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Chemical Evaluation of the Nutritive Value of the Raffia Palm Fruit (*Raphia hookeri*)

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ABSTRACT

Investigations were carried out to determine the chemical composition of the fruit of the raffia palm (Raphia hookeri: *Family, Palmaceae or Palmae*). *The peel and pulp (edible portion) were analysed. The effect of boiling on the chemical composition of the pulp was also investigated.*

The peel contained more moisture (62·4%) than the pulp (38·0%) in terms of wet weight. The protein and ether extract contents of the peel were found to be 3·2% and 1·8% of dry material, respectively. The ash content was 5·5%. Crude fibre gave a very high value of 70·3% for the peel, but the carbohydrate content was low (19·3%).

There were decreases in the values of some nutrients after boiling the edible pulp of the fruit. Protein content decreased from 6·1% to 4·4% upon boiling. Ether extract and carbohydrate contents decreased from 11·8% to 11·3% and from 61·4% to 58·8%, respectively. Boiling increased the crude fibre and ash contents of the pulp from 17·7% and 3·0% to 21·2% and 4·3%, respectively. The calorific value decreased from 380·5 kcals to 354·7 kcals.

Tannin content was highest of all the toxic substances evaluated. There was a decrease from 597 to 360 mg/100 g on boiling. The peel contained 234 mg/100 g tannins and 24·3 mg/100 g hydrocyanic acid. Boiling the pulp resulted in reduction of the HCN from 12·4 to 9·2 mg/100 g, phytic acid from 1·0 to 0·4 mg/100 g, and oxalate from 26·4 to 17·6 mg/100 g. The peel had more oxalate (39·6 mg/100 g) and cyanide (24·3 mg/100 g) but less phytic acid (0·6 mg/100 g) than the pulp.

Ascorbic acid and carotene contents decreased upon cooking the pulp

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from 63·0 mg/100 g and 33·4 μg/100 g to 28·3 mg/100 g and 10·6 μg/100 g, respectively. The peel had an ascorbic acid content of 37·2 mg/100 g and carotene content of 8·6 μg/100 g.

Calcium, potassium, sodium and phosphorus decreased with cooking, while magnesium, zinc and iron contents were increased. Potassium had the highest level followed by calcium. The pulp had (mg/100 g): K, 1075; Ca, 875; Mg, 315; Zn, 9·6; P, 76·8; and Na, 16. The peel had (mg/100 g): Ca, 250; Mg, 450; K, 700; Na, 8; Zn, 3·5; and P, 37·7. Copper, chromium and cobalt were not detected in the fruit.

The results are discussed in terms of the value of the fruit as food for man or animals.

INTRODUCTION

Fruits are among the 14 food groups considered in the *Food composition table for use in Africa* (FAO, 1968). Fruits are usually regarded as good sources of vitamins, mineral elements, water and carbohydrates. Among the plant food materials, a lot of nutritional studies have been carried out on cereals, tubers, grain, legumes, nuts and vegetables.

Nutritional studies on a number of fruits have also been reported (FAO, 1968; Oyenuga, 1968). There are, however, certain lesser known fruits in Nigeria which have received little or no attention. One such fruit is the raffia palm fruit.

The raffia palm tree (*Raphia hookeri*) is commonly found in West Africa and is abundant in the southern parts of Nigeria, in particular the south-eastern parts. The raffia palm tree is a representative of the family Palmae or Palmaceae. The raffia palm usually grows to 12 m high. The stem is covered with black leaf-fibres (piassava). The leaves are erect and pinnate, and up to 12 m long with linear leaflets (about 25 cm long and 5 cm wide) and prickly midribs. The tree flowers in May with the male and female flowers on the same flower stalk. The fruits are usually oblong–ellipsoid in a scaly cone comprised of rhomboid–triangular reddish-brown scales. Each fruit has an irregular grooved single seed. A bunch of fruits may contain as many as 400 fruits. Raffia, obtained from the leaves, is used in Nigeria for making raffia cloth, mats, hoods, bags, ropes, etc. It is also a source of piassava used commercially in the manufacture of strong brushes. It is a source of raffia palm wine obtained from the fermented sap resulting from tapping the terminal bud of the mature tree. It is also a source of raffia bamboo used in making ladders,

chairs, and beds, and for building. The leaves are used in making roof mats and the young terminal leaves can be eaten as vegetables (Irvine, 1961). The trunks are used in building and in canoes.

The fruit pulp (*ube*: Efik) of some species of raffia palm are eaten in the south-eastern parts of Nigeria. The yellow oily pulp is used as a bitter flavouring or occasionally as a food, particularly when fresh. It is sweeter in some species of raffia palm than in others. It can be eaten raw or after boiling but the taste is more agreeable when boiled than when raw. The pulp is normally consumed with boiled, sliced cassava tuber (*edita iwa*: Ibibio). The pulp is sometimes pounded with other plant substances and used as fish poison. A yellow fat, raffia butter, can be obtained from the pulp by boiling and has an agreeable taste, when fresh. As an oil, 'piassava oil', this is used for lighting and even for cooking; also as a lubricant and as a hair-dressing pomade (Irvine, 1961). The fruit pulp is also used as medicine with stomachic and laxative properties and as a linament for various pains.

The seeds of raffia palm are cut to make rings and are also used as fish poisons; the ash from the seed is used as kitchen salt in some countries of West Africa. The kernel is said to be boiled and eaten by the Fulani and Tiv of Nigeria and also in Gabon (Irvine, 1961).

There is at present very little information on the nutritive value of the fruit of raffia palm tree. The proximate composition of raffia palm kernel has been reported by FAO (1968). It was found to contain moisture, 10·6%; protein, 7·8%; fat, 1·0%; carbohydrate, 63·3%; fibre, 8·1% and ash, 9·2%.

There is no available information on the chemical composition of the edible pulp. The present series of investigations were carried out to determine, by chemical evaluation, the nutritive value of the raffia palm fruit, with special reference to the peel and the pulp (raw and cooked).

EXPERIMENTAL

Collection and treatment of samples for analysis

Samples of fruit of raffia palm, *Raphia hookeri*, were obtained from trees growing in Calabar and Uyo, in the Cross River State of Nigeria. They were conveyed to the laboratory and sorted into three groups for analyses, namely, the peel, the raw pulp and the cooked pulp. The cooked

pulp was obtained after boiling the whole fruit in water for 2 h. The hard kernels or seeds were discarded. The samples for analysis were broken into smaller pieces to allow for effective drying. They were then dried in a hot air circulating oven (Astel–Hearson) at about 60 °C for 12 to 24 h, and then ground in a steel-bladed grinding mill (National Model MR 308, Japan) into a fine powder which passed through a 30 mesh sieve (Joslyn, 1970; AOAC, 1975). They were stored in air-tight bottles from which aliquots were taken for analysis. Moisture was determined on the wet samples by drying to constant weight at a temperature of 60–80 °C in a hot air circulating oven.

Analysis of samples

The methods used for analysis were the standard methods of Joslyn (1970) and the recommended methods by the Association of Official Analytical Chemists (AOAC, 1975).

Ash was determined by incineration of the sample in a muffle furnace at 600 °C for 24 h; the percentage of the material burnt off was regarded as the organic matter. Crude lipid was estimated by exhaustive extraction of a known weight of dried sample with petroleum ether (bp 40–60 °C) using a Soxhlet apparatus.

The micro-Kjeldahl method was used for the determination of crude protein. Crude fibre was obtained from the loss in weight on ignition of dried residue remaining after digestion of a fat-free sample with 1·25% H_2SO_4 and 1·25% NaOH solutions under specified conditions. The carbohydrate content (excluding fibre) was obtained by subtracting the sum of protein, fat, ash and fibre from the total dry matter. The caloric value was obtained by multiplying the mean values of the crude protein, lipid and carbohydrate by Atwater factors of 4, 9 and 4, respectively, and taking the sum of the products expressed in kilocalories.

Mineral element composition was determined using an atomic absorption spectrophotometer. The alkaline titration method was used in the estimation of HCN (AOAC, 1975). The method of Burns (1971) was used for estimation of tannin and the method of Dye (1956) for the estimation of oxalate. The method of McCance & Widdowson (1953) was used for estimation of phytic acid. Carotene was estimated by the colorimetric method of AOVC (1966) and ascorbic acid was determined by the method of Roe & Kuether (1943) as modified by Scharffert & Kingsley (1955).

The results were subjected to statistical analysis using the t-test (Armitage, 1974).

RESULTS AND DISCUSSION

The results are shown in Tables 1–4. Table 1 shows the proximate composition of the raffia palm fruit samples, expressed in percentage dry weight with the exception of the moisture content which is expressed in percentage wet weight. It also shows the food energy in kilocalories per 100 g of the food samples. The moisture in the peel was 62·4 % of wet weight, and 38 % in both cooked and raw pulp samples. The low moisture content of the pulp is an indication of the high solid matter content of the samples. The crude protein was low, being 3·2 % for the peel, 6·1 % for the raw pulp and 4·4 % for the cooked pulp. It appears that cooking reduced the quantity of protein in the sample. It will be rewarding to determine the quality of these proteins using chemical score in terms of the essential amino acids composition and also by feeding experiments on animals. Studies in these directions are in progress.

The fat (ether extract) for the peel was 1·8 %, for the cooked and raw pulp, 11·3 % and 11·8 %, respectively. The pulp appears to be oily and cooking did not affect the fat content in any appreciable way. It will be of interest to characterise the fat and to find out other possible uses for it. Studies are also being carried out in this direction. There are claims that the oil is used in lighting, as pomade, lubricants and for cooking (Irvine, 1961). It is of

TABLE 1
Proximate Composition (Mean ± standard error)[a] of Fruit of Raffia Palm (% dry matter)

	Peel	*Raw pulp*	*Cooked pulp*
Food energy (kcals)	104·2 ± 2·0	380·5 ± 5·5	354·7 ± 6·1
Moisture (fresh weight)	62·4 ± 0·1	38·0 ± 1·1	38·0 ± 1·1
Crude protein	3·2 ± 0·2	6·1 ± 0·4	4·4 ± 0·5
Ether extract	1·8 ± 0·1	11·8 ± 0·1	11·3 ± 0·8
Crude fibre	70·3 ± 0·8	17·7 ± 0·6	21·2 ± 0·3
Ash	5·5 ± 0·1	3·0 ± 0·1	4·3 ± 0·2
Carbohydrate	19·3 ± 0·3	61·4 ± 0·1	58·8 ± 0·6

[a] Mean of 8 determinations in triplicate.

TABLE 2
Minerals of the Fruit of Raffia Palm (mg/100 g dry matter)[a]

Mineral element	*Peel*	*Raw pulp*	*Cooked pulp*
Calcium	250	875	800
Magnesium	450	315	415
Potassium	700	1075	675
Sodium	8·0	16·0	13·0
Phosphorus	37·7	76·8	63·7
Iron	0	0	10·0
Copper	0	0	0
Zinc	3·5	9·6	10·5
Chromium	0	0	0
Cobalt	0	0	0

[a] Average of 2 determinations in triplicate.

TABLE 3
Levels of Ascorbic Acid and Carotene in the Fruit of Raffia Palm (Mean ± standard error)[a]

	Ascorbic acid (mg/100 g dry matter)	*Carotene (μg/100 g dry matter)*
Peel	37·2 ± 1·3	8·6 ± 0·3
Raw pulp	63·0 ± 2·5	33·4 ± 1·4
Cooked pulp	28·3 ± 1·5	10·6 ± 1·1

[a] Mean of 4 determinations in triplicate.

TABLE 4
Levels of Some Toxic Substances in the Fruit of the Raffia Palm (mg/100 g dry matter) (Mean ± standard error)[a]

	Peel	*Raw pulp*	*Cooked pulp*
Tannin	234 ± 4·2	597 ± 7·6	360 ± 5·5
HCN	24·3 ± 0·02	12·4 ± 0·04	9·2 ± 0·02
Phytic acid	0·6 ± 0·2	1·0 ± 0·1	0·4 ± 0·1
Total oxalate	39·6 ± 2·1	26·4 ± 1·8	17·6 ± 1·1
Soluble oxalate	38·5 ± 2·6	18·3 ± 1·5	12·1 ± 1·9
Soluble oxalate as % total oxalate	97·2	69·4	68·8

[a] Mean of 4 determinations in triplicate.

importance to demonstrate that the properties of the oil or fat qualify it for such uses.

The crude fibre content was 70·3 % for the peel, 17·7 % for the raw pulp and 21·2 % for the cooked pulp. The values were quite high showing that the samples contained a large amount of non-alkaline and non-acid digestible substances. The high fibre content is bound to influence the digestibility of the edible portion.

The ash content of the samples was 5·5 % for the peel, 3·0 % for the raw pulp and 4·3 % for the cooked pulp. The values can be considered high for fruits and may be an indication of the high mineral content. The carbohydrate content was 19·3 % for the peel, 61·4 % for the raw pulp and 58·8 % for the cooked pulp. There was a slight decrease in carbohydrate content with cooking. The low carbohydrate in the peel is an indication of the presence of non-carbohydrate substances in a large amount. The food energy was 104·2 kcal for the peel, 380·5 kcal for the raw pulp and 354·7 kcal for the cooked pulp. The pulp contains an adequate amount of food energy.

Table 2 shows the elemental composition of the samples. The samples were high in calcium: 250 mg/100 g, in the peel; 875 mg/100 g in the raw pulp and 800 mg/100 g in the cooked pulp. Magnesium was also high ranging from 300–450 mg/100 g dry material. Potassium was very high, being 700 mg/100 g in the peel, 1075 mg/100 g in the raw pulp and 675 mg/100 g in the cooked pulp. Sodium was comparatively low, ranging from 8–16 mg/100 g dry material. Phosphorus was also low, being 37·7 mg/100 g in the peel, 76·8 mg/100 g in the raw pulp and 63·7 mg/100 g in the cooked pulp. Thus the pulp can be considered as a good source of the macro-elements, calcium, magnesium and potassium. The difference in the level of K, in raw and cooked pulp may be due to loss of K to cooking water. It is also a good source of the trace or micro-elements, iron and zinc. Copper, chromium and cobalt were not detected in the samples. Iron was detected only in the cooked sample suggesting that it may be present in a bound form in the raw samples and hence could not be determined. Iron could also have been introduced from other parts of the fruit during cooking.

Table 3 shows the levels of ascorbic acid and carotene in the samples analysed. The level of ascorbic acid was 37·2 mg/100 g in the peel, 63·0 mg/100 g in the raw pulp and 28·3 mg/100 g in the cooked pulp. These values are low to moderate when compared with the levels in ascorbic acid-rich fruits such as starapple (Edem *et al.*, 1983), and baobab fruits

(Addy & Eka, 1981). The carotene content was 8·6 μg/100 g for the peel, 33·4 μg/100 g for the raw pulp and 10·6 μg/100 g for the cooked pulp. The raw pulp can be considered as a good source of carotene. Cooking tended to reduce the levels of the two vitamins considerably.

Table 4 shows the levels of toxic substances in the fruit of raffia palm, in mg/100 g dry material. The tannin was high in the samples, ranging from 234 to 598 mg/100 g. Tannin is known to bind irreversibly to proteins and thereby render them unavailable to the consumers (Godstein & Swain, 1965). The high level of tannin thus tends to reduce the nutritive value of the fruit pulp. The tannin level was reduced by cooking. The hydrocyanic acid (HCN) level was low, ranging from 10 to 24 mg/100 g dry material. A dose of 35 mg HCN is considered toxic to man. However, cooking of the pulp reduces the level of HCN in the samples. The level of the phytic acid ranged from 0·4 to 1·1 mg/100 g of the dry samples. There was also reduction on cooking of the samples. Phytic acid is known to interfere with the utilisation of minerals such as calcium, magnesium and iron, and also phosphorus. The total oxalate and soluble oxalate levels were below the toxic levels, given as 2–5 g (Munro & Bassir, 1969). Soluble oxalate is believed to be the toxic form of oxalate and can lead to formation of insoluble oxalate salts with calcium, magnesium and iron, resulting in oxalate stones and also interfering with the utilisation of minerals. The total oxalate ranged between 18 and 40 mg/100 g of the dry samples while the soluble oxalate ranged between 13 and 39 mg/100 g.

Cooking tended to reduce the level of both types of oxalate. The percentage of the soluble oxalate was high in all cases being 97·2 % for the peel, 69·4 % for the raw pulp and 68·8 % for the cooked pulp. Studies should be carried out to determine the role of all the toxic elements in the nutritional status of the fruits.

CONCLUSION

Evaluation of the nutritive value of raffia palm fruit has been carried out by chemical analysis. The findings show that the pulp of the fruit, raw or cooked, is a good source of carbohydrate, certain minerals such as calcium, magnesium, potassium, iron and zinc, and also a good source of the vitamins, ascorbic acid and carotene. It was found to be a poor source of proteins but a moderate source of fat. The pulp contained toxic substances that were reduced by cooking. It will be rewarding to carry out

an amino acid analysis of the protein in the pulp and also to characterise the fats so as to have a more complete picture of the nutritive value of the fruits. Biological studies using experimental animals as well as toxicological studies may be necessary to establish whether or not the pulp of the fruit is safe for human consumption. Studies in these directions are in progress.

REFERENCES

Addy, E. O. H. & Eka, O. U. (1981). Nutritive value of pulp of baobab fruit. *Nigerian J. Sci.*, **13**, 6.

AOAC (1975). *Methods of analysis.* (12th edn.) Association of Official Analytical Chemists, Washington DC.

AOVC (1966). *Methods of vitamin assay.* (3rd edn.) Association of Vitamin Chemists, Interscience, New York.

Armitage, R. (1974). *Statistical methods in medical research.* John Wiley and Sons, New York, p. 119.

Burns, R. E. (1971). Methods of estimation of tannin in the grain sorghum. *Agron. J.*, **63**, 511.

Dye, W. B. (1956). Studies on *Halogeton glomeralus. Weeds*, **4**, 55.

Edem, D. O., Eka, O. U. & Ifon, E. T. (1983). Chemical evaluation of the nutritive value of African starapple (*Chrysophyllum albidum*). *Food Chem.* (In press).

FAO (1968). *Food composition table for use in Africa.* Food and Agricultural Organisation of the United Nations, Rome, Italy.

Godstein, J. L. & Swain, T. (1965). The inhibition of enzymes by tannins. *Phytochemistry*, **4**, 185.

Irvine, F. R. (Ed.) (1961). In: *Woody plants of Ghana with special reference to their uses.* Oxford University Press, London.

Joslyn, M. A. (1970). *Methods of food analysis* (2nd edn). Academic Press, New York.

McCance, R. A. & Widdowson, E. M. (1953). Phytin in human nutrition. *Biochem. J.*, **29**, 2694.

Munro, A. & Bassir, O. (1969). Oxalate in Nigerian vegetables. *West Afr. J. Biol. Appl. Chem.*, **12**, 14.

Oyenuga, V. A. (1968). *Nigerian foods and feedingstuffs* (3rd edn). Ibadan University Press, Ibadan.

Roe, J. H. & Kuether, C. A. (1943). The determination of ascorbic acid in whole blood and urine through the 2,4-dinitrophenyl-hydrazine derivative of dehydroascorbic acid. *J. Biol. Chem.*, **147**, 339.

Scharffert, R. P. & Kingsley, G. R. (1955). A rapid method for the determination of reduced dehydro- and total ascorbic acid in biological materials. *J. Biol. Chem.*, **212**, 59.