Nutritional and Antinutritional Composition of Raw and Cooked Raffia Palm (*Raphia farinifera*) Fruits from Nupe Land, Nigeria

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ABSTRACT

Background: : *Raffia palm (Raphia farinifera) fruit belongs to the family of Arecaceae.*

Objective: *The work is aimed at evaluating the nutritional and anti-nutritional analysis of Raffia palm (Raphia farinifera) fruit from Nupe land.*

Methods*: The fresh fruits of Raphia farinifera were cooked for two hours before carrying out the analysis. The parameters analyzed involve proximate composition (moisture, crude fiber, protein, fat, carbohydrate, and energy contents), minerals (calcium, potassium, sodium, iron, and magnesium), and antinutritional factors (oxalate, tannin, phytate, and cyanide) using standard procedures and methods.*

Results: *High levels of moisture (20.90%) and carbohydrate (83.34%) were noted in boiled Raphia farinifera than in the raw samples. However, a low level of ash (2.97%), protein (1.24%), fiber (0.50%), fat (2.30%), and energy (341Kcal/100g) were observed in the boiled Raphia farinifera than in the raw one. The mineral contents in the boiled sample were reduced significantly ($p<0.05$) compared to the raw one. Reductions of antinutritional factors to the levels of their permission limit were noted in the cooked samples compared to the raw one.*

Conclusion: *Therefore, the Raphia farinifera fruit consumption after cooking could be beneficial to the health of consumers and help in combating the problem of malnutrition in Nigeria.*

Keywords: Antinutrient, Nutrients, Minerals, Proximate Content, *Raphia farinifera*

INTRODUCTION

A lot of wild edible fruits are recommended as a good and important nutrient source in the developing nations facing the problems of food scarcity and an adequate amount of nutrition is given to the inhabitants by the said fruits(1). Recently, high interest has been developed for the evaluation of various wild edible fruits for their nutritional contents (2).Fruits being a vital portion of a good diet can provide adequate supplementation of food. Fruits are also a good source of vitamins; minerals, antioxidants, and micronutrients (3).Humans take in fruits, even without understanding their nutritional content and value due to its attractive and edible nature. An example of such fruit is Raffia palm (*Raphia farinifera*).This fruit is not easily digested in their natural state and should be cooked prior to consumption. Cooking improves the digestibility, promotes palatability of such fruit, and enhances its keeping quality as well as making the fruit safer for consumption (4). Uche et al., (5) reported that nutritional and antinutritional factors may be affected by boiling.

Raphia farinifera belongs to the family of Arecaceae, with the local name as Bankoro in Nupe language. It is mostly cultivated in a swampy soil and grown adequately in weather and climate with a temperature of about 23 – 33

°C (6). The raffia palm tree is typically grown in African tropical regions (7). Raffia palms are one of the sources of palm wine and broom production. *Raphia farinifera* which belongs to the family of *Arecaceae* is locally called as bankoro in the Nupe language. It can be used as food upon boiling for humans. Its oils are rich in Fatty acids such as oleic acid, linoleic acid, and palmitic acid. Raffia palm oils also contain sterol compounds like β sitosterol (8). The root of *Raphia farinifera* can be used in treating toothache. The sheath of the leaf contains good fibers that are used in treating disorders of the digestive tract and the fruit pulp after boiling are used in preventing dysentery (8). Based on the economic significance of *Raphia farinifera* and its underutilization by humans necessitate the evaluation of its nutritional and anti-nutritional composition as affected by cooking.

MATERIALS AND METHODS

Collection of samples

The fruits of the specimens, *Raphia farinifera* were sourced locally from Tama village along Kateregi-Minna road, Niger State. They were identified, labeled, and deposited in the herbarium section of the Ibrahim Badamasi Babangida University, Lapai (IBBUL), Nigeria.

Sample preparation

The fruits of *Raphia farinifera* sampled were washed with distilled water and subjected to cooking at 100 °C for 2 hours. The mesocarp portion of the cooked fruits was removed gently; air-dried at room temperature for 5 days and then packed in an airtight container for further usage.

Moisture content determination

This was determined using the method of AOAC, (9) following the description of Shumaila and Mahpara (10). In a short note, the sample of about 1.5 g was weighed into a dried crucible dish and the weight was labeled W_1. Thereafter, the crucible dish containing the specimen was inserted into an oven at 100-105°Cfor 12 hr to have a constant weight. Then the cooled crucible and its contents was again weighed, and labeled W_2. Hence, the % of moisture was calculated as:

$$\% \text{ Moisture} = \frac{W_1 - W_2 \times 100}{SW}$$

Note:
SW = specimen weight
W_1 = Initial weight of specimen and crucible dish
W_2 = Final weight of specimen and crucible dish

Ash content determination

This is done using the method of AOAC, (9) considering the description of Shumaila and Mahpara, (10). Briefly, a clean, dried, and cooled empty crucible dish acquired from a muffle furnace at 600°C was labeled W_1.About1.0g of the specimen was introduced into the crucible dish and labeled W_3. Inside the Muffle furnace at 550°C for 2-4 hr, the oxidation of all the organic matter in the specimen contained in the crucible was confirmed by changing the color of the specimen into gray-white. Then the cooled crucible dish containing the gray-white colored sample inside the desiccators was weighed and labeled W_3. The % ash was calculated as:

$$\% \text{ Ash} = \frac{W_3 - W_1 \times 100}{SW}$$

Note:
SW = specimen weight
W_1 = Initial weight of specimen and crucible dish
W_3 = Final weight of specimen and crucible dish

Protein content determination

This was performed using the Kjeldahl method of AOAC (9) which was described by Shumalia and Mahpara (10). Briefly, about 1 g of the dried specimen was placed into a digestion flask containing 15ml of Conc. H_2SO_4 and top up with 5g of digestion mixture. The mixture was then heated for 2 hr to turn the digestion colour to bluish-green colour. Then the cooled digest was placed into a volumetric flask (100ml). About 10ml of the digest was placed into the distillation tube, 10ml of 0.5 N NaOH was added and distilled for 10 min. The ammonia produced was collected as ammonium oxide into a conical flask with the addition of 20ml of 4% boric acid solution and drops of indicator (methyl red). Then the distillate was titrated against a standard solution (0.1 N HCl) until a pink colour was observed as the endpoint. The blank sample was repeated following the same procedure. The % crude protein was calculated as:

$$\% \text{ Crude Protein} = 6.25 \times \%N$$

Crude fat determination

This was performed using a Soxhlet apparatus through AOAC, (9) method following the description of Shumalia and Mahpara,(10). Briefly, 1.0g of the sample (moisture-free) was wrapped in filter paper and placed into the

extraction tube. Thereafter, a beaker filled with petroleum ether was placed in a heating mantle, fixed to the Soxhlet apparatus for extraction, and the extract in the beaker was transferred into a dish and placed in the water bath for ether to evaporate. Then, the dish containing the extract was introduced into an oven at 105°C, cooled in the desiccators, and weighed. The % crude fat was calculated as:

$$\%\text{Crude Fat} = \frac{\text{Weight of ether extract after cooling} \times 100}{\text{Weight of sample}}$$

Crude fiber determination

This is done using the method of AOAC, (9) considering the description of Shumaila and Mahpara, (10). Briefly, about 0.153 g of the sample was weighed into a crucible dish (W_1) with the addition of preheated H_2SO_4 (150ml), a few drops of form-suppresser, and the mixture was heated for 30 min. Thereafter, an oven at 150°C was used to dry the mixture for1 hour, cooled, and then weighed (W_2). The crucibles containing the sample were then placed in a muffle furnace at 55°C for 4 hrs and allowed to cool. The % crude fiber was calculated as:

$$\%\ \text{Crude fiber} = \frac{W_1 - W_2 \times 100}{W_3}$$

Carbohydrate content determination

The % carbohydrate was calculated using nitrogen free extract (NFE) as:

Mineral determination

The minerals were determined using AOAC (9) method described by Shumaila and Mahpara, (10). Iron (Fe), calcium (Ca), and magnesium (Mg) of both fresh and cooked *Raphia farinifera* were determined using Atomic Absorption Spectrometry. While sodium (Na), potassium (K), and phosphorus (P) were determined using a flame photometer. Briefly, 1.0g of the sample (powder) was placed in the digestive tube, with the addition of HNO_3 (12ml), and the mixture was kept overnight at 0°C. Thereafter, into the mixture about 3.0ml of perchloric acid was added and kept overnight at 0°C for digestion. Complete digestion was confirmed with the appearance of white fumes after 80 min. The mixture was kept cool; all content was transferred to a volumetric flask and made to mark 100 ml using distilled water.

NFE = (100 - % moisture + % crude fat + % crude protein + % ash + % crude fibre)

Anti-nutritive determinations

Oxalate

This was evaluated following the method of Peters et al. (1). Two grams of each diet were added into a 150 ml conical flask containing 80 ml of 0.75M H_2SO_4. Each solution was stirred using a magnetic stirrer for 1hr and filtered. Then, about twenty milliliters (20 ml) of each filtrate was pipette and titrated hot at (80°C) against 0.2M KMNO4 to have a faint pink colored as the endpoint. Oxalate content was calculated as T × constant

Phytate

This was done using the method of Peters et al. (1). Briefly, about five grams (5 g) of each sample dissolved in 120 l of HCl for 4hrs, separately. Each of the mixtures was filtered, then, about 5 ml of 0.2% NH_4SCN and 50 ml of distilled water were added to 20 ml of each filtrate. The solution was then titrated against a standard $FeCl_3$ solution to observe a brownish yellow colour as the endpoint. The phytate content was calculated as T × constant

Tannin

This was performed using the method described by Shaba et al., (11) and Shumaila and Mahpara,(10).Briefly, 0.2g of the sample was placed into a 50ml beaker containing 25ml of 60% methanol, covered with Parafilm and placed in a water bath at 80°C foran hr. The mixture was vigorously stirred, filtered into a 100ml volumetric flask containing a mixture of 20ml of water, 2.5ml of Folin-Denis reagent and 10ml of Na_2CO_3, and mixed vigorously with a stir. Thereafter, the mixture was kept for 15 min to allow a bluish-green colour formation, the absorbance of the tannic acid standard solutions, and that of samples were read at 760nm using a UV-spectrophotometer (model 752).

Cyanide

This was done using the alkaline picrate method as described by Onwuka, (12). Exactly, 5.0g of the sample (powdered) was weighed into a 100ml conical flask containing 50ml of distilled water, kept standing overnight, and filtered. Thereafter, 1ml of sample filtrate was measured in a corked test tube containing 4ml of alkaline picrate and incubated in a water bath for 5mins to allow reddish-brown colour formation. The absorbance of sample filtrate and that of cyanide standard

Table 1. Proximate composition of processed and unprocessed *Raphia farinifera*

Sample	Nutrient						
	Moisture (%)	Ash (%)	Protein (%)	Fiber (%)	Fat (%)	Carbohydrate (%)	Energy (KCal/100g)
Raw	12.14±0.11[a]	3.50±0.14[a]	2.50±0.15[a]	1.20±0.21[a]	3.64±0.23[a]	81.40±0.12[a]	375±0.14[a]
Cooked	20.90±0.11[b]	2.97±0.24[b]	1.24±0.25[b]	0.50±0.15[b]	2.30±0.12[b]	83.34±0.21[b]	341±0.13[b]

Data are presented as mean ± SD. Different superscript (s) down the column are significantly different from each other at < 0.05.

solution were measured, separately, at 490nmusing a UV-spectrophotometer (model 752).

Caloric value

This was calculated in kilocalories per 100 g (kcal/100 g) by multiplying the crude fat, protein, and carbohydrate values by Atwater factors of 37, 17, and 17 respectively (11).

RESULTS

The results of proximate composition in both raw and cooked *Raphia farinifera* are presented in Table 1. A significant difference was established between the proximate components in unprocessed *Raphia farinifera* compared to those in cooked *Raphia farinifera* (Table 1).

High moisture (20.90%) and carbohydrate (83.34%) contents were significantly recorded in cooked *Raphia farinifera* as compared to that of unprocessed *Raphia farinifera* (12.14 and 81.40%), respectively. However, ash, protein, fiber, fat, carbohydrate, and energy contents of

Table 2. Mineral composition of processed and unprocessed *Raphia farinifera*

Sample	Mineral				
	Calcium (mg/100g)	Potassium (mg/100g	Sodium (mg/100g)	Magnesium (mg/100g)	Iron (mg/100g)
Raw	275.10±0.21[a]	345.12±0.13[a]	235.63±0.16[a]	56.60±0.21[a]	14.57±0.22[a]
Cooked	240.21±0.23[b]	224.40±0.14[b]	210.20±0.12[a]	43.40±0.24[b]	13.20±0.12[b]
Change	↓34.89*	↓120.72*	↓25.43*	↓13.20*	↓1.37*
RDA	*210-800, **800, ***1200	*400-3000, **,***4700	*120, **,***1500	*30-130, **240-360, ***320-340	*0.27-11, **8-15, ***10

*Data are presented as mean ± SD. Different superscript (s) down the column are significantly different from each other at < 0.05. ↓: Signifying decrease, RDA: Recommended dietary allowance in mg/day (US, Department of Agriculture) and could be accessed through http://www.nap.edu/.*Infants; **children; ***adults.*

Table 3. Antinutrient composition of processed and unprocessed *Raphael farinifera*

Sample	Oxalate (mg/100g)	Phytate (mg/100g)	Tannin (mg/100g)	Cyanide (mg/100g)
Raw	27.10±0.21[a]	1.15±0.13[a]	587.63±0.16[a]	16.60±0.21[a]
Cooked	16.21±0.23[b]	0.42±0.14[b]	320.20±0.12[a]	10.40±0.24[b]
Change	↓10.89	↓0.73	↓267.43	↓6.20

Data are presented as mean ± SD. Different superscript (s) down the column are significantly different from each other at < 0.05. ↓: Signifying decrease.

raw *Raphia farinifera* were significantly higher ($P<0.05$) than those of processed *Raphia farinifera* (Table 1).

Table 2 shows the results of mineral composition in both raw and cooked *Raphia farinifera*. It reveals a significant increase ($P>0.05$) of all mineral levels evaluated in raw *Raphia farinifera* compared to those in processed *Raphia farinifera* (Table 2).

Higher content of Ca (275.10 mg/100g), K (345.12 mg/100g), Na (235.63mg/100g), Mg (56.60mg/100g), and Fe (14.57mg/100g) were recorded in unprocessed *Raphael farinifera*. While boiling significantly ($P<0.05$) reduce the levels of all minerals in *Raphael farinifera* as follows: {Ca (140.21mg/100g), K (224.40mg/100g), Na (210.20mg/100g), Mg (43.40mg/100g), and Fe (13.20mg/100g).
The results of the anti-nutrient contents are shown in Table 3. Higher significant ($P<0.05$) values of all antinutrient evaluated were recorded in unprocessed *Raphael farinifera* compared to that of the cooked sample (Table 3).

DISCUSSION

A high significant value of moisture observed in the unprocessed sample, which is lower than the recommended range (0-13%) as reported by James, (13) signifies that the sample has a better shelf life even without processing and it can resist the microbial destruction. However, the reverse is not the case as the moisture content in the cooked sample increase significantly ($P<0.05$) which was even above the recommended range (0-13%) as stated by James, (13). This elevation observed could signify the absorption of water during the boiling. Cooking processes elevated the moisture content due to water absorption during boiling (14). It could be probably due to the damage of the cell by the boiling effect. This elevated moisture content as observed in the sample showed that it may be more inclined to microbial damages (11). Shaba et al., (11) have demonstrated that nourishments with high moisture content are more inclined to perishability. Rise in moisture content after cooking was reported by Goly et al. (15) in yam tubers, Amon et al. (16) in taro tubers. Moisture is a vital biochemical parameter to be considered during the storage and viability of food samples (5, 17). James, (13) has narrated that moisture levels above 13% encourage microbial attack. An increase in moisture content can encourage the growth of microorganisms (17). Besides, low ash content observed in processed *Raphia farinifera* compared to the unprocessed *Raphia farinifera* suggest a high deposit of minerals in the sample and can serve as a vital tool for the evaluation of mineral elements(18).That is *Raphia farinifera* may likely contain high qualities essential minerals which serve as a tool to measure and grade the nutritive quality of foods (11, 15).The ash values obtained in both raw and cooked *Raphia farinifera* are within the acceptable limit (2.4-5.0%) as a recommendation by FAO (19). This finding correlates with that of Goly et al. (15) that the ash content of yam was reduced upon cooking. Ash represents the mineral matter left after food material is burnt in oxygen (20). Enwereuzoh et al. (20) have reported that ash is a vital biochemical tool used to determine the content of mineral in a sample. Also, the lower level of crude protein observed in the processed *Raphia farinifera* compared to the raw sample could be associated with leaching of the protein in the boiled sample. This finding complies with what was reported by Uche et al. (5), Goly et al. (15), and Adegunwa et al, (21). Shaba et al. (11) have reported that crude protein works as cell response mediators, catalysis for enzymes, and cell growth and differentiation.
Likewise, a slight decrease in fiber content obtained in the cooked *Raphia farinifera* compared to that of the raw one agreed with the reports of Goly et al. (15) that cooking reduced the content of fiber in the processed yam tuber than to the raw one. The crude fiber is a representative of sugar (indigestible) in the sample (5). Diets with low fiber content could be agents of stomach constipation and liable to be associated with colon diseases such as piles, appendicitis, and colon cancer (15). Shaba et al. (11) have demonstrated that fiber is very vital; it favours water absorption and roughage provision in the bowels and taking care of intestinal transit. It reduces the plasma cholesterol absorption in the gut and causes the digestion and conversion of starch to simple sugars to be delayed. Diets with high fiber could be a vital tool in preventing the processes of oxidative in food products and an important functional ingredient in the food.(22). Low crude fat content observed in the cooked *Raphia farinifera* as compared to unprocessed one could suggest that *Raphia farinifera* is generally not a better source of fat. This finding compromised with the reported obtained by Peters et al. (1), Uche et al. (5), and Goly et al. (15) that boiling reduces the fat composition of a

sample. Peters et al. (1) have demonstrated that fat performs a vital role in the shelf life of foods. The low-fat foods are always desirable as it may prevent the generation of rancidity, unpleasant, and odourous compounds in foods (1). However, high carbohydrate content recorded in the cooked sample than to raw one justifies that *Raphia farinifera* fruits are potential energy suppliers. This finding is in line with what was reported by Uche et al. (5), Goly et al. (15) that boiling increases the carbohydrate composition of the sample. Agiang et al. (23) have demonstrated that boiling breaks down the granules and make the cellulose softened, which make the starch available. Enwereuzoh et al. (20) have narrated that the source of energy provision for the body cells (brain), which depends on carbohydrate for its function. It is also a function in the maintenance of plasma level and controls the delay of the body protein digestion by promoting protein bioavailability (20).

Subsequently, the low levels of all macrominerals recorded in the cooked *Raphia farinifera* fruits could be probably due to the leakage of minerals from the sample to the water medium during boiling. Though the amount of calcium and potassium recorded in *Raphia farinifera* fruits is likely higher than what was reported in *Sphenostylis stenocarpa* (5), but comparably lowered than what was demonstrated by Shaba et al. (11) for date palm fruit.

Variedly, the iron, magnesium, and sodium levels observed in *Raphia farinifera* fruit were differed inappreciably to what was reported by Uche et al. (5) for African Yam Beans and by Shaba et al. (11) for Date palm fruit. All these still suggested that *Raphia farinifera* fruit could be an alternative source of these minerals. , the levels of potassium and magnesium in processed *Raphia farinifera* fruit were far less than the recommended Dietary Allowance (RDA) of these minerals for infants, children, and adults. However, the calcium, sodium, and iron contents of the cooked *Raphia farinifera* fruit met the RDA for infants only, but its inclusion in other diets/foods, its RDA could be met. The activities of metabolism are sole guided through mineral elements. Peters *et al*. (1) have demonstrated that calcium is a macronutrient essential to health and wellbeing, which control diverse biological functions in the human body. It serves as a second messenger for nearly every biological process, stabilizes much protein, and in deficient amounts is associated with a large number of diseases.

Furthermore, the reductions of antinutrient factors upon boiling to their permissible limit have been reported by Uche et al. (5). The high reduction on the content of tannin in cooked *Raphia farinifera* may be possible due to the leaching of tannin to the boiling water medium. It may also due to the effect of heat on the heat-labile tannin content in the sample. This is in line with what was reported by Uche et al. (5) for the boiled *Sphenostylis stenocarpa* seeds and Goly et al. (15) for the boiled *Dioscorea esculenta* tubers. Tannins are polyphenol compounds that are water-soluble (24). Goly et al. (15) has reported that reduction in the level of tannin upon boiling could have resulted from the thermal degradation and denaturation of the tannin and its insoluble complexes formation. The nutrient contents of food can be affected by tannin through insoluble complexes formation with protein and reduce the protein digestibility (25). Tannin can also alter the quality of protein by reducing its digestibility and palatability, and causing cancer of the intestinal tract Tannin forms complexes with iron and make it unavailable to the system (15).A significant reduction ($p<0.05$) of phytate levels in the boiled *Raphia farinifera* fruit could be possibly due to its insoluble complexes formation with protein. This agrees with the report of Bhandari et al. (26) that phytate can form complexes with protein, minerals, and other compounds to give phytate-protein and phytate-protein–mineral complexes, respectively. Martın-Cabrejas et al. (27) have demonstrated that cooking, socking and germination substantially decrease the level of phytate. Loss of phytate levels upon boiling was observed in yam samples (28, 15) and wild yams tubers of Nepal (26). Hence, the information on the phytate level in foods could be vital as its high concentration can negatively affect the digestibility and lower the bioavailability of many essential minerals. Subsequently, the drastic reduction of oxalate content in cooked *Raphia farinifera* after boiling could suggest oxalate dissolution in boiling water. Cooking may results in the sample's skin damage, considerably enhancing the leaking of the dissolved oxalate into the boiling water medium. This may be the cause of high oxalate level reduction after boiling. Okaka et al. (29) have demonstrated that boiling with water does affect the levels of oxalate. This finding is in line with the report of Goly et al. (15) that cooking reduces the oxalate composition. Considerably, the oxalate level reduction upon boiling may have a great benefit on the consumer's health, as it can increase the availability of dietary nutrients in the

system and preventing the occurrence of kidney stones on consumers (15). Oxalate easily forms complexes with available minerals and rendered them not bioavailable (5). Oxalate is responsible for inaccessible of calcium in the body by forming insoluble salts (11). Lastly, Low significant ($p<0.06$) value of cyanide observed in boiled *Raphia farinifera* fruit than to raw one could be attributed to the enhanced leaching of cyanide in the boiled sample into the heated water. This finding agreed with what was reported by Uche et al. (5), Goly et al. (15) that boiling reduces antinutrient factors in *Sphenostylis stenocarpa* seeds and *Dioscorea esculenta* tubers, respectively. The cyanide level of the raw *Raphia farinifera* fruit recorded was less than what was discovered by Uche et al. (5) in raw *Sphenostylis stenocarpa* seeds and Chikwendu, (30) in the ground bean. Fortunately, cooking was able to reduce the cyanide level beyond its permissible level, which is saved for human consumption. Generally, cyanides are heat-labile and can easily be inactivated upon boiling (5). Shaba et al. (11) demonstrated that a low level of cyanide in the sample beyond the permissible limit signifies it's toxic-free upon consumption.

CONCLUSION

The findings of this study showed that *Raphia farinifera* fruit possesses a good nutritional profile with high levels of proximate composition and minerals as compared to common yam tubers and legume grains. Boiling reduces drastically, the antinutritional factors of *Raphia farinifera* fruit beyond their permissible limits. Therefore, based on these findings, the *Raphia farinifera* fruit consumption could be beneficial to the health of consumers and help in combating the problem of malnutrition in Nigeria.

CONFLICT OF INTEREST

No conflict of interest declared.

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