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Research Article

Proximate and Phyto-chemical Composition of Some Indigenous Fruits and Nut (Seeds) from Abia State, Nigeria

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Abstract

The chemical composition and antimicrobial evaluation of three tropical seeds African oil bean (*Pentaclethra macrophylla* (BENTH), African bush mango (*Irvingia gabonensis v*ar *gabonensis* (Baill), and African walnut (*Tetracarpidium conophorum* (Hutch and Dalziel), were investigated. Raw and cooked portions of each of the seeds of the *P. macrophylla, I. gabonensis var gabonensis and T. conophorum,* were used for the instigation. The parameters considered were proximate composition, mineral content, phytochemical determination. Results obtained showed that the composition varied significantly between the raw and cooked seeds. Generally, the moisture, Protein, Fat, Fibre Ash and Carbohydrate composition of the raw seeds were higher than those obtained from the cooked seeds. Protein content was higher in *T. conophorum* (28.59 ± 0.10 raw and 24.09 ± 0.10 cooked), followed by that of *P. macrophylla* (22.46 ± 0.10, raw and 20.54 ± 0.10 cooked) the least was in *I. gabonensis var gabonensis* (13.59 ± 0.10, raw and 11.20 ± 0.17, cooked). *I. gabonensis var gabonensis* contained more fats *(*51.53 ± 0.19 for raw and 46.45 ± 0.13 for, cooked) than *P. macrophylla* (43.06 ± 0.09, for raw and 41.90 ± 0.05 for, cooked). *T. conophorum* had less fat of 38.55 ± 0.09 for raw and 31.89 ± 0.17 for, cooked. Similarly, *I. gabonensis var gabonensis* contained more Carbohydrates (24.15 ± 0.10 for raw and 32.54 ± 0.37 for, cooked) than *T. conophorum* and *P. macrophylla* with 11.81 ± 0.33 for raw and 26.87 ± 1.48 for cooked, 18.74 ± 0.31 for raw and 24.16 ± 0.19 for cooked, respectively. The phytochemicals considered in the investigation were, Alkaloids, Flaonoids, Tannins, Saponins, Hydrogen cyanide (HCN), Phytates and oxalates. The composition of these chemicals took the same trend as with the Nutritional contents. The raw seeds contained significantly more of the chemicals than the cooked portions. Raw *T. conophorum* had more Alkaloids (1.57 ± 0.07) than *P. macrophylla* (1.33 ± 0.02) and *I. gabonensis var gabonensis* (1.19 ± 0.03). Their cooked portions contained 0.35 ± 0.03, 0.40 ± 0.03 and 0.27 ± 0.01, respectively. The tren applied to Flavonoids. *T. conophorum* had more Flavonoids 1.07 ± 0.04 (raw), 0.25 ± 0.03 (cooked), *P. macrophylla* (0.99 ± 0.41, raw) 0.25 ± 0.01(cooked) and *I. gabonensis var gabonensis* (0.85 ± 0.03 raw), 0.21 ± 0.02(cooked). Tannins content for raw *P. macrophylla* and raw *T. conophorum* is the same *(*0.67 ± 0.01) and higher than that of *I. gabonensis var gabonensis* (0.51 ± 0.03), *T. conophorum* while the values for their cooked portions were 0.21 ± 0.02 (*P. macrophylla)* 0.15 ± 0.02 *(T. conophorum) and* 0.13 ± 0.01 *(I. gabonensis var gabonensis*). The values for saponins were 0.43 ± 0.01 and 0.11 ± 0.01, 0.31 ± 0.02 and 0.07 ± 0.01, 17 ± 0.01and0.04 ± 0.01 for raw and cooked *P. macrophylla, T. conophorum* and *I. gabonensis var gabonensis* respectively. Raw *P. macrophylla* had very significantly high content of HCN (14.02 ± 0.18) followed by *T. conophorum* (9.33 ± 0.01) and (5.69 ± 0.29) *I. gabonensis v*ar *gabonensis.* Cooked *I. gabonensis var gabonensis* had least HCN (1.31 ± 0.07 (followed by *T. conophorum* (2.21 ± 0.22) Phytate and oxalate contents of raw and cooked *P. macrophylla were* 0.61 ± 0.03 and 0.17 ± 0.01 and 0.45 ± 0.02 and 0.13 ± 0.02 respectively. For *I. gabonensis var gabonensis* 0.35 ± 0.02 and 0.11 ± 0.01, 0.43 ± 0.01 and 0.10 ± 0.01 respectively and *T. conophorum,* 0.50 ± 0.03and 0.12 ± 0.01and 0.51 ± 0.02 and 0.13 ± 0.01 respectively.

Keywords: *T. conophorum; P. macrophylla;* Alkaloids

Introduction

Fruits are the fleshy seed-associated structures of a plant formed from the ovary after fertilization while a nut is a simple dry fruit consisting of one or more kernels inside a hard shell. Botanically many nuts are actually seeds.

African oil bean (*Pentraclethra macrophylla* Benth*, Fabaceae*) African bush mango (*Irvingia gabonensis* Baill*, Irvingiaceae*), and African walnut (*Tetracarpidium conophorum* Hutch and Dalziel*, Euphorbiaceae*), are some of the fruits and seeds. Fruits and nuts are essential components of animal and human diets and desert. They represent diverse genetic resources in tropical and subtropical regions of the world.

In Nigeria, because of the premium placed on exotic fruits and nuts many of the indigenous ones have become endangered in spite of the huge benefits derivable from them. They have thus become grossly underutilized.

African oil bean (*Pentraclethra macrophylla* Benth,) African bush mango (*Irvingia gabonensis* Baill,) and African walnut (*Tetracarpidium conophorum* Hutch and Dalziel, happens to be some of the fruits and nuts in this category.

Pentaclethra. macrophylla (Benth*)* popularly known as Ugba in southern Nigeria, possess edible seeds. The seeds of *P. macrophylla* are known to be highly nutritious [1] and contain appreciable amounts of thermostable amylases and lipases [2]. The seeds are consumed by an estimated 15 million people in Eastern Nigeria, majority of whom are Igbos [3]. It is a tradition food generally prepared in homes and employed as small family business. Well fermented and processed beans are added to soup as flavouring [3]. It can also be eaten with stock fish and garden egg and leaves. With bitter kola (*Garcinia kola)* or kola nuts (*Cola acuminata and C. nitida*). It is an important and cheap source of protein for people whose staple food are deficient in proteins [4].

African Bush mango (*Irvingia gabonensis,* Baill.) grows either wild in forests of tropical Africa or as household economic trees. It is a multipurpose tree as it provides food, fuel, fibre, medicines and timber. Fruits are edible having yellow pulp. Seeds contain oil used in different culinary purposes and wood is hardy and green having resistance to termites. In Nigeria, two varieties of this species were identified in 1974, *I. gabonensis var. gabonensis* (with sweet edible fruit) and I. *gabonensis var. excelsa* (with bitter fruit), it has quality fruit and oil in its kernel is used for bakery and cosmetic purposes and for preparation of dikka fat, chocolate and soap. Pharmaceutical purposes for preparation of anti-ulcer and analgesic medicine [5,6]. Fat produced form nuts of bush mango are used in various purposes [7].

Tetracarpidium conophorum Hutch and Dalziel also known as Owusa nut is a climbing shrub with a fruit that is mostly four-seeded. The plant is commonly used by local people in its native range. The seeds are rich in oil.

All parts of *T. conophorum* have been used ethno medically, including the stem bark, leaves, seeds and roots. The bark is used by local people as a mild laxative [8]. The walnut may be cultivated and harvested from the plantation for consumption and marketing purposes. The most important use of the fruit of walnut and hickories is directly for eating.

A lot of works have been done on the proximate and chemical composition of the seeds and nuts of *P. macrophylla*, *Irvingia gabonensis* and *Tetracarpidium conophorum* [9,10]. However, no literature exists on the comparative analysis of the raw and cooked seeds and nuts of the three plants.

Materials and Methods

Sources of materials

The seeds, of *Pentraclethra macrophylla* (Benth)*, Irvingia gabonensis* (Baill), and *Tetracarpidium conophorum* [11]. were obtained from Ubani Central Market, Umuahaia and their vegetative botanical identities were confirmed in the Department of Plant Science and Biotechnology, College of Natural and Applied science, Michael Okpara University of Agriculture, Umudike Nigeria. by Prof. I.C. Okwelehie.

Preparation of samples for analyses

The seeds were sorted to remove any bad ones (shriveled, diseased etc.) and each seed type was divided into two portions A and B.

The A portion were separately dried in the oven at 65˚C for six hours and then ground into power using a Corona (Landers) blender, model Y. CIA, S.A. 0897 and thereafter sieved through layers of cheese cloth. The sieved samples were dispensed into clean dry specimen bottles and stored at room temperature.

Each of the B portions was boiled in distilled water for one hours. The boiled Samples were allowed to cool, then sliced into bits. The sliced samples were dried in the oven at 65˚C for twelve-four hours and thereafter ground to powder as descried for the raw portions and the dispensed into specimen bottles.

Proximate analysis

Moisture content determination

This was determined by the gravimetric method [12]. A measured weight of each sample (5g) was weighed into a dry weighed crucible. The crucible and its sample content were dried in the oven at 105^{0}C for 2 hours in the first instance. After 1 hours, the sample was removed and then reweighed. The drying, cooling and weighing was continued repeatedly until a constant value was obtained. By the difference, the weight of moisture lost was determined and expressed as percentage. It was calculated as:

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

Where,

W_1= Weight of empty crucible

W_2 =Weight of crucible ± sample before drying

W_3= Weight of crucible ± sample after drying to constant weight

Ash content determination

The total ash content was done using the furnace incineration gravimetric method [13]. Five grams (5g) of each sample was put in a weighed crucible. The sample in the crucible was put in a muffle furnace set at 550^{0}C and allowed to burn until the samples became a grey ash. The sample in the crucible was carefully removed from the furnace (taking care not allow air blow ash away) and cooled in a desiccator. It was reweighed to determine the weight differences of ash obtain and in percentage.

It was calculated as:

$$\%\text{Moisture content} = \frac{W_2 - W_1}{W} \times \frac{100}{1}$$

Where,

W =Weight of sample

W_1= Weight of empty crucible

W_2= Weight of crucible ± Ash

Determination of fat content

Fat content of the samples were determined by solvent extraction method as described by [12,14]. Five grams (5g) of each sample was wrapped in a porous paper (Whitman No.1 filter paper). The wrapped sample was placed in a flask (air tight container) containing 200mls of petroleum ether (N- Hexane) and allowed to stand for 24 hrs., forceps was used to bring out the wrapped samples and dried them in the oven at100 ^{0}C for an hour (wrapped samples was sun dried first to remove any residual solvent) cooled in desiccators and reweighed. The fat content was determined by the weight difference and expressed as a percentage of the sample weight.

It was calculated as follows:

$$\%\text{ Fat} = \frac{W_2 - W_1}{W} \times \frac{100}{1}$$

Where,

W = Weight of Sample

W_1 = Weight of empty filter paper

W_2 = Weight of the wrapped filter paper after drying.

Crude fiber determination

The crude fiber was determined by James., *et al*. 2011 method, using 5g of each sample. The samples were weighed into a conical flask and boiled in 200ml of 1.25% H_2SO_4 solution under reflux for 30 minutes. After that, the samples were washed in severely portion of hot water using a two-fold Muslim cloth to trap the particles. The washed samples were carefully transferred quantitatively back to the flask and 200 mls off 1.25% NaOH solution was added to it. Again, the sample were boiled for 30mins and washed as before with hot water. Then transferred carefully into a weighed crucible and dried in the oven at 130 ^{0}C, then reweighed (w_1) and placed in a muffle furnace and burnt at 550^{0}C until they became ash, cooled in desiccators and weighed.

The crude content was calculated gravimetrically as:

$$\%\text{ Crude fiber} = \frac{W_1 - W_2}{W} \times \frac{100}{1}$$

Where,

W = Weight of sample

W_1 = Weight of crucible ± sample after boiling washing and drying in oven

W_2 = Weight of crucible ± sample as ash

Protein determination

The protein content of the samples was determined by kjeldahl method described by [12]. The total nitrogen was determined and multiplied with the factor 6.2B to obtain the protein. One half gram (0.5g) of each sample was mixed with 10mL of concentrated sulphuric acid. Analytical Reagent Grade (AR grade) in a kjedahl digested flask. A tablet of selenium catalyst added to it and the mixture was digested (heated) under a fume cupboard until a clear solution was obtained in a spate flask. The acid and other reagent were digested but without sample to form the blank control. All the digest was transferred carefully into a 100 ml volumetric flask using distilled water and made up to a mark in the flask. A 10mL portion of each digest was mixed with equal volume of 45% NaOH solution in kjeldahl distilling unit. The mixture was distilled and the distillate collected into 10 mL of 4% Boric acid solution containing three (3) drops of mixed indicators (Bromocresol green and methyl red). A total of 50ml distillates was obtained and titrated against 0.02N H_2SO_4 solution titration was done from the initial green colour to a deep red point.

The nitrogen content was calculated as follow:

$$\% \text{ Nitrogen} = \frac{(100 \times N \times 14 \times Vf)\ T}{W \quad 100 \quad Va}$$

Where,

W = Weight of sample analyzed

N = Conc. Of $_{H2SO4}$ titrate

Vf = Total volume of digest

Va = Volume of digest distilled

T = Total value - blank

Carbohydrate content determination

The carbohydrate content of was determined the method described by [12,14], using the formula; % NFE= x 100 - %(a+b+c+d+e)

Where: NFE = Nitrogen Free Extract, a = Moisture, b = Ash, c = Fibre, d = Protein, and e = Fat.

Determination of phytochemicals

Determination of tannins

This was determined by the Folin-Denis colorimetric method [16]. 2 cm^3 of the fruits(seed) boiled water extract was put in a 50 cm^3 flask and made up to mark. It was allowed to stand for 30 min at room temperature. It was filtered. 2 cm^3 of the filtrate was mixed with equal volume of Folin-Demis reagent followed by 2.5 cm^3 of saturated Na_2CO_3 solution. In the same way, standard tannin solution (tannic acid) was treated as well. The mixtures were allowed to stand for 90 minutes and then made up to 50 cm^3 mark before their absorbance were read in a spectrophotometer at 600 - 630 nm with the reagent blank at zero. The tannin content was calculated as shown below:

%Tannin

w = Weight of sample (g); au = Absorbance of sample (nm); as = Absorbance of standard tannin solution (nm); c = Concentration of standard tannin solution (M); vf = Total volume of extract (cm^3); va = Volume of extract analyzed (cm^3); D = Dilution factor.

Determination of flavonoids

This was done by the ethyl acetate precipitation gravimetric method. 5 cm^3 of sample was extracted with 50 cm^3 of 2M HCl solution by heating for 15-20 min. It was allowed to cool and then filtered. The flavonoid in the filtrate was precipitated by drop wise addition of 3 cm^3 of ethyl acetate. The flavonoid precipitate (ppt) was recovered by filtration using a weighed filter paper. The ppt in the filter paper was dried for 15 minutes in the oven at 100^0C and cooled in a dessicator and reweighed [15]. By difference, the flavonoid content was calculated using the formula below:

%Flavonoid

w = Weight of sample (g); W_1 = Weight of empty filter paper (g); W_2 = Weight of filter paper ± flavonoid ppt (g); vf = Total volume of boiled water extract (cm^3); va = Volume of extract analyzed (cm^3).

Determination of alkaloids

Alkaloid content of the plant extract was determined using the alkaline precipitation gravimetric method. 10 cm^3 of extract was mixed with 40 cm^3 of 10% acetic acid in ethanol and allowed to stand for 4h at room temperature. The mixture was filtered and the filtrate was concentrated by evaporation to ¼ of its volume. The concentrated extract was treated with drop wise addition of conc. NH_4OH solution (2 cm^3). The precipitated alkaloid was recovered by filtration using weighed filter paper. It was dried in the oven and cooled in the desiccator before weighing [15]. The formula below was used to calculate the alkaloid content.

%Alkaloid

w = Weight of sample (g); W_1 = Weight of empty filter paper (g); W_2 = Weight of filter paper ± alkaloid ppt (g); vf = Total volume of boiled water extract (cm^3); va = Volume of extract analyzed (cm^3).

Determination of saponins

This was done using the solvent extraction gravimetric method. 10 cm^3 of the extract sample was mixed with 50 cm^3 of 20% aqueous ethanol solution and heated in a water bath for 1 hour. It was filtered and the filtrate was concentrated by evaporation to about half its original volume. It was treated with equal volume (30 cm^3) of diethyl ether and transferred to a separating funnel. After partitioning, the aqueous layer was recovered while the other layer was discarded. Fresh ether was added to the aqueous layer and re-separated in the funnel. The recovered aqueous layer was treated with 60 cm^3 of normal butanal to extract the saponin which was collected as the upper layer in the separating funnel. The saponin extract was washed with 5% sodium chloride solution. After recovering (the butanol extract), it was put in a previously weighed evaporating dish and dried in the oven for 30 min at 60^0C. It was cooled in a desiccator and reweighed [15]. The saponin content was calculated as shown below.

%Saponin

w = Weight of sample (g); W_1 = Weight of empty evaporating dish (g); W_2 = Weight of dried evaporating dish ± saponin ppt (g); vf = Total volume of extract (cm^3); va = Volume of extract used (cm^3).

Determination of phytates

The bi-pyridine colorimetric method [16] was used. 5 cm^3 of sample was mixed with 50 cm^3 of dilute HCl solution for 30 minutes. It was filtered and the filtrate (extract) was used for the analysis. 0.5 cm^3 of the extract was dispensed into a flask and treated with 1 cm^3 of the 2,2-bipyridine solution. Meanwhile, standard phytate solution (sodium phytate) was prepared and 1 cm^3 portion of it was treated with the bi- pyridine solution as described for the sample extract. The absorbance of the sample extract and the standard phytate solution were read in a spectrophotometer at 510 nm with the reagent blank at zero. The formula below was used to calculate the phytate content.

%Phytate

w = Weight of sample (g); Au = Absorbance of sample (nm); As = Absorbance of standard phytate solution (nm); c = concentration of standard phytate solution (M); vf = Total volume of sample extract (cm^3); va = Volume of sample analyses (cm^3); D = Dilution factor.

Determination of oxalate content

The permanganate titrimetric method [17] was used. A measured volume of the extract sample 5 cm^3 was mixed with 95 cm^3 of distilled water and 5 cm^3 of 6 M HCl solution was added to it and boiled for 30 min under reflux. It was allowed to cool at room temperature and then filtered through Whatman No 1 filter paper. The filtrate was neutralized by the addition of 3 drops of methyl red indicator and treated with dropwise addition of concentrated NH_4OH until a faint yellow color was obtained. The neutralized extract was heated to near boiling and filtered (to remove ferrous ion precipitate). It was heated again to near boiling and 10 cm^3 of 5% $CaCl_2$ solution was added to it with constant stirring. After cooling, it was allowed to stand at 5^0C in a laboratory freezer. After 18 h, it was centrifuged and the supernatant was discarded and the ppt was dissolved in 10 cm^3 of 20% (v/v) H_2SO_4 solution. Exactly 40 cm^3 of distilled water was added to it and heated to near boiling and then titrated while still hot against 0.05M $KMnO_4$ solution to a faint pink colouration. The calculation was done using:

%oxalate

W(g)

EW

Determination of cyanogenic glycosides (HCN)

The alkaline picrate colorimetric method described by [16] was used. Stripes of filter papers were cut from Whatman No. 1 filter paper. The alkaline picrate solution was prepared by dissolving 1g of picrate and 5g of $NaCO_3$ in a small volume of warm water and made up to 200 cm^3 with distilled water. The picrate paper was prepared by dipping the rectangular pieces of filter paper in picric acid solution and dried. Each test sample (1 cm^3) was dispersed in 200 cm^3 of distilled water in a 250 cm^3 conical flask. An alkaline picrate paper was suspended inside the flask and held in place with the stopper used to cork the flask. Care was taken to ensure that the picrate paper did not touch the surface of the mixture in the flask. These were incubated at room temperature for 18h (overnight). And then each picrate paper was carefully removed and eluted in 60 cm^3 of distilled water. A standard cyanide solution was prepared (0.05M). The absorbance of the standard solution prepared was read as well as the absorbance of the sample solution. The absor-

bance of the standard solution prepared was read first before each of the sample replicates was read. The absorbance was measured in the spectrophotometer at 540 nm using the reagent blank to set the instrument at zero. The cyanide content was determined by calculating as shown below.

%HCN mg/kg

w = Weight of sample (g); Au = Absorbance of sample (nm); As = Absorbance of standard solution (nm); c = Concentration of standard solution (M); vf = Total volume of sample extract (cm^3); va = Volume of sample analyses (cm^3); D = Dilution factor.

Results

Sample	Mc	Protein	Fat	Fibre	Ash	CHO
Pentraclethra macrophyla, raw	a 9.12 ± 0.14	c 22.46 ± 0.10	c 43.06 ± 0.09	c 3.23 ± 0.04	c 3.39 ± 0.02	d 18.74 ± 0.31
Pentraclethra macrophyla, cooked	bc 8.03 ± 0.10	d 20.54 ± 0.10	d 41.90 ± 0.05	c 2.97 ± 0.12	d 2.41 ± 0.04	c 24.16 ± 0.19
Irvingia gabonensis raw	d 6.23 ± 0.26	e 13.59 ± 0.10	a 51.53 ± 0.19	d 2.17 ± 0.01	d 2.33 ± 0.06	c 24.15 ± 0.10
Irvingia gabonensis cooked	d 6.21 ± 0.07	f 11.20 ± 0.17	b 46.45 ± 0.13	d 1.91 ± 0.03	e 1.68 ± 0.03	a 32.54 ± 0.37
Tetracapidium conophorum raw	ab 8.69 ± 0.27	a 28.59 ± 0.10	e 38.55 ± 0.09	a 6.53 ± 0.10	a 5.85 ± 0.07	e 11.81 ± 0.33
Tetracapidium conophorum cooked	c 7.45 ± 0.92	d 24.09 ± 0.10	f 31.89 ± 0.17	b 5.30 ± 0.56	b 4.39 ± 0.07	b 26.87 ± 1.48

Table 1: Proximate composition (%).

Values show means of triplicate analysis ± standard deviation. Figures with different superscripts. In the column are significantly different ($p < 0.05$).

Table 1 shows the result of proximate composition of the raw and cooked seeds, of *Pentraclethra macrophyla Irvingia gabonensis,* and *Tetracapidium conophorum.* The results showed variations of significant differences in the proximate composition of the different seeds on one hand and between the raw and cooked seeds as well. Generally, the moisture, Protein, Fat, Fibre Ash and Carbohydrate composition of the raw seeds were higher than those obtained from the cooked seeds. Protein content was higher in *T. conophorum* (28.59 ± 0.10 raw and 24.09 ± 0.10 cooked), followed by that of *P. macrophylla* (22.46 ± 0.10, raw and 20.54 ± 0.10 cooked) the least was in *I. gabonensis var gabonensis* (13.59 ± 0.10, raw and 11.20 ± 0.17, cooked). *I. gabonensis var gabonensis* contained more fats (51.53 ± 0.19 for raw and 46.45 ± 0.13 for, cooked) than *P. macrophylla* (43.06 ± 0.09, for raw and 41.90 ± 0.05 for, cooked). *T. conophorum* had less fat of 38.55 ± 0.09 for raw and 31.89 ± 0.17 for, cooked. Similarly, *I. gabonensis var gabonensis* contained more Carbohydrates (24.15 ± 0.10 for raw and 32.54 ± 0.37 for, cooked) than *T. conophorum* and *P. macrophylla* with 11.81 ± 0.33 for raw and 26.87 ± 1.48 for cooked, 18.74 ± 0.31 for raw and 24.16 ± 0.19 for cooked, respectively.

Samples	Alkaloid	Flavonoid	Tannin	Saponin	HCN	Phytate	Oxalate
Pentraclethra macrophyla, raw	b 1.33 ± 0.02	b 0.99 ± 0.41	a 0.67 ± 0.01	a 0.43 ± 0.01	a. 14.02 ± 0.18	a 0.61 ± 0.03	b 0.45 ± 0.02
Pentraclethra macrophyla, cooked	d 0.40 ± 0.03	d 0.25 ± 0.01	c 0.21 ± 0.02	d 0.11 ± 0.01	d 2.49 ± 0.05	d 0.17 ± 0.01	c 0.13 ± 0.02
Irvingia gabonensis raw	c 1.19 ± 0.03	c 0.85 ± 0.03	b 0.51 ± 0.03	c 0.17 ± 0.01	c 5.69 ± 0.29	c 0.35 ± 0.02	b 0.43 ± 0.01
Irvingia gabonensis cooked	e 0.27 ± 0.01	d 0.21 ± 0.02	d 0.13 ± 0.01	f 04 ± 0.01	e 1.31 ± 0.07	e 0.11 ± 0.01	c 0.10 ± 0.01
Tetracapidium conophorum raw	a 1.57 ± 0.07	a 1.07 ± 0.04	a 0.67 ± 0.01	b 0.31 ± 0.02	b 9.33 ± 0.01	b 0.50 ± 0.03	a 0.51 ± 0.02
Tetracapidium conophorum cooked	d 0.35 ± 0.03	d 0.25 ± 0.03	d 0.15 ± 0.02	e 0.07 ± 0.01	d 2.21 ± 0.22	e 0.12 ± 0.01	c 0.13 ± 0.01

Table 2: Quantitative phytochemical.

Values shows means of triplicate analysis ± standard deviation. Figures with different superscript in the column are significantly difference ($p < 0.05$).

The result of the phytochemicals of the raw and cooked samples are summarized in table 2. The results showed that the raw seeds contained significantly more of the chemicals than the cooked portions. Raw *T. conophorum* had more Alkaloids (1.57 ± 0.07) than *P. macrophylla* (1.33 ± 0.02) and *I. gabonensis var gabonensis* (1.19 ± 0.03). Their cooked portions contained 0.35 ± 0.03, 0.40 ± 0.03 and 0.27 ± 0.01, respectively. The tren applied to Flavonoids. *T. conophorum* had more Flavonoids 1.07 ± 0.04 (raw), 0.25 ± 0.03 (cooked), *P. macrophylla* (0.99 ± 0.41, raw) 0.25 ± 0.01 (cooked) and *I. gabonensis var gabonensis* (0.85 ± 0.03 raw), 0.21 ± 0.02(cooked). Tannins content for raw *P. macrophylla* and raw *T. conophorum* is the same *(*0.67 ± 0.01) and higher than that of *I. gabonensis var gabonensis* (0.51 ± 0.03), *T. conophorum* while the values for their cooked portions were 0.21 ± 0.02 (*P. macrophylla)* 0.15 ± 0.02 *(T. conophorum) and* 0.13 ± 0.01 *(I. gabonensis v*ar gabonensis). The values for saponins were 0.43 ± 0.01 and 0.11 ± 0.01, 0.31 ± 0.02 and 0.07 ± 0.01, 17 ± 0.01 and 0.04 ± 0.01 for raw and cooked *P. macrophylla, T. conophorum* and *I. gabonensis var gabonensis* respectively. *Raw P. macrophylla* had very significantly high content of HCN (14.02 ± 0.18) followed by *T. conophorum* (9.33 ± 0.01) and (5.69 ± 0.29) *I. gabonensis v*ar *gabonensis.* Cooked *I. gabonensis var gabonensis* had least HCN (1.31 ± 0.07 (followed by *T. conophorum* (2.21 ± 0.22) Phytate and oxalate contents of raw and cooked *P. macrophylla were* 0.61 ± 0.03 and 0.17 ± 0.01 and 0.45 ± 0.02 and 0.13 ± 0.02 respectively. For *I. gabonensis var gabonensis* 0.35 ± 0.02 and 0.11 ± 0.01, 0.43 ± 0.01 and 0.10 ± 0.01 respectively and *T. conophorum,* 0.50 ± 0.03 and 0.12 ± 0.01 and 0.51 ± 0.02 and 0.13 ± 0.01 respectively.

Discussion and Conclusion

P. macrophyla, *I. gabonensis* and *T. conophorum* seeds are edible and like other indigenous edible seeds, are consumed for their nutritional and medicinal values. The three seeds are not eaten raw but are cooked and either further processed before as in the case of *P. macrophyla*, and *I. gabonensis* before use or eaten directly as in the case of *T. conophorum*. The result showed that cooking appeared to have reduced the proximate composition of the seeds.

The moisture content of seeds was low generally in both raw and cooked seeds because they were dried in the prior to analysis. Low moisture content is desirable in food and feed stuff as it discourages the growth of microorganisms and improve storability [18]. The relatively lower moisture content of the *I. gabonensis* could be attributed to hydrophobicity since the seed has high oil content which repel water. Protein content was higher in the raw seeds than in the cooked ones. Comparatively it was higher

(28.59%) in the raw walnut seed and least (13.59%) in the raw *I. gabonensis* seed. The cooked seeds contain much lower protein content 20.54%, 11.20% and 24.59% than the raw one, 22.40% 13.59% and 28.59% for the *P. macrophyla*, *I. gabonensis* and *T. conophorum* seeds respectively. The process of cooking caused a reduction in the protein content of all the seeds. This may be due to the fact that protein is heat labile and often denatured by strong heat. Notwithstanding, the protein content of the seeds are quite appreciable showing the seeds as good sources of plant protein which can be used as alternative to the costly animal protein sources. Protein aids cell repair and regeneration in the body and also serve as co-enzymes in many body physiological activities.

Fat content of the three seed varied significantly with the *I. gabonensis* seed having the highest fat content (51.53%) while the *T. conophorum* had the least (38.55%). However, the high level of fat in the seeds makes then oil seeds. Cooking led to loss of fat and the fat loss was slight but significantly different ($p < 0.05$). fats (oil) in foods improve flavour and mouth feel, and act as insulator for heat conservation as well as solvent for important fat soluble vitamins [19,20].

Crude fiber was highest (6.58%) in raw *T. conophorum* seed and lowest (2.97%) in raw *I. gabonensis* seed. In the three seeds, cooking caused slight but significantly different reduction in the crude fiber content which already was low in *P. macrophyla* (2.97%) and *I. gabonensis* (2.17%). Fibre is essential in foods in the it adds back to food and aid in absorption this making for good bowel movement [18]. The ash content was in the range of 2.33% (*I. gabonensis*) to 5.85% (*T. conophorum*) in the raw seeds and from 1.68% (*I. gabonesis*) to 4.39% (*T. conophorum*) in the cooked seeds.

The process of boiling this caused reduction in the ash content and this could be attributed to solubilization and subsequent leach out into the boiling water. Ash content in food represent the inorganic minerals and as such the reduction minerals and as such the reduction was considered to be undesirable. Carbohydrate was low in all three seeds being in the range of 11.81% (raw *I. gabonensis*) to 32.54% (cooked *T. conophorum*). The variation in the carbohydrate content was attributed to the effect of similar variations in the other components of the proximate composition some carbohydrate was simply calculated by difference [21].

This result show that cooking resulted in reduction of alkaloid. Alkaloid are reported to have powerful effect on today physiology as well as play useful role the metabolism and control of development in using systems [22,23]. Again alkaloids are used widely in medicines due to their analgesia and antibacterial properties. Excess of alkaloids especially tropane alkaloids are toxic.

Flavonoid is in the range of 0.85 ± 0.03 (*I. gabonensis*) to 1.07 ± 0.04 (*T. conophorum*) in the raw seeds while the range was from 0.21 ± 0.02 (*I. gabonensis*) to 0.25 ± 0.03 (*T. conophorum*) in the cooked seeds. Boiling had strong effect on the flavonoid content of the seeds. The values obtained in the raw seeds show that the seed contain high flavonoid concentration. But the values obtained in the cooked seeds show a very high level of reduction ranging from 74.75% (0.99-0.25) reduction in *P. macrophyla* to 76.64% (1.07 - 0.25) reduction in *T. conophorum* while the reduction in *I. gabonensis*, flavonoid content was 75.29% (0.85 - 0.21).

Flavonoids have lots of health benefits including their ability to inhibit the imitation of tumors and their progression [24] and antioxidant activity which prevents oxidative cell destructions.

The level of tannins in the raw seeds was in the range of 0.51% (*I. gabonensis*) to 0. 67% (*P. macrophyla* and *T. conophorum*) which the cooked ones recorded tannin content ranging from 0.13% (*I. gabonensis*) to 0.21% (*P. macrophyla*) is showing high reduction due to cooking. Tannins are sometimes expanded as anti-nutrients due to their ability to coagulate proteins. However, reports show that tannins possess medicinal and health benefits including inhibition of pathogenic fungi (Burkill 1995) stimulation of phagocytic cell for body defense and lost mediated tumor activity (Burkill, 1995). The effect of cooking on saponin content of the seeds was reduction from 0.43% to 0.11% in *P. macrophyla*, 0.17% to 0.00% in *I. gabonensis* and from 0.31% 0.07% in *T. conophorum*. This represent reductions ranging from 74.4% in *P. macrophyla* to 100% (0.17% to 0.00). Osuagwu and Ihenwosu [23] reported that saponins play important roles in medicines including serving as expectorant and as emulsifying agents as well as elution of anti-fungal properties [22,23]. The reduction effect of cooking was seen also in the quality of HCN, phytate and oxalate. In the raw seeds, the values for HCN was from 5.69 mg/kg (*I. gabonensis*) to 14.02 mg/kg (*P. macrophyla*) but reduced to a range of 1.31 mg/kg (*I. gabonensis*) to 14.02 mg/kg (*P. macrophyla*) but reduced to a range of 1.31mg/kg (*I. gabonensis*) to 2.49 mg/kg (*P. macrophyla*). Hydrocyanic acid (HCN) is toxic and is known to lethal at concentrations above the critical level of 50mg/kg [18]. However, it reported to be soluble in water as well volatile, properties which makes for ease of reduction

and elimination thermal treatment involving water. This perhaps explain the high level of reduction in cooked seen as recorded in this work [25].

Phytate content of the seeds was also reduced from 0.61% to 0.17% (*P. macrophyla*), 0.35% to 0.11% (*I. gabonensis*) and from 0.50% to 0.12% (*T. conophorum*) while the oxalate content reduced from 0.45% to 0.13%, 0.43% to 0.11% and 0.51% to 0.13% in *P. macrophyla*, *I. gabonensis* and *T. conophorum* seeds due to the cooking. Phytates and oxalate are recognized as ant-nutrient because both interfere with digestion and absorption of dietary mineral by chelation which render such mineral insoluble in their new farmers and hence unavailable for absorption and utilization in the body.

Generally, therefore, the process of cooking caused reduction in the quality of phytochemicals in the three seeds. While the reduction of some phytochemicals with health benefits may be undesirable, the mediation in the toxic one like HCN and the anti-nutrients like phytate and oxalate is desirable since they elucidate deleterious effects when ingested.

Figure 1: Seeds of *Pentraclethra macrophyl.*

Figure 2: Fruits of *Irvingia gabonensis*.

Figure 3: Fruits of *Tetracapidium conophorum*.

Figure 4: Seeds of *Tetracapidium conophorum*.

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