shea butter were obtained from three locations in Nigeria. Namely: Ibadan in Oyo state, Ilorin in Kwara state and Gbako-kassara in Niger state. The geographical grids for three locations are tabulated in Table 1

Table 1: GPS of sampling points

Sampling points	latitude	longitude
1. Oke-Ogun, Oyo state	7^{o} 19.60’	4^{o} 4.40’
2. Ilorin, Kwara state	8^{o} 29.3’	4^{o} 31.80’
3. Gbako-kasarawa, Minna, Niger	9^{o} 8.52’	6^{o} 0.54’

2.2 Sample collection

The seeds of shea butter collected from the three different locations were kept in clean

polythene bags for identification. They were later taken to the laboratory for processing and analyses.

2.2. 1 Sample preparation

The outer coatings of the Shea seeds were removed by crushing them with a mortar and pestle. The inner seeds were ground using melon grinding machine and the ground samples from the three different locations were taken to the laboratory at Federal Institute of Industrial Research (FIIRO), Oshodi-Lagos.

2.3 *Proximate analysis*

2.3.1 Determination of the Moisture content

The moistude content was determined using the oven drying method (Pousga *et al.*, 2007), which involved drying the sample to constant weight in an overn temperature of 105 ºC for 3 hours. The constant weight sample obtained was weight and the moisture content was estimated by substsituting values to equation 1using equation 1.

$$Moisture\ content\ (\%) = \frac{W_2 - W_3}{W_2 - W_1} \times \frac{100}{1} \quad (1)$$

where w_1 is the initial weight of the empty crucible, W_2 is the weight of the crucible containing the sample before drying while W_3 is the weight after drying.

2.3.2 Determination of the Ash content

One gramme (1g) of finely ground sample was weighed into a porcelain crucible which had been ignited. The crucible was placed in a muffled furnace and heated at 500ºC for four hours, removed and cooled. The ignited residue was moistened with 2 ml distilled water and slowly and carefully 5ml of 8N HCl. It was transferred again into the cool muffle furnace and the temperature was increased step wise to 550 ± 5ºC. The temperature was maintained for 8 hours until white ash was obtained. It was then brought out and allowed to cool in a desiccator and weighed again. The Percentage weight was calculated as the weight of ash multiplied by 100 over the original weight of the samples used.

$$Ash\ content\ (\%) = \frac{Weight\ of\ ash}{Weight\ of\ original\ sample} \times \frac{100}{1} \quad (2)$$

2.3.3 Determination of the Lipid content (Fat) using the soxhlet extraction method

Twenty grams (20 g) of the samples were weighed and carefully placed inside a fat-free thimble. This was covered with cotton wool to avoid loss of the sample. The loaded thimble was put in the Soxhlet extractor and about 200 ml of petroleum ether was poured into a weighed fat-free soxhlet flask with the flask attached to the extractor. The flask was placed on a heating mantle such that the petroleum ether in the flask refluxed. Cooling was achieved by a running tap connected to the extractor for at least 6 hours after which the solvent was completely siphoned into the flask. Rotary vacuum evaporator was used to evaporate the solvent leaving behind the extracted lipids in the soxhlet. The flask was removed from the evaporator and dried to a constant weight in the oven at 60°C. The flask was then cooled in a desiccator and weighed. Each determination was done in triplicate. The amount of fat extracted was calculated using equation 3,

$$Ether\ extract\ (\%) = \frac{Weight\ of extract}{Weight\ of\ dry\ sample} \times \frac{100}{1} \quad (3)$$

2.3.4 Determination of the crude protein

Total protein was determined by the Kjeldahl method as modified by Pousga *et al*, (2007). The analysis of protein content in a compound by the Kjeldahl method is based upon the determination of the amount of reduced nitrogen present. Thirty grams (30 g) of each sample was weighed into a filter paper and put into a Kjedahl flask, 10 tablets of Na_2SO were added with 1 g of CuSO4 respectively. Twenty millilitres (20 ml) of concentrated H_2SO_4 were added and then digested in a fume cupboard until the solution became colourless. It was

cooled overnight and transferred into a 500 ml flat bottom flask with 200 ml of distilled water. This was then cooled with the aid of packs of the ice block. About 60 to 70 ml of 40% of NaOH were poured into the conical flask which was used as the receiver with 50 ml of 4% boric acid using methyl red as an indicator. The ammonia gas was then distilled into the receiver until the whole gas evaporated. Titration was done in the receiver with 0.1 N H2SO4 until the solution became colourless. The amount of Crude protein was calculated using the expression shown in equation 4

$$Crude\ protein\ (\%) = \frac{V_s - V_b \times 1.01401 \times N \times 6.25}{Original\ weight\ of\ the\ sample} \quad (4)$$

where V_s = volume (ml) of acid required to titrate sample, V_b = Volume (ml) of acid required to titrate blank and N acid = normality of acid.

2.3.5. Determination of the crude fibre

Twenty grams (20 g) of each grounded shea nut seed sample were defatted separately with Diethyl ether for 8 hours and boiled under reflux for exactly 30 min with 200 ml of 1.25% H_2SO_4. It was then filtered through cheesecloth on a fluted funnel. This was later washed with boiling water to completely remove the acid. The residue was then boiled in a round-bottomed flask with 200 ml of 1.25% Sodium hydroxide (NaOH) for another 30 min and filtered through a previously weighed couch crucible. The crucible was then dried with samples in an oven at 100°C, left to cool in a desiccator and later weighed. This was later incinerated in a muffle furnace at 600°C for 2 to 3 hours and later allowed to cool in a desiccator and weighed. The formula used is presented as equation 5

$$Crude\ fibre\ (\%) = \frac{Weight\ of\ fibre\ (g) \times 100}{Weight\ of\ original\ sample} \quad (5)$$

2.3.6 Determination of the carbohydrates

The proximate value of the carbohydrates was calculated using the formula:

$$Carbohydrate\ (\%) = 100 - MC - AC - CF - EE - CP \quad (6)$$

where CP is the crude protein, CF is the crude fat content, EE is the ether extract, MC is the moisture content and AC is the ash content.

2.4 Method of data Analysis

Proximate analyses of each of the compositions of the shea butter from the three different locations were carried out on the samples. The variance in the means of each of the components for each location was determined and multiple comparisons were obtained with Dunnett's multiple comparison test using GraphPad prism v6.0.5..

3.0 Results and Discussion

The results of the proximate analysis of *Vitellaria paradoxa (Shea butter)*seeds obtained from the laboratory analysis carried out in FIIRO, Oshodi-Lagos to determine the proximate composition of shea butter seeds from the three different locations at Oke-Ogun, Ilorin and Gbako-kasarawa in Niger state are shown in Table 1

Fig. 2: shows the same order of abundance in nutritional value as in fig 3.1 with carbohydrate content of 50.93% followed by crude fat (19.5%), crude fibre (8.2%), moisture content (10.35%), crude protein (7.35%) and total ash (3.67%) respectively.

Table 2: Proximate analysis of shea butter (*Vitellaria paradoxa*) Seed from Oke-Ogun

S/N	Parameter	Composition (%)
1	Moisture content	6.71±0.11
2	Total ash	4.32±0.046*
3	Crude protein	6.23±0.06
4	Crude fat	23.34±0.23
5	Crude fibre	8.34±0.035
6	Carbohydrate	51.06±0.11

Table 3; Proximate analysis of shea butter (*Vitellaria paradoxa*) seed from Ilorin

S/N	Parameter	Composition (%)
1	Moisture content	10.35±0.06
2	Total ash	3.67±0.017
3	Crude protein	7.35±0.077
4	Crude fat	19.5±0.10
5	Crude fibre	8.20±0.12
6	Carbohydrate	50.93±0.20

Table 4: ~~3.3.~~ Proximate analysis of shea butter (*Vitellaria paradoxa*) Seed from Minna.

S/N	Parameter	Composition (%)
1	Moisture content	9.54±0.136
2	Total ash	4.10±0.087
3	Crude protein	6.79±0.07
4	Crude fat	18.98±0.13
5	Crude fibre	8.34±0.035
6	Carbohydrate	52.62±0.29

Values are mean ± standard deviation of triplicate determinations. * significant t-test at p < 0.05.There are no significant differences in the mean values of the nutritional components across the three locations when compared using student's t-test.

Fig. 3 shows the same order of abundance in mean nutritional value as in Figs. 1 and 2 with the carbohydrate content of 52.62% followed by crude fat (18.98%), crude fibre (7.98%), moisture content (9.54%), crude protein (6.78%) and total ash (4.1%) respectively.

Table

Table 5: ~~3.4.~~ Mean ± standard deviation derived from the combined analysis of variance of the proximate contents of *Vitellaria paradoxa* sampled across the three locations.

Parameter	Oke-Ogun	Illorin	Minna
Moisture (%)	6.71±0.11	10.35±0.06	9.54±0.136
Crude protein (%)	4.32*±0.046	3.67±0.017	4.10±0.087
Crude fat (%)	6.23±0.06	7.35±0.077	6.79±0.07
Crude fibre (%	23.34±0.23	19.5±0.10	18.98±0.13
Carbohydrate (%)	51.06±0.11	50.93±0.20	52.62±0.29

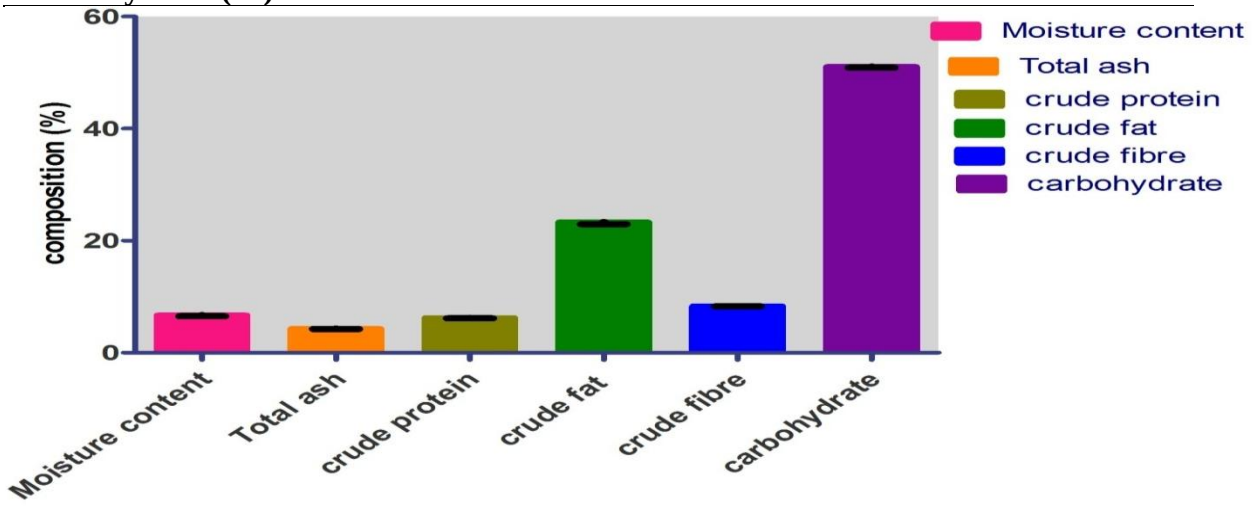

Fig. 1 shows that carbohydrate content (51.06%) is the highest followed by crude fat (23.34%), crude fibre (8.34%), moisture content (6.71%), crude protein (6.23%) and total ash (4.32%) respectively

Fig. 4 shows a comparative proximate analysis of the mean nutritional content of shea butter across the three sampling points. From the observation on this chart, Oke-Ogun sampling point has shea butter seed with the highest crude fats, followed by Ilorin and Minna respectively. Ilorin samples have the best moisture content, crude protein and crude fibre, while Minna has shea butter seed with the highest carbohydrate content. This shows that shea butter seed varies in their nutritional values with geographical areas.

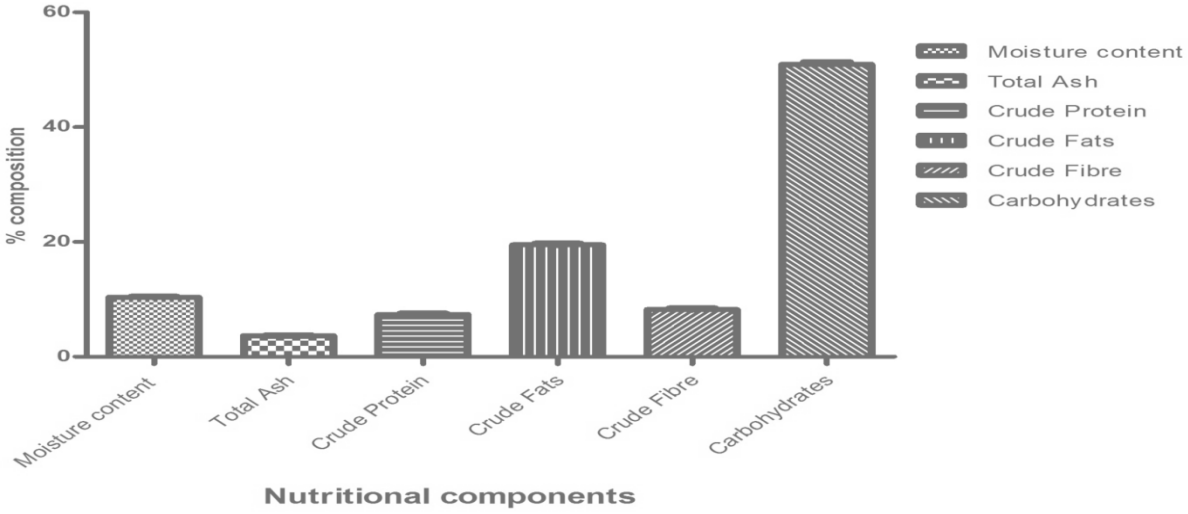

Fig. 2: Chart of the proximate analysis of shea butter (*Vitellaria paradoxa*) seed obtained from Ilorin

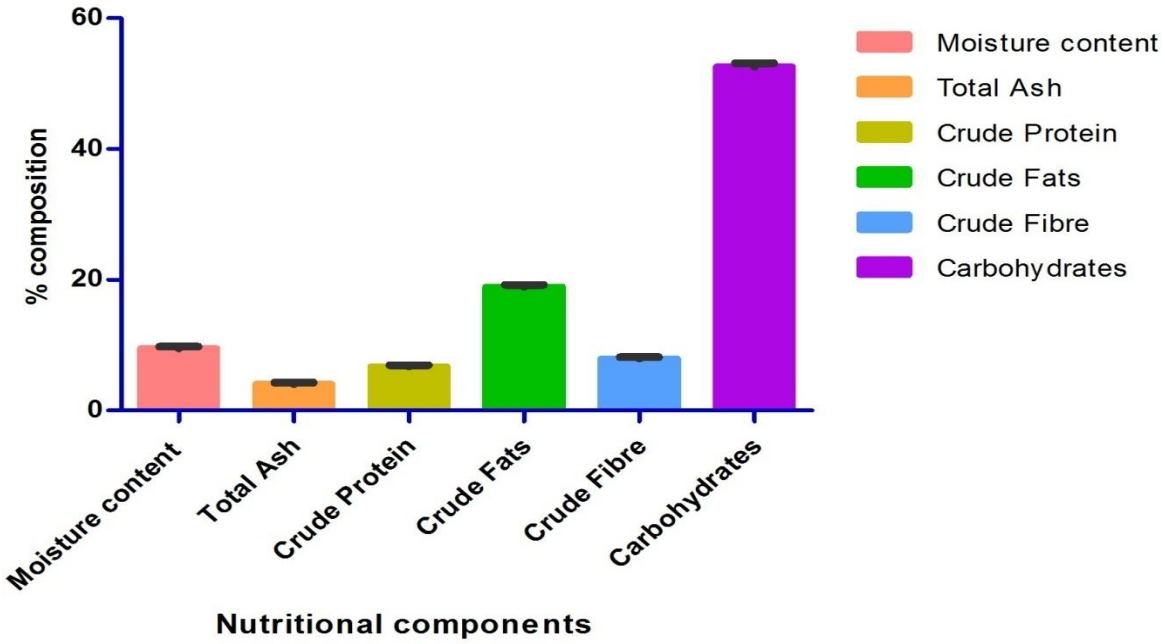

Fig. 3: Chart of the proximate analysis of shea butter (*Vitellaria paradoxa*) seed from Gbako-kasarawa, Minna

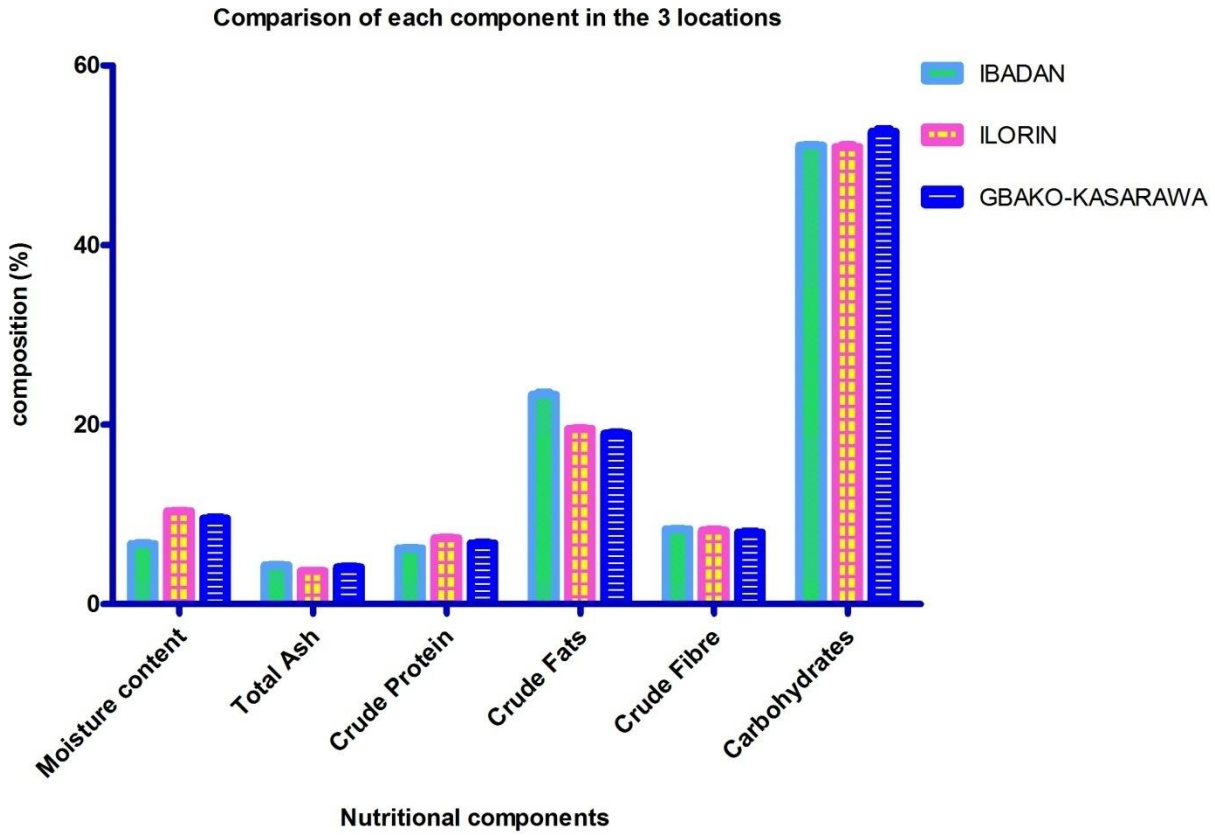

Fig. 4: Chart of the proximate analysis of shea butter (*Vitellaria paradoxa*) seeds across the three locations.

Indigenous tree fruits in the African parklands such as the shea fruits constitute a great source of essential nutrients such as vitamins, minerals, carbohydrates, crude fibre and proteins (Okullo *et al*., 2010). Like other edible fruits, shea fruits are rich in different carbohydrates such as glucose, fructose and galactose (Neuwinger, 1994). The proximate analysis result of Shea butter ((*V. paradoxa)* seeds showed the moisture content range to be between 6.71% and 10.35% across the three locations but was highest in the seed sample of Ilorin. This indicates that *V. paradoxa* seed has low moisture content hence a long shelf life that is, it can be stored for a long time. Seeds of *Jatropha curcas, Pentaclethra macrophylla, Cocos nucifera* L. and *Cococynthis citrullus* have also been reported to have average moisture content values of 5.00% (Ubogu *et al.* 2013), 11.87% (Alinnor *et al.* 2011), and 7.51% and 4.27% (Obasi *et al.* 2012) respectively. Moisture content is among the most vital and frequently used measurement in the processing, preservation and storage of food (Onwuka, 2005). The protein content ranges between 6.23% and 7.35% in *V. paradoxa* seed across the three locations but was also highest in the seed samples of Ilorin. A protein content value range of 1.43% - 6.36%, and 7.05% - 8.10% has been reported for mango seed kernel varieties (Kittiphoom, 2012) and walnut kernel varieties (Ozcan *et al.* , 2010). 33.69%, and 36.73% and 32.48% protein content values were reported for almond seed (Akpabio *et al*. 2012), and yellow and brown mustard seed respectively (Abul-fadl *et al*., 2011). Proteins are for the growth and repair of tissues and also as an alternative energy source in the absence of carbohydrates and fat (Ujowundu *et al.* 2010).

V. paradoxa seed is a high fat (oil rich) source given a fat composition value which ranges between 18.98 and 23.34% across the three locations. Comparatively, Ubogu *et al* (2013) and Alinnor *et al* (2011) also reported 46.24% and 46.95% fat contents of *J. curcas* seed and *P. macrophylla* seed respectively while *Livistona chinensis* seed fat content of 2.86% (Nwosu *et al.* 2012) is very low compared to the values obtained in this study.

Ash content in this study ranges between 3.67% and 4.32% across the three locations but was highest in the seed samples of Oke-Ogun. The abundance of ash content signifies mineral content levels in the seed. Seeds of *Detarium senegalense* and *Prunus armeniaca* L. varieties have lower ash contents of 1.93% (Sowemimo *et al*. 2011) and 2.11% - 3.89% (Manzoor *et al.* 2012) respectively when compared to the values obtained in this study. However, a higher ash content value, 9.7% was reported for *Annona muricata* seeds (Kimbonguila *et al.* 2010).

The fibre composition value obtained in this study ranges between 8.20% and 8.34% across the three locations but was highest in the seed samples of Oke-Ogun and Minna of Niger state. The range is within the crude fibre values of most wild and domesticated fruits (Ramulu and Rao, 2003) and higher than in legumes with mean values ranging between 5-6% (Aremu *et al*., 2006). Fibre content is used as an index of the value in poultry and feeding stocks feed (Ubogu *et al*. 2013). Crude fibre is made up largely of cellulose together with a little lignin which is indigestible in humans. It helps in the maintenance of normal peristaltic movement of the intestinal tract which aids digestion (Alinnor *et al.* 2011). Diets containing high fibre content could reduce the occurrence of such disorders as constipation, colon diseases, diabetes, cardiovascular diseases and obesity (Omosuli *et al*., 2009). This study, is in agreement with Onwuka (2005), that shea fruit pulp is a rich source of energy and capable of supplying the daily energy requirements of the body.

A significant variation was exhibited in carbohydrate content ($P \leq 0.05$) for the varieties across the three different locations. The carbohydrate value obtained ranges between 50.93% and 52.62% and was highest in the seed samples of Minna of Niger state. This shows that *V. paradoxa* is a high carbohydrate and energy source. Carbohydrate provides raw materials for many industries (Ubogu *et al.* 2013). Shea fruit has more carbohydrates that are vital in nutrition and are also good source of energy (Anhwange *et al*., 2004). The consumption of shea fruit after hard labour could provide an immediate source of energy for the farmers. Thus, justifies the promotion of the consumption of shea fruits in Nigeria and beyond.

It is pertinent to also state that indigenous tree fruits in the African parklands such as the shea fruits (which is a product of the shea seed) constitute a great source of essential nutrients like other edible fruits. Therefore, *V. paradoxa* seed has a good proximate composition profile across the three locations of Oke-Ogun, Ilorin and Minna of Niger state. It also implies that promoting the consumption of shea fruit will be of great benefit to the human diet.

4.0 Conclusion

The study on the proximate analysis of shea butter seeds from three different locations in Nigeria reveals that Vitellaria paradoxa (shea butter) seeds possess high nutritional value and energy content. Across the sampled locations of Oke-Ogun, Ilorin, and Minna, the seeds exhibited consistent levels of moisture content, protein, fat, fiber, ash, and carbohydrate, with slight variations. Shea butter seeds can serve as valuable raw materials for various industries, including food, cosmetics, and soap manufacturing, as well as for animal feed formulations. The findings underscore the potential of shea butter seeds as a source of

essential nutrients, highlighting their significance in both human and animal diets.

Based on the above conclusion, the following recommendations are made

(i) **Industrial Utilization:** Given the high nutritional and commercial value of shea butter seeds, there is a need to develop processes for their industrial utilization. This could involve designing extraction methods for producing shea butter oil for use in food, cosmetic, and pharmaceutical industries.

(ii) **Research and Development:** Further research is warranted to explore the full potential of shea butter seeds, including their applications in animal feed formulations. This could lead to innovative ways of utilizing shea butter seeds to meet the growing demand for nutritious and sustainable feed ingredients.

(iii) **Conservation Efforts:** Considering that shea trees grow in the wild, conservation efforts should be undertaken to preserve their genetic diversity and ensure their long-term sustainability. This could involve initiatives aimed at promoting sustainable harvesting practices and protecting natural habitats where shea trees thrive.

(iv) **Promotion of Consumption:** Shea butter seeds, with their rich nutritional profile, should be promoted for consumption both domestically and internationally. Public awareness campaigns highlighting the health benefits of shea butter seeds could encourage their inclusion in diets and foster economic opportunities for local communities.

(v) **Domestication:** Further studies should explore the feasibility of domesticating shea trees to enhance their cultivation and production. This could lead to increased yields, improved crop management practices, and greater resilience to environmental challenges, ultimately contributing to food security and rural development.

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Compliance with Ethical Standards

Declarations

The authors declare that they have no conflict of interest.

Data availability

All data used in this study will be readily available to the public.

Consent for publication

Not Applicable

Availability of data and materials

The publisher has the right to make the data public.

Competing interests

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Authors' contribution

The entire components of the work was designed and executed by the auth.