Nutritional Composition of Seed and Physicochemical Properties of Seed Oil of *Vitellaria paradoxa*

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Abstract- **This study involved the investigation of the nutritional composition of *Vitellaria paradoxa* seed by determining its proximate, vitamin and mineral content, and physicochemical properties of seed oil of *Vitellaria paradoxa.* The results of the proximate composition analysis showed that the seed contained 2.842% moisture, 4.183% ash, 49.155% fat, 9.30% protein, 12.678% fibre and 21.842% carbohydrate and its energy content was 2348.149kJ/100g. The mineral composition analysis showed that the seed contained 61.70ppm K, 52.00ppm Fe, 30.20ppm Ca, 6.24 ppm Mg, 5.10ppm Na, 0.80ppm Cu, 0.72 ppm Zn, 0.30 ppm Mn, 0.04 ppm Ni, 0.02 ppm Pb,0.0l ppm Cd, and 0.01 ppm Co while its vitamins A and C contents were 15012.09 µg/mg and 189.53 mg/g respectively. The result obtained for physicochemical properties of the seed oil showed 0.895g/cm^3 specific gravity, 1.464 refractive index, 4.297mg/g acid value, 68.018mg/g iodine value, 224.4mg/g saponification value and 2.160 mg/g free fatty acid. The results obtained in this study for the nutritional (proximate, mineral and vitamin) composition of *V. paradoxa* seed show that the seed has a high nutritional and energy values, and would be useful raw materials for industries, and animal feed formulations. The seed oil can be described as having good nutritional quality and high commercial value. It is edible and would find applications in food, soap and cosmetics manufacturing besides domestic cooking purposes.**

Index Terms*— nutritional, oil, proximate, physicochemical, seed, *Vitellaria paradoxa

I. Introduction

Shea butter tree is indigenous to Sub-Saharan Africa and belongs to the family *Sapotaceae*. It grows in the wild and has a huge economic and ecological potential [1]. It is divided into two subspecies: *nilotica* and *paradoxa*. *Vitellaria paradoxa* is also classified as *Butyrospermum parkii* and *B. paradoxa* [2].

The shea tree usually grows to average height of about 15m with profuse branches and a thick waxy and deeply fissured bark that make it fire resistant. Its fruit contains one or two nuts which are brown and shiny. Shea nut is known as Kwara, Osisi and Emi among the Hausa, Igbo and Yoruba people of Nigeria respectively [3]. The shea tree occurs in 19 countries across the Africa continent namely Benin, Ghana, Chad, Burkina Faso, Cameroon, Central African Republic, Ethiopia, Guinea Bissau, Cote d'Voire, Mali, Niger, Nigeria, Senegal, Sierra Leone, Sudan, Togo, Uganda, Zaire and Guinea. In Nigeria, the shea tree grows in the following states: Niger, Kwara, Kebbi, Kaduna and Oyo [4].

The Shea tree is perennial. The shea fruit is 4-8cm and greenish – yellow in color, containing the hard shelled seed (nut) enclosing a soft kernel with oil content of 40-60%. The shea fruit is ellipsoidal berry consists of a thin, tart, nutritious pulp that surrounds a relatively large, oil rich seed from which shea butter is extracted [5]. Fruiting of shea tree may start at 10 years of age and attains full fruit production between 20 to 50 years. It flowers in the dry season. Ripening of fruits take place during the rainy season [6].

The fat obtained from the shea kernel is referred to as shea butter and it is the most valued product from the shea tree [7]. Shea butter is frequently used for local domestic purposes such as cooking, lightning, in soap manufacture or as skin moisturizer as well as in traditional medicine [6]. Shea butter is also valued medicinally for a number of uses – to relieve rheumatic and joint pains, applied to open wounds to quicken healing times and prevent infection. It also widely used to treat skin problems such as dryness, sun burn, burns, ulcers, and dermatitis [6]. Traditionally, shea butter is rubbed on pregnant women during childbirth new born babies and adolescents because of its soothing properties [8]. Shea butter is called "Ori" by the Yoruba people of SouthWestern Nigeria. 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).

This study investigated the nutritional (proximate, mineral and vitamin) composition of seed, and physicochemical properties of seed oil of *Vitellaria paradoxa*.

II. MATERIALS AND METHODS

Vitellaria paradoxa seeds were bought from Oja Oba Market, Ikirun, Osun State, Nigeria. The seeds were cleaned and sun dried for two weeks. The sun dried seeds were deshelled and the kernels obtained were broken into smaller pieces, ground and kept in airtight containers prior to nutritional composition analysis. The *V. paradoxa* seed oil used in this study was obtained by soxhlet extraction of a portion of the ground *V. paradoxa* seed kernel with n-hexane. Proximate composition analysis of *V.* seed for moisture, protein, fat, ash, fibre, carbohydrate and energy values were carried out according to the procedures of A.O.A.C., [9]. Mineral (Na, K, Ca, Mg, Zn, Fe, Cd, Ni, Cu, Mn, Pb, Co) composition analysis were carried out according to the methods described by Gafar *et al*., [10]. Vitamins A and C contents determinations were according to the methods described by Musa *et al*., [11]. Physicochemical properties of the seed oil were determined according to the procedures of A.O.A.C., [9]. All analyses are triplicate determinations. Result values are expressed as mean ± standard deviation of triplicate determinations.

III. RESULTS AND DISCUSSION

The results of the proximate, mineral and vitamin composition analyses of *V. paradoxa* seed are as presented in Tables I, II and III respectively. The result of the physicochemical properties of *V. paradoxa* seed oil is presented in Table IV.

Low moisture content of the seeds is an advantage of high shelf life of the seeds [12]. A moisture composition value of 2.842% (Table I) indicates that *V. paradoxa* seed has a long shelf life - it can be stored for a long time. *Jatropha curcas*, *Pentaclethra macrophylla*, and *Cocos nucifera* Linn and *Cococynthis citrullus* seeds have been reported to have average moisture content values of 5.00% [13], 11.87% [14], and 7.51% and 4.27% [15] respectively.

TABLE I. PROXIMATE COMPOSITION OF *VITELLARIA PARADOXA* SEED

Parameter	Composition (%)
Moisture	2.842±0.13
Protein	9.300±0.05
Fat	49.155±0.13
Ash	4.183±0.10
Fibre	12.678v0.13
Carbohydrate	21.842±0.27
Energy value (KJ/100g)	2348.149±0.41

Values are mean ± standard deviation of triplicate determinations

The protein content was 9.30% in *V. paradoxa* seed. A protein content value ranges of 1.43% - 6.36%, and 7.05% - 8.10% were reported for mango seed kernel varieties [16] and walnut kernel varieties [17]. 33.69%, and 36.73% and 32.48% protein content values were reported for almond seed [18], and yellow and brown mustard seed [19] respectively. Proteins are for growth and repair of tissues and also as an alternative energy source in the absence of carbohydrate and fat [20].

V. paradoxa seed is a high fat (oil rich) source given a fat composition value of 49.155% comparable to 46.24% and 46.95% fat contents of *J. curcas* seed [13] and *P. macrophylla* seed [14] respectively. Desma seed has a higher fat content of 53.3% [21] while *Livistona chinensis* seed fat content of 2.86% [22] is very low compared to 49.155% obtained in this study.

Ash content signifies mineral contents levels. Seeds of *Detarium senegalense* and *Prunus armeniaca* L. varieties have lower ash contents of 1.93% [23] and 2.11% - 3.89% [24] respectively compared to 4.183% obtained in this study. However, a higher ash content value, 9.7% was reported for *Annona muricata* seeds [25].

The fibre composition value (12.678%) obtained in this study indicates that *V. paradoxa* seed is a good source of fibre. Fibre has useful role in providing roughage that aids digestion [14]. Fibre content is used as an index of value in poultry and feeding stocks feed [13]. Crude fibre content values of 2.69%, 5.51% and 7.70%, 20.90% - 23.93% and 38.21% have been reported for seeds of *Dacryodes edulis* [20], *C. nucifera* and *C. citrullus* [15], *Carum roxburghianum* [26] and *L. chinensis* [22] respectively.

The carbohydrate and energy values are 21.842% and 2348.99KJ/100g respectively (Table I). *V. paradoxa* seed may also be termed a high carbohydrate and energy source. Carbohydrate provides raw materials for many industries [13]. Carbohydrate supplies energy to cells such as brain, muscles and blood. It contributes to fat metabolism and spare proteins as an energy source [14]. Overall, *V. paradoxa* seed has a good proximate composition profile.

The mineral composition profile of *V. paradoxa* seed (Table II) is good as all the studied mineral elements (Na, K,

TABLE II. MINERAL COMPOSITION OF *VITELLARIA PARADOXA* SEED

Mineral	Composition (ppm)
Na	5.10±0.01
K	61.70±0.30
Ca	30.24±0.04
Mg	6.24±0.01
Zn	0.72±0.00
Fe	52.00±0.11
Cd	0.01±0.00
Ni	0.04±0.00
Cu	0.80±0.00
Mn	0.30±0.02
Pb	0.02±0.00
Co	0.01±0.00

Values are mean ± standard deviation of triplicate determinations

Ca, Mg, Zn, Fe, Cd, Ni, Cu, Mn, Pb, Co) are present though variation among the mineral elements exist in their level of abundance in the seed (Table II). Ca, Fe, K, Mg and Na are the predominant minerals.

The Na/K ratio is < 1 as deduced from Table II. A diet high in potassium and low in sodium favours lower blood pressure [27]. Iron is a necessary component of haemoglobin and myoglobin for oxygen transport and cellular possesses of growth and division. Iron also has a role in energy metabolism as it facilitates transfer of electrons in the election transport chain for the formation of ATP [28]. Distorted enzymatic activity and poor electrolyte balance of the blood fluid are related to inadequate Na, K, Mg as they are the most required elements of living cells [27].

The Na, K, Ca, Mg, Zn and Cu values reported for *P. macrophylla* seeds [14] are higher than those obtained in this study. The Na, Ca, Mg, Zn, Fe, and Cd levels reported for *J. curcas* seeds [13] are higher than those of this study. Walnut kernel varieties levels of Na, K, Ca, Mg, Zn, Cu, Ni and Mn [17] are also higher than those obtained for *V. paradoxa* seeds in this study. However, the Fe content of *V. paradoxa* seed of this study is higher than those reported for *P. macrophylla* seeds and walnut kernel varieties; and its K content is higher than those of *J. curcas* seeds. The Na, K, Ca, Fe and Mg mineral composition values obtained in this study are higher than those reported for Almond seed [18], and Na, K, Ca and Mg mineral composition values reported for *A. muricata* seeds [25] are lower than those obtained in this study.

The vitamins A and C composition of *V. paradoxa* seed are 15012.09 µg/mg and 189.53mg/g respectively (Table III). *V. paradoxa* seed thus have a high level of vitamin C content and an appreciable amount of vitamin A content. Its vitamin C is higher than that of *P. africana* seeds (0.92 ± 0.02mg/100g) [20] but lower than those of *Adasonia digitata* (6.71 ± 0.04mg/100g), groundnut (9.8mg/100g) and *D. edulis* (25.76 ± 1.51mg/100g) seeds [20]. While its Vitamin A content is

TABLE III. VITAMIN COMPOSITION OF *VITELLARIA PARADOXA* SEED

Vitamin	Composition
Vitamin A (µg/g)	15012.09
Vitamin C (mg/g)	189.53

Values are mean ± standard deviation of triplicate determinations

lower than those of *P. africana* (0.89 ± 0.01ug/100g), *D. edulis* (1.13 ± 0.04mg/100g) and *A. digitata* (5.26 ± 0.03ug/100g) [20].

Vitamin C strengthens the body immunity against infections, helps in collagen and thyroxin synthesis and enhances iron absorption. Vitamin A is a component of the visual pigments in the retina regulates gene expression and cell differentiation. It is an antioxidant. The deficiency may lead to night blindness, xeropthlamia and keratinization of skin [29]. Healthy ruminants synthesize adequate amounts of Vitamin C under normal conditions. Vitamin A is necessary for many functions in the ruminants including vision, bone growth, immunity and maintenance of epithelial tissue [28].

The physicochemical properties of *V. paradoxa* seed oil are as shown in Table IV. The refractive index value obtained was 1.464 which is comparable to those reported for cashew nut oil (1.458) [30], *Bischofia javanica* seed oil (1.4863) [31], *P. armeniaca* L. varieties seed oils (1.4655-14.790) [24], and walnut cultivars kernel oil (1.534 - 1.537) [17]. Pure oils have marked ranges of refractive index and density; thus the degree of variation of a typical oil from its true value may indicate its relative purity [32].

The specific gravity value of 0.895g/cm^3 of *V. paradoxa* seed oil fell within the range of values reported for *P. macrophylla* (0.89), *Treculia africana* (0.81), *Persea gratesima* (0.90), *Telferia occidentalis* (0.83) and *C. nucifera* (0.86) [33].

V. paradoxa seed oil has a low acid value (4.2973mgKOH/g) and can therefore be termed an edible oil. The acid value reported for almond, *L. chinensis* and pumpkin seed oils were 1.68mgKOH/g [18], 43.828mg KOH/g [22] and 0.78mg KOH/g [32] respectively. Its free fatty acid value is also low at 2.160mg/g. Acid value and percentage free fatty acid are used as indicator of the edibility of oil [13]. Low acid

TABLE IV. PHYSICOCHEMICAL PROPERTIES OF *VITELLARIA PARADOXA* SEED OIL

Parameter	Value
Refractive index	1.464±0.01
Specific gravity (g/cm^3)	0.895±0.01
Acid value (mg/g)	4.297±0.18
Free fatty acid (mg/g)	2.160±0.02
Iodine value (mg/g)	68.018±0.15
Saponification value (mg/g)	224.40±0.22

Values are mean ± standard deviation of triplicate determinations values

and corresponding low levels of free fatty acids in the oil suggest low level of hydrolytic and lipolytic activities in the oil. Thus, the seed oil studied could be good sources of raw materials for industries [15]. 1.68mgKOH/g, 6.59mgKOH/g and 10.7mgKOH/g acid values were reported for almond [18], *B. javanica* [31] and cashew nut [30] seed oils respectively. The acid values reported for seed oils of Pumpkin, *A. muricata* and *P. armeniaca* L varieties are 0.39 [32], 14.2 [25], and 0.41- 0.93 [24] respectively.

V. paradoxa seed oil is a nondrying oil. This is because its iodine value (68.018mg/g) is less than 180 [15] (Table IV) and it indicates low level of unsaturation and the presence of saturated fatty acid. It may find application as raw material in industries for the manufacture of vegetable oil-based ice cream [22] but not in the manufacture of paints and varnishes [31].

A saponification value of 224.4mg/g obtained for *V. paradoxa* seed oil indicates that it may be useful in the production of liquid soap and shampoo [13]. Desma and *B. javanica* seed oils have saponification values of 186mgKOH/g [21] and 289.3mgKOH/g [31] respectively.

Physicochemical characteristics of any oil are important for determining its nutritional quality and commercial value [34]. The physicochemical characteristics of *V. paradoxa* seed oil

obtained in this study show *V. paradoxa* seed oil as being of good nutritional quality and high commercial value.

IV. CONCLUSION

The results obtained in this study for the nutritional (proximate, mineral and vitamin) composition of *V. paradoxa* seed show that the seed has a high nutritional and energy values, and would be useful raw materials for industries, and animal feed formulations. The seed oil can be described as having good nutritional quality and high commercial value. It is edible and would find applications in food, soap and cosmetics manufacturing besides domestic cooking purposes. Processes for the industrial production of *V. paradoxa* seed oil as vegetable oil should be designed while studies into the utilization of the seed as raw materials for animal feed industry should be carried out so that the conventional oil seeds (groundnut, soybeans, palm kernel) presently used as raw materials for animal feed industry would be better utilized for human food.

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