Nutritional and Phytochemical Composition of *Vitellaria paradoxa* (Shea fruit pulp)

O. A. Akoma[1], N. Y. Nma, S. A. Musa and A. B. Salihu
Department of Chemical Sciences, Federal Polytechnic, P.M.B 55, Bida, Nigeria

[1]Corresponding author:-
E-mail address: annobilorakoma@gmail.com

Abstract

The nutritional and phytochemical compositions of the Shea fruits (*Vitellaria paradoxa*) were investigated using standard methods. The phytochemical screening revealed the presence of tannins, alkaloids, saponins, steroids, flavonoids, anthraquinones and cardiac glycosides. The proximate analysis revealed that the percentage composition of the fruit was as follows:- moisture (75.4), ash (11.6), crude fat (10.6), crude protein (4.4), crude fibre (9.1), carbohydrate (17.8) and energy value (385.2 kcal/g). The mineral composition (%) of the dried Shea fruit pulp as evaluated in this study consisted of K (1.97), Na (0.47), Ca (5.50), Mg (1.75), P (1.24); Zn (1.81) and Fe (3.01). The results obtained in this study further reiterate the reason why there is high consumption of Shea fruits by farmers in West and Central Africa for both its nutritional and medicinal benefits.

Key words: Nutritional properties, Phytochemicals, Shea fruit pulp

Introduction

Traditional and folk medicines derived from plants-stem, bark, root, fruit, leaves and seeds have been discovered to play a significant role in the prevention and cure of diseases, sickness and disorders in humans around the globe [1]. About three-quarter of the world's population relies on plants and their extracts for healthcare [2]. In decades of military rules in Nigeria, there was abject poverty which has rendered many children undernourished [3]. In

2015, 29% of Nigerian children of 5yrs and below were said to be underweight. These children have weak resistance to infection and were susceptible to die from malaria, diarrhea and respiratory diseases due to poor feeding practices and a shortfall in food intake. Recently, Nigeria has been identified among the countries to be at the risk of food crises (famine) especially in the North Eastern part due to insurgency and in the North Central part due to ravaging herdsmen attacks on farms which needs urgent intervention by humanitarian assistance [4]. It was reported that 2.1 million Nigerians in the North East suffers food crises and poor nutritional status due to insurgency and 4.7 million due to conflicts among tribes, high food prices and widespread of internally displaced persons [4]. More so, a good number of people especially those living in the rural areas largely depends on the therapeutic effects of herbs because most of these effects have stood the test of time. They have particularly being used in the treatment of allergic, metabolic, cardiovascular and other degenerative or life threatening diseases and as well as food sources [5], this is because of their bioactive and nutritional constituents [6]. Generally, fruits from plants particularly those from agroforestry species have been reported as good sources of dietary supplement because of their minerals and vitamins which provide the nutritional and energy requirements needed by the human body to grow and also curtail malnutrition among children [7].

Fruits from agroforestry species such as those of *V. paradoxa* tree have been recognized by the rural dwellers to supplement their daily energy needs [7]. *Vitellaria paradoxa* commonly known as Shea butter tree (*Sapotaceae*); is the only species in the genus indigenous to Africa [8]. The Shea tree fruit consist of a thin tart nutritious pulp that surrounds a relatively large oil-rich seed from which Shea butter is extracted. The importance of the Shea nut is second to the numerous benefits of shea butter derived from it [9]. The sweet pulp is consumed locally when ripened because it is a rich source of sugars, calcium, iron, potassium, magnesium and phosphorus [10]. The major constituent of the pulp is vitamin C, which is required as an

essential nutrient in both humans and animals [11]. Vitamin C is an antioxidant which reduces the risk of high blood pressure, enhances human immunity and lack of it may result in scurvy [12]. The pulp also is known to be anti-carcinogenic hence has chemotherapeutic quality. It is also used as pain reliever in bones, nerves, inflammation, dislocation and arthritis [9]. The oil is also used as local lamp illuminant and for soap production. The fruit contains carbohydrates such as glucose, fructose and galactose [13] and usually, the period of harvesting of the fruit coincides with the high energy requirements in farm planting and the consumption of this fruit meet this immediate energy demand by farmers after hard labour [14]. The objective of this study is to evaluate the nutritional and phytochemical properties of dried Shea fruit pulp.

Materials and methods

Sample collection and preparation

Hundred medium sizes ripped mature Shea butter fruits (*Vitellaria paradoxa*) were collected from Dzwayagi village, Gbako Local Government Area in Niger State in June, 2017 and identified by a botanist (Mr S. Gallah) in the Department of Biological Sciences, Federal Polytechnic, Bida with voucher numbers 40-43. The specimens were deposited at the herbarium of the Department of Biological Sciences, Federal Polytechnic, Bida, Nigeria following which it was depulped manually to obtain 450g of wet Shea fruit pulp. The pulp comprising of the epicarp and mesocarp were oven dried at 35^{o}C to a constant weight for five (5) days and then pulverized using laboratory blender, sieved (mesh size 350µm); the fine powder obtained after sieving was weighed then packaged in a transparent air tight glass bottle and stored at ambient temperature (31±2^{o}C) for analyses.

Extraction

Two hundred grams (200g) of the pulverized Shea fruit pulp was extracted as described by Ezeokeke *et al*. [15] with 70% methanol (Analar) by cold maceration three consecutive times

for 3days and then concentrated using Rotary Evaporator (Perkin Elmer 6000; India) at 35^{o}C; 10.6g of the dry extract was obtained.

Digestion of sample

Two gram (2g) of the pulverized Shea fruit pulp was digested with 5cm^3 conc. HNO_3 and 5cm^3 conc. H_2SO_4 (1:1) in a Kjeldahl apparatus according to Kjeldahl digestion method until a clear colorless solution was obtained. The solution was allowed to cool and then made up the top mark with distilled water in a 100cm^3 volumetric flask [16].

Proximate analysis

The proximate content of the dried pulverized Shea fruit was carried out according to standard methods described by AOAC [17] to estimate the ash, crude protein, crude fat, crude fibre and carbohydrate contents of the sample.

(a) Crude protein

The digested sample was transferred into the micro Kjeldahl distillation unit and made alkaline with 17ml of 40% NaOH and then distilled into a receiver containing 10ml of boric acid indicator. The distillate was collected and then titrated against 0.1N H_2SO_4 and a blank was made.

$$\% \text{ Nitrogen} = \frac{(A-B)\ X\ 0.1\ X\ 100\ X\ N}{1000\ X\ 0.2(g)}$$

A = Titre of sample

B = Titre of blank

0.1 = Normality of acid

14.01 = Equivalent weighed nitrogen

0.2g = weight of the sample in g

1000 x 0.2 = conversion of gram to milligram.

% Crude protein = % Nitrogen x 6.25 (protein factor of plant-protein)

Where 6.25 = Factor use to multiply nitrogen to get crude protein

(b) Crude fat

Ten gram (10g) of the digest was extracted with n-hexane in a soxhlet apparatus at 60^{o}C and the extract was dried for 30min at 100^{o}C and then cooled to obtained; the total lipid content and the percentage fat was calculated as:-

% crude fat = $\frac{W2-W1}{W}$ x 100

Where

W2 = Weight of the beaker with the extracted oil

W1 = Weight of the empty beaker

W = Weight of sample.

(c) Crude fibre

Five gram (5g) of the residue from the heated digest in 150ml of KOH solution was dried in an oven at 105^{o}C for 12h and weighed. The amount of crude fiber in percentage was calculated as follows:-

% crude fibre = $\frac{Weight\ of\ crucible+dry\ residue-Weight\ of\ crucible+ash}{Weight\ of\ the\ sample}$ x 100

(d) Ash content

The ash content was determined by heating 2g of sample in a dry crucible in a muffle furnace for 8h at 550^{o}C until all carbon were removed. The ash content was calculated as follows:-

Ash content (%) = $\frac{Weight\ of\ ash}{Weight\ of\ the\ sample}$ x 100

(e) Carbohydrate content

The total carbohydrate content of the sample was measured by difference.

Mineral analysis

The analysis of the mineral constituents of the sample were carried out using Atomic Absorption Spectrophotometer (Model 320N, Surgicare, England) for Mg, Zn, Ca, Fe, P

while the Na and K contents were determined using Flame Photometer (Model FP 640, Mumbai, India) using the methods of AOAC [18].

Phytochemical analysis

The phytochemical analysis of the methanol extract of the Shea fruit pulp (*Vitellaria paradoxa*) was carried out according to standard methods as described by Sofowora [19] and Trease and Evans [20].

(a) Cardiac glycosides (Keller-Killianc test)

About 1cm^3 glacial ethanoic acid and 2cm^3 $FeCl_3$ was added to 0.5g crude extract with 1cm^3 H_2SO_4. Formation of a purple colour at the interphase indicates cardiac glycosides.

(b) Saponins (Frothing test)

About 5cm^3 of distilled water was added to 0.5g of crude extract in a test tube, shaken vigorously for 30min and left standing for 45min. A honey comb froth which persists for 30min indicates the presence of saponin.

(c) Tannins (Iron III chloride test)

10cm^3 of distilled water was added to 0.5g of crude extract and boiled. The mixture was allowed to cool, filtered and few drops of $FeCl_3$ solution was added to the filtrate. Formation of blue-black coloration indicates the presence of tannins.

(d) Flavonoids (Sodium hydroxide test)

Few drops of 10% NaOH solution was added to 0.5g of crude extract then 5cm^3 of HCl. A yellowish coloured solution indicates the presence of flavonoids.

(e) Steriods (Lieberman-Burchard's test)

10cm^3 of chloroform was added to 0.5g of crude extract with 1cm^3 of acetic anhydride and then 1cm3 conc. H_2SO_4 carefully. The blue-green colour formed indicates steroids.

(f) Alkaloids

0.5g of the crude extract was hydrolyzed with 1% HCl over a water bath. The resulting mixture was cooled and filtered. To 5cm^3 of the filtrate was added few drops of Wagner's reagent. Formation of reddish brown precipitate indicates the presence of alkaloids. Another portion of the filtrate was also added to Dragendorff's reagent, in 2cm^3 of H_2O. A reddish brown colour also indicates the presences of alkaloids.

Statistical analysis

The mean data of triplicate proximate and mineral analyses were computed using SPSS software version 20.

Results and discussion

The result in Table 1 shows the nutritional composition of the Shea fruit pulp with moderate moisture content of 75.39% which contributed to it being been highly perishable if poorly preserved and but contributes to its soft texture making it edible. The moisture content of the dried Shea fruit pulp obtained in this study (Table 1) is in agreement with the moisture content of 72.4 - 75.3% reported by Okullo *et al.* [14]. The total carbohydrate content of 17.96% obtained in this study is within the range of the carbohydrate value (12.4-19.4%) reported by Neuwinger [21] in a similar study. Like in other edible fruits, the Shea fruit pulp is rich in carbohydrate content such as galactose, fructose and glucose which serves as source of high energy required by farmers during farm planting. Shea fruit has been reported to contain more carbohydrates that are vital in nutrition and as good source of energy [22] and it is believed that regular eating a Shea fruit after hard labour could provide immediate energy sources [21].

Also, the result in Table 1 showed that the crude fibre content (%) in the dried Shea fruit was 9.06; crude fibre helps in the maintenance of normal peristaltic movement of the digestive

tract. Thus diet containing high crude fibre may reduce disorders such as constipation, colon diseases, diabetes, heart diseases and obesity [23].

Table 1: Proximate composition of dried Shea fruit pulp

Analysis	Concentration[1]
Proximate content (%)	
Moisture	75.39 ± 0.01
Ash	11.55 ± 0.78
Crude fat	10.60 ± 0.22
Crude protein	4.49 ± 0.28
Crude fibre	9.06 ± 0.67
Carbohydrate	17.97 ± 0.58
Energy value (Kcal/g)	385.21 ± 4.26
Mineral content (%)	
Potassium	1.97 ± 0.01
Sodium	0.47 ± 0.01
Calcium	5.50 ± 0.14
Magnesium	1.75 ± 0.01
Phosphorus	1.24 ± 0.11
Zinc	1.81 ± 0.12
Iron	3.01 ± 0.13

[1]Each data is mean ±SD of triplicate determinations

The crude protein (4.49%) in the Shea fruit obtained in this study is higher than that reported on Shea fruit pulp in Uganda by Prokarite [24]. This variation may be due to differences in soil, climate and other environmental conditions. Also, the crude fat content (10.6%) obtained in study is higher than the 1.5-3.5% reported by Wilhelmina [25] in his study on Shea fruit in Ghana. This may be due to differences in post harvest handling processing. The ash content (11.55%) of the Shea fruit pulp obtained in this study is comparable to those reported for other edible fruits across the West African region. Ash content of fruits and seeds is important because it determines the amount of minerals and trace metals that are vital in human dietary intake [26]. Furthermore, the high energy value of Shea fruit recorded in this study (385.21 Kcal/g) is an indication of its high carbohydrate content and as well as the

varieties of carbohydrates (fructose, galactose and glucose) it contains [21]; this therefore maybe the reason why it is highly patronized by farmers in West and Central Africa [27].

Mineral composition in Shea fruit pulp

The result in Table 2 showed that the Shea fruit pulp investigated in this study contains Na, K, Mg, Fe, P, Zn, and Ca in various amounts which are important minerals that constitute the nutrients required by human and animals for growth and development [28]. The K content in Shea fruit obtained in this study (1.97%) is comparable with the 2.0% K content reported in other wild and domesticated edible fruits. Potassium plays a vital role in protein, synthesis, body fluid balance, nerve and muscular function, glucose and glycogen absorption and regulating blood pressure [23]. The amount of Na present in the studied Shea fruit pulp is 0.47% and is still within the recommended daily allowance of 0.50 % as reported by NRC [29]. From this study, the Na/K ratio was calculated to be 0.24 % which is less than 1 %; this indicates that Shea fruit pulp is recommended for consumption and in the management and control of hypertension [29]. The amount of Ca estimated in the Shea fruit pulp is 5.50% which indicates that Ca is the major mineral present in the Shea fruit pulp although it is lower than the 8.8 % Ca reported in a similar study [14]. Calcium play the role of cofactor in many physiological and metabolized functions such as in bone and teeth formation, nervous system, hormonal secretions, enzyme activations, and blood clotting [28]. The result in Table 1 also showed that the Shea fruit pulp analyzed in this study contains P (1.24%), Zn (1.86%) and Fe (3.01%). Also, the Mg in the Shea fruit pulp (1.75%) as evaluated in this study is below the 6.0% recommended by NRC [29] in similar fruit pulp. Magnesium is an important element required for release of enzymes required for synthesis and break down of carbohydrates, fats, proteins in synthesis of RNA and DNA [30].

Phytochemical constituent of Shea fruit pulp

The presence of alkaloids, saponins, tannins, anthraquinones, terpenes, flavonoids, and glycosides as phytochemical constituents in the Shea fruit pulp (Table 2) may be the basis of its medicinal and health properties and hence explains why it has been used to cure and prevent various illness and diseases [31]; therefore, the valuable pharmaceutical properties of *V. paradoxa* may be due to the presence of these bioactive compounds (Table 2).

Table 2: Qualitative phytochemical constituent of methanol extracts of dried Shea fruit pulp

Phytochemical constituent	Inference[1]
Saponins	++
Flavonoids	++
Alkaloids	+++
Tannins	++
Anthraquinones	+
Carbohydrates	++
Steroids	+++
Cardiac glycosides	+

[1] Key ++ = high concentration; +++ = very high concentration and + = moderate concentration

Alkaloids are heterocyclic nitrogen-containing compounds found to have anti-malaria, antibacterial, anti-cancer, analgesic, anti-asthma, anti-hyperglycemic and anti-arrhythmic effect [32]. This may be responsible for the use of the Shea pulp in treating diseases such as cancer, body pain and diabetes. Tannins are bioactive compounds with a hot astringent taste that are toxic to microorganisms, therefore, their presence in Shea fruit pulp may be the basis for their anti-diarrheal and anti-hemorrhage roles in human [33]. Furthermore, flavonoids are polyphenolic bioactive compounds which reduce the risk of cardiovascular disorder and lower hypertension; and this may be the reasons why Shea fruits are eaten by rural dwellers especially those diagnosed as being hypertensive [34]. Also, the presence of saponins could be responsible for the use of the Shea fruit ash in local soap making and to cure skin diseases.

Saponins generally have a soapy feel, hemolytic activity and lowering of cholesterol thus the pulp is chewed raw to reduce high cholesterols in man [35].

Conclusion

The findings of this research show that Shea fruit pulp has a high nutritional potential and health benefits. Therefore, large-scale cultivation of *V. paradoxa* should be promoted so as to meet up with its high consumption.

Ethical approval and consent: NA

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