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Comparative Studies on the Proximate Composition and Anti-Nutrient Content of the Cotyledons of Two Species of *Irvingia* (Ogbono) Sold in Anyigba Main Market, Kogi State, Nigeria

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Abstract

The Proximate Composition, Mineral Composition, Anti-nutrient factors and Vitamin Composition of *irvingia gabonensis* and *irvingia wombolu* seeds were determined using standard analytical techniques. Moistures, ash, crude fat, crude fibre, protein and carbohydrates content of irvingia *wombolu* and *gabonensis* were (%): 4.85±0.57 and 6.28±1.5, 1.51±0.12 and 1.71±0.05, 53.8±0.98 and 58.7±0.29 and 9.30±2.94 respectively. The fatty acid and calorific value were recorded for the cotyledon as follows: 43.0 and 47.0 for *irvingia wombolu*; 2518.4 and 2560.6 for *irvingia gabonensis*. The most abundant minerals, irvingia wombolu and gabonensis were: Ca (89.3±1.61 and 115.1±2.72) mg/100g sample; K (59.0±1.81 and 84.4±9.0) mg/100g; Na (48.6±2.12 and 64.6±5.11) mg/100g; Mg (41.5±1.15 and 44.5±5.36) Mg/100g; Fe (20.5±0.35) and 36.8±3.75) Mg/100g respectively. Generally the two species were found to be good source of essential minerals while metals such as Zn, Cd, Pb, Cu and Hg were below the detection limit of the AAS used. The levels of Na/K ratios were desirable compared with the recommended values. In the anti-nutrients, *Irvingia gabonensis* was higher in tannin, oxalate and phytate as follows; *Tannin* (0.66±0.17 and 0.13±0.02) mg/100g; Oxalate (0.38±0.06 and 0.30±0.08) mg/100g; Phytate (0.02±0.00 and 0.01±0.01) Mg/100g respectively for *Irvingia gabonensis* and *Irvingia wombolu*. The analysis showed that the two Irvingia species studied are highly nutritive in minerals and fat content. The benefits of essential nutrients and minerals in maintaining good health were highlighted.

Key Words: *Irvingia* species, cotyledons, proximate composition and Anti-nutrient

Introduction

The discovery of some under utilized fruits, vegetables and other plant derivatives used as human food is constantly receiving the attention of the scientists. The rural dwellers depend on wild fruits to meet their daily food needs, such as i*rvingia species*.

Irvingia gabonensis and *irvingia wombolu* re important high-valued indigenous multi-purpose tree species grown in West and Central Africa [1]. Prior to 1975, *irvingia gabonensis* and i*rvingia wombolu* were clumped together as one species of *irvingia gabonensis*, however, a distinction was made between the two by Okafor 1975, [2] who recognised *irvingia gabonensis ver*. Gabonensis as having a frocet edible pulp and *irvingia gabonensis ver*. Excels, having a bitter edible pulp. Following this distinction, Harris 1996 [3] revised the taxonomy of the irvingacese, splitting *irvingia gabonensis* (*Var. excels*) described by Okafor 1975 as the bitter variety from *irvingia gabonensis* (*Var. gabonensis*) the sweet variety, to create *irvingia wombolu* ver moesen. The sweet variety is now simply named *irvingia gabonensis* while the bitter one is *Irvingia wombolu*.

Irvingia gabonensis is harvested during the rainy season around July and *Irvingia wombolu* is harvested during the dry season around November. *Irvingia gabonensis* and *Irvingia wombolu* look very similar and indeed are often difficult to distinguish from herbarium specimens alone [3] . However, there are characteristics that distinguish the two, most noticeably the edibility of the fruit monocarp.

Studies on *Irvingia* have often failed to identify which species is being analysed, therefore in some cases figures given for *Irvingia gabonensis* are currently for *Irvingia wombolu* [7]. The fruits are broadly ellipsoid, green when unripe and yellow when riped with a fleshy monocarp. The onset of ripening predisposes the fruits to post harvest spoilage microorganisms such as *Aspergillus* and *Botrytis* species, whose actions on the fruit produce the brownish-black rot disease symptoms [8,9]. Although the fresh fruit of *Irvingia* species have long been known to have a short shelf-life after harvest [9]. A systematic assessment of post harvest spoilage of *Irvingia* fruits has been done only recently [9]. The study did not take into account the potential difference between *Irvingia gabonensis* and *Irvingia wombolu*.

The fruit comprises of freshy part and the nut, which consist of a hard shell and the kernel seed. Its seeds have an outer brown testa (hull). Ogbono seed is obtained by collecting the bush mango's seed, split this to obtain a pearly white Ovoid kernel that is sun dried. The average length, width and thickness of the nut are 43.3 x 30.62 x 22.11 mm respectively [10].

Ainge and Brown (2001) [11] reported that the defatted flour of *Irvingia gabonensis* is potentially useful as raw materials in food product development. Based on its nutritional properties, the Kernel oil and meal have been reported as potential base material for confectioneries, edible fats, soaps and cosmetics [12, 13, 14] . The wide spread utilization of *Irvingia gabonensis* Kernels as a local sub-Sahara African traditional food necessitate a good understanding of the properties that could further promote its exploitation [15, 16, 17, & 18]. Previous studies by other researchers on the compositional, nutritional and biochemical aspect of *Irvingia gabonensis* Kernels and its Kernel fat constitute the currently existing literature but that of *Irvingia Wombolu* have not been reported.

Irvingia gabonensis and *Irvingia Wombolu* are very similar and the consumer and industrial users depend on the taste and drawability of these species before their research. However, the work will also help the consumers and users of their product to know the nutritional values of the two species of *Irvingia* to create room for comparison and know if the two species contain the same proximate, mineral, vitamin as well as anti-nutrient as these will avail us preregister information that would enable consumers, farmers and agro allied practitioners to make informed decisions on the choice of *Irvingia species* to domesticate.

Experimental

All the reagents used were of analytical grade and they were used without further purification. All the apparatus and equipment were properly cleaned according to standard. The dried kernel of *Irvingia gabonensis and Irvingia Wombolu* were purchased in Anyigba main market, in Kogi State Nigeria. The Kernels were further oven-dried at 55^{o}C for 5hrs. The cooled dried sample were ground using mortar and pestle into a fine powder and was kept in plastic rubber for analysis.

Determination of protein content

Two **grams** (2g) of the sample were taken into digestion flask and 10ml of concentrated H_2SO_4 along with 8g of digestion mixture (K_2SO_4 and $CUSO_4$) i.e. 8:1 ratio were added and mixed together by swirling in order to maintain homogeneity. The flask was then heated to start digestion until the mixture turned blue-green in colour. After 2hrs of digestion, the digest was cooled and transferred to 100ml volumetric flask adding the distilled water to make up the volume. After the digestion, distillation was carried out using Markam still distillation apparatus and 10ml of the digest was introduced into the digestion tube before 10ml of 0.5m NaOH was added through the same way leaving for 10minutes.

Ammonia produced in the process was collected as ammonium hydroxide (NH_4 OH, yellow in color) in a conical flask containing 20ml of 40% boric acid and solution with few drops of modified methyl red indicator. The distillate was then titrated against standard 0.1M HCl solution until the appearance of pink colour was observed. Alongside the titration, a blank was also ran using the same 0.1M HCl. Percentage crude protein content of the same was calculated and multiplied by a factor of 6.25 [19].

% crude protein = 6.25x%N

%N = (S-B) xNx0.014xDx100

Weight of the sample x V where S = sample of titration reading
B = Blank titration reading
N = Normality of HCl
D = Dilution of sample after digestion
V = Volume taken for distillation
0. 014 = milli equivalent weight of Nitrogen

Determinations of Moisture Content

5g of the sample was weighed initially as W_o and then transferred into a dry Petri dish and weight (W_1). The petric dish was placed in the oven for 8 hour at 105^0C until a constant weight was obtained (W_o). After eight (8)hours, the petric dish was removed from the oven and cooled in a desicator for 30 minute. After cooling, the Petri dish was weighed again as final weight (W_2). (Pearson D. 1976) the percentage moisture was calculated using the formula.

$$\%\text{moisture} = \frac{W_1 - W_2 \times 100}{W_0}$$

Where W_0 = Weight of sample
W_1 = Weight of sample and petric dish before heating
W_2 = Weight of sample and petric dish after heating.

Determination of fat content

Dry extraction method was used for this analysis [18]. Crude fat was determined by extraction method using Soxhlet apparatus. Two grams of moisture free sample was wrapped in filter paper placed in fat-free thimble and then inserted into the extraction tube as W_1. the receiving beaker was dried and then weighted as (W_0) and later transferred about 250ml of petroleum either into it which was then switched on at 600^0C and water was allowed to run in from tap by the use of a tube. This process lasted for 6 hours after which there were sequentially eight siphoning to ensure clean colorless fat-free solvent in the tube above the receiving flask. The content of the flask was then subjected to evaporation, leaving only the fat extract as W_2. The percentage crude fat was then calculated as

$$\text{Crude Fat \%} = \frac{W_1 - W_2 \times 100}{W_0}$$

Where W_0 = weight of beaker or flask before extraction
W_1 = Weight of beaker or flask and sample before extraction
W_2 = Weight of beaker or flask and sample after extraction.

Determination of Fiber Content

Exactly 5g of the sample was weighed and labelled as W_0; it was then transferred to a porous crucible and placed into the fiber machine keeping the value at off positions. Thereafter, 150ml of H_2SO_4 solution and few drops of acetone was added to the column the cooler was then op en to turn on the heating element (Power at 900C – 100^0C). After boiling the power was reduced to 300C and left for 30 minutes. The valve was then opened to drain and acid and distilled water was used to rinse the column three times to ensure complete removal of acid from the sample. The above procedure was repeated using 150ml of KOH and later the sample was dried in the oven for an hour at 150^0C.

After drying the sample was cooled in the desiccator and weighed as (W_1). This weighed sample was then placed in the furnace for oxidation of the organic matter for 3 hours at 600^0C. When this was ashed completely, it was then cooled and reweighed finally as $(W_2)^{18}$ and the percentage crude fiber was calculated as

$$\text{Crude Fibre \%} = \frac{W_1 - W_2 \times 100}{W_0}$$

Where W_0 = initial weight of sample
W_1 = Weight of mixture after drying
W_2 = Weight of mixed sample after ashing

Determination of Ash Content

Ash content was determined by the use of muffle furnace[(20)]. A clean empty crucible was placed in a muffle furnace at 600^0C for 1 hour at which it was removed and allowed to cool in a desiccators. The initial weight was determined and recorded as (W1). Two grams of the sample was taken in the crucible and labeled (W2). The sample was then ignited over a burner using blow pipe. After ignition, the crucible was placed in muffled furnace at 550^0C for 4 hours. After ashing, the crucible was removed (a grey white ash was observed, which indicates complete oxidation of all organic matter in the sample) and placed in a desiccators to Cool. After cooling the weight was determined as (W3). Percentage ash was calculated as

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

W_2

Where W_0 = initial weight of empty crucible

W_1 = Weight of sample

W_2 = Weight of sample and crucible after ashing

Determination of Vitamin A (Beta-coarotenoids)

One gram (1g) of the sample was accurately measured into 20ml of acetone, it was left for 1 hour and filtered. 10ml of distilled water was added to the filtrate. The filtrate was poured into a separating funnel. 5ml of petroleum either was added to the funnel and was allowed to flowed and left for some minute to separate. The lower layer was discarded and the absorbance was measured at 446nm [18].

Concentration of B – Carotene

$$= \frac{V \times 383 \times as - ab}{100W}$$

Where as – absorbance of sample at 446nm ab = the cuvette error

383 = the extinction coefficient for carotenoids

V = volume used for the analysis

W = Weight of sample in gram.

Determination of Vitamin B2 and B6 (thiamin and Riboflavin).

The standard fluorimetric method of the Association of Official Analytical chemists 1984 [21] was followed. The procedure for thiamin and Riboflavin is as follows. A portion (30ml) of hydrochloric acid (0.1M) solution was added to about 5g of the sample and the content was mixed thoroughly, 1ml of the solution was transferred to a cleaned test tube and added 4ml of distilled water. To the second test tube 5ml of pyridoxine solution was added (standard) and in the third test distilled water was used as the mobile phase. For the blank determination, sodium hydrosulfite ($Na_2S_2O_4$) was dissolved in 0.4% sodium acetate as specified in the AOAC (1984) [18] semi automated method. The sample was aspirated into the sample loop and fluorescence was recorded.

Determination of Mineral Element

For wet digestion of sample, exactly 1.0g of the samples was taken in digesting glass tube-10ml of nitric acid (Conc. HNO_3) and 5ml of sulphuric acid was added to the sample and mixture was kept for overnight at room temperature. Then 2ml of perchoric acid ($HClO_4$) was added to this mixture and was kept in the fumes block for digestion. The temperature was increased gradually starting from 50^0C and increasing up to 250 – 300^0C. The digestion completed in about 70 – 85 minutes as indicated by the appearance of white fumes. The mixture was left to cool down and the content of the tubes were transferred to 100ml volumetric flasks and the volumes of the contest were made to 100ml with distilled water. The wet digested solution was transferred to plastic bottle labeled accurately. Store digest was use for mineral determination.

Determination of Na, K, Ca, Fe, Mg by Flame Photometer.

Na, K, Ca, Mg analysis of the sample was done by the method of flame photometry. (Model 405, corning, U.K). The same wet digested food sample solution was used for the experiment and was done in Agric laboratory department KSU, Anyigba. Standard solution of 20, 40, 60 and 80 milli equivalent/L were used for calculation for the total mineral intake is as

$$Mw = \frac{\text{Absorbency (ppm)} \times \text{dry wt} \times D}{\text{Wt of sample} \times 1000}$$

Determination of Zn, Cd, Pd, Cu, and Hg by Atomic Absorption Spectrophotometer

The digested sample was analyzed for heavy metal contents by Atomic Absorption spectrophotometer (Hitachi model 170.10). The experiment was done in the University of Ibadan Chemistry Lab. Department. The absorption measurement of the element for the *irvingia* species was read out. Different **electrode** lamps were used for each mineral. The equipment was run for standard solution of each mineral before and during to check that it is working properly. The dilution factor for minerals was 100. The concentrations of minerals recorded in terms of ppm were converted to milligrams (mg) of the mineral by multiplying the ppm with dilution factor and dividing by 1000 as follow.

$$Mw = \frac{\text{Absorbency} \times \text{dry wt} \times D}{}$$

Wt of sample x 1000

Determination of Oxalate

The total oxalates were determined according to the procedure of Fasset, 1996 [22]. The extraction was done by weighing 1g of each sample and soaked with 100ml of distilled water. These were allowed to stand for 3h and filtered through double layer of filter paper. 10, 20, 30, 40 and 50ppm standard solution of Oxalic acid were prepared and read on the spectrophotometer at 420nm for the absorbance. The absorbance of filtrate from each sample were also read on the spectronic 20.

Oxalate = Ab x Sl x 1000

Where Ab = absorbance

Sl = Slop from the standard curve

= 0.008

Determination of Phytate

Phytate were determined using the method of Mega 1986 [23]. 2g of each sample was weighed. 100ml of 2% concentrated hydrochloric acid was used to soak each sample into conical flask for 6hrs and filtered through a double layer of hardened filter paper. 50ml of each filtrate was placed in 250ml beaker and 107ml of distilled water was added in each case to give proper acidity. 10ml of 0.3% ammonium thiocynate solution was titrated with standard iron (110) chloride solution which contain 0.00495g iron per ml. The end point was slightly brownish-Yellow which persist for 5 minutes.

%phytale

= Y x 1. 19 x 100

Where Y = titration x 0.00195

0.00195 = Mw of phytic acid

1.19 = extinct constant for phytate

Determination of Tannin

Tennins were determined using method of Dawa, Chinma and Igyor, 1988 [24]. 0.2g of each sample was weighed into a beaker-each was soaked with solvent mixture (80ml of acetone and 20ml of glacial acetic acid) for 5h to extract tannin. The filtrate were removed and the sample were filtered through a double layer filter paper to obtain the filtrate. A set of standard solution of tannic acid was prepared ranging from 0 to 10ppm. The absorbance of the standard solution as well as that of the filtrate were read at 720nm on a spectronic 20.

Tannic = Abs x 0.65 x 1000

Where abs = absorbance, 0.065 = slope from the standard curve.

Results

Table 1. Proximate composition of the cotyledon of the *irvingia gabonensis* and *irvingia wombolu*

Parameter content	**Sample code**					
	Irvingia Wombolu			*Irvingia Gabonensis*		
	A	B	Mean±SD	A	B	Mean ± SD
Moisture%	5.25	4.45	4.85±0.57	5.20	7.35	6.28±1.52
Ash%	1.43	1.60	1.51±0.12	1.68	1.75	1.71±0.05
Crude fibre%	8.30	9.07	8.69±0.54	10.2	10.6	10.4±0.25
Crude fat%	53.1	54.5	53.8±0.98	58.5	58.9	58.7±0.30
Protein%	8.62	7.50	8.06±0.79	13.1	15.0	13.6±0.39
Carbohydrate%	23.3	22.9	23.1±0.29	11.4	7.2	9.30±2.94
Fatty acide (kg/100g)	42.5	43.6	43.0	46.8	47.1	47.0
Energy (Kg/100g)	2506.8	2532	2518.4	2578.5	2542.7	2560.6

Carbohydrate percentage calculated as the (100 – total of other compounds) calculated fatty acids (0.8 x crude fat); calculated metabolizable energy (protein x 17 + fat x 37 + carbohydrate x 17).

Table 2: Some anti-nutrient factors in *irvingia wombolu* and *irvingia gabonensis* cotyledon.

Parameter content	*Irvingia Wombolu*	*Irvingia Gabonensis*

	A	B	Mean±SD	A	B	Mean ± SD
Oxalate (g/100g)	0.24	0.36	0.30±0.08	0.33	0.4	0.38±0.06
Tannin (mg/100g)	0.33	0.30	0.31±0.02	0.79	0.5	0.66±0.17
Phytate (mg/100g)	0.01	0.01	0.01±0.01	0.02	0.02	0.02±0.01

Table 3: Vitamins composition of the *Irvingia Wombolu* and *Irvingia gabonensis* cotyledon.

Parameter content	**Irvingia Wombolu**			*Irvingia Gabonensis*		
	A	B	Mean±SD	A	B	Mean ± SD
B-ca1rotene (ppm)	11.3	6.7	8.98±3.22	14.2	16.1	15.2±1.33
Vitamin B2(mg/100g)	0.17	0.1	0.16±0.02	0.2	0.2	0.2±0.00
Vitamin B6(mg/100g)	0.18	0.1	0.14±0.06	0.2	0.27	0.26±0.02

Table 4: Mineral composition of *Irvingia wombolu* and *irvingia gabonensis* cotyledon (Mg.100g).

Mineral	*Irvingia Wombolu*			*Irvingia Gabonensis*		
	A	B	Mean±SD	A	B	Mean ± SD
Potassium (K)	60.2	57.7	59.0±1.81	90.8	78.1	84.5±9.0
Sodium (Na)	50.1	47.1	48.6±2.12	5.2	7.3	64.6±5.11
Calcium (Ca)	90.4	88.1	89.3±1.61	113.2	117.4	115.1±2.72
Iron (Fe)	20.3	20.7	20.5±0.35	34.1	39.4	36.8±3.75
Magnesium (Mg)	40.7	42.3	41.5±1.15	48.2	40.7	44.5±5.36
Zinc (Zn)	0.03	0.04	0.04±0.01	0.02	0.02	0.02±0.0002
Cadmium (Cd)	0.002	0.03	0.02±0.02	0.03	0.02	0.02±0.005
Lead (Pb)	0.003	0.03	0.03±0.004	0.005	0.005	0.05±0.003
Copper (Cu)	0.03	0.03	0.03±0.004	0.02	0.02	0.02±0.003
Silver (Ag)	0.03	0.03	0.03±0.001	0.04	0.04	0.04±0.003

Discussion

Proximate composition of *Irvingia wombolu* and the *Irvingia gabonensis* is presented in Table 1. The moisture Content of 4.85% and 6.28% for *I. wombolu* and *I. gabonensis* seed respectively is low which is within the range value of most seeds and legumes [25]. The low moisture value ensures a long life of the seed without microbial spoilage. Thus moisture content of *I. gabonensis* (6.28%) is greater than those of *I. wombolu* (4.85%). These values were low when compared with those of walnut flour reported by Ogungbenle 2009 [26] and quinoa flour reported by Ogungbenle 2003 [27]; the crude fibre levels of the *I. wombolu* and the *I. gabonensis* were 8.69% and 10.4% respectively. The fibre levels of the *I. wombolu* was lower than that of *I. gabonensis* sample. These values reported were lower than that of bambara groundnut 15.2% (Aremu, Olofe and Akintayo, 2005 [28]. The high fibre content may improve bowel function and provide faecal bulk digestion. The fiber values were reasonable and the indigestible cellulose they contain may absorb water and provide roughage for better functioning of the alimentary system as well as combine with intestinal cholesterol for excretion in the faeces reported by Makkar, 1986 [29]. It has been reported that intake of dietary fibre can lower cholesterol level, risk of coronary heart disease, hypertension, diabetes and breast cancer [30]. The crude fat values of the *I. Wombolu* and *I. gabonensis* were 53.8% and 58.7% respectively. The fat in *I. gabonensis* was higher than that of *I. wombolu*. These values qualified Africa Mango as oil-rich when compared with the range of oil-rich legume (43.8-51.9%) [31]. This high value of the crude fat suggests that the kernel may be a good source of quality vegetable oil for both domestic and industrial uses. The crude protein for *I. wombolu* and *I. gabonensis* were 8.06% and 13.6% respectively. The crude protein value of 8.06% for *I. wombolu* is low compared to some commonly consumed plant protein in

Nigeria and this does not qualify the seed as protein rich plant food. The observed low value in this study may be due to long lasting storage before been used for the experiment. The ash content of 1.51% and 1.71% of *I. wombolu* and *I. gabonensis* was low, but this value is relatively lower than those of bitter leaf (15.86%) and moringa oleifera (15.09%) [32], which shows that all the nutrients in the sample are all utilized. The carbohydrate content for *I. wombolu* and *I. gabonensis* have 23.1% and 9.30% respectively which shows that the sample were good in energy given. The calculated fatty acid value 47.0 and 43.0 for *irvingia gabonensis* and *irvingia wombolu* obtained for the two samples suggest that the oil may be suitable as edible oil and industrial purpose [33] and also the calculated metabolizable energy value showed that the sample have energy concentration favourably compared to cereals [34].

Table 2: present the anti-nutrients for both the *I. wombolu* and *I. gabonensis* seed sample. The phytae value was lower than those of kidney bean (40.8mg/g) reported by Olaofe, Famurewa and Ekwagbere 2010 [35], Soybean (40.5%) and cow pea (20.4mg/g) reported by Aletor and Omodara, 1994 [36]. Phytate can affect digestibility by chelating with calcium or by binding with substrates or proteolytic enzymes. Phytate is also associated with increased cooking time in legumes reported by Nwakolo and Bragg 1977 [36]. The tannins content in the samples generally can be considered to be of little nutritional significant. The levels of the tannin in this study (0.31mg/100g and 0.66mg/100g) for *I. wombolu* and *I. gabonensis* respectively were in the same range value of 0.3 – 7.8g/100g in M pruriens reported by Agbede and Metor, 2005 [37]; the Oxalate value of this study were 0.23 and 0.38g/100g in *I. wombolu* and *I. gabonensis* respectively. The presence of Oxalate has undesirable effects on Ca absorption and utilization. This acid combine with Ca to form calcium oxalate, which passes through the intestine unabsorbed. The amount of oxalate formed depends on the amount of oxalic acid in the food reported by Fleck, (1976) [38]. About half of all kidney stones are Calcium Oxalate, either alone or mixed with the salts of calcium phosphate, magnesium, ammonium phosphate and calcium carbonate. Formation of these stone frequently reflects chronic alkalinity of bladder and renal pelvic urine caused by infection with bacteria that hydrolyzed urea, releasing ammonia [39]. Oxalate levels in the present report were very low.

The data on the mineral composition for *I. wombolu* and *I. gabonensis* were shown in table 4. the sample were found to contain appreciable amount of calcium, sodium, potassium, magnesium, iron and extremely low level of lead, cadmium, zinc, copper and silver. The most abundant mineral was calcium in *I. wombolu* and *I. gabonensis* with value of 89.3 and 115.1mg/100g sample respectively. This is contrary to the observation of some researchers who had reported that potassium is the most abundant mineral in agriculture products [40], [41], [28]. The least abundant mineral was Iron (20.5mg/100g) in *I. wombolu* and (36.8mg/100g) in *I. gabonensis.* Sodium, potassium and magnesium were high in both samples. The presence of calcium and magnesium would make *I. wombolu* and *I. gabonensis* sample suitable for bone formation for children since the deficiency of these mineral (Ca and Mg) can lead to abnormal bone development [41]. Magnesium is also an activators of many enzymes systems and maintain the electrical potential in nerves [41]. Sodium and potassium are required for the maintenance of osmotic balance of the body fluids, the pH of the body to regulate muscles and nerves irritability, control glucose absorption and enhance normal retention of protein during growth (NRC, 1989) [42]. The sodium to potassium ratio in the body is of great concern for the prevention of high blood pressure. The Na/K ratio of less than one is recommended. However Na/K ratios in *I. wombolu* and *I. gabonensis* (0.8 and 0.76) respectively are less than one. The Iron content (20.5 and 36.8g/100g sample) were relatively high in the samples [25]. Iron is required for blood formation and also important for normal functioning of the central nervous system [25]. Metals such as lead, cadmium, zinc, copper and silver were below detection limit of the AAS.

The vitamin composition of *I. wombolu* and *I. gabonensis* were presented in table 5.

The vitamin A contents of *irvingia Wombolu* and *irvingia Gabonensis* were (8.98mg/100g and 15.2mg/100g) respectively. The vitamin A

content of *irvingia gabonensis* was higher than that of *irvingia wombolu*. Vitamin A is a fat-soluble vitamin that is good for healthy vision, skin, bones and other tissues in the body. It also works as an anti-oxidant, fighting cell damage. Taking high level of antioxidant, such as vitamin A, along with zinc, may reduce the risk of developing advanced age-related muscular degeneration by about 25 percent. Vitamin B2, also called riboflavin is one of the 8 – B vitamins. All B vitamins help the body to convert food (carbohydrate) into flud (glucose), which is used to produce energy. It is often referred to as B-complex vitamins which help the body metabolize fats and protein. They are necessary for a healthy liver, skin, hair eye and proper functioning of the nervous system. Riboflavin works as an antioxidant, fighting damage particles in the body known as free radical. It is also needed to help the body change vitamin B6 and folate into forms it can use. It is also important for growth and red blood cell production. The value of vitamin B2 were higher in *irvingia gabonensis* (0.23mg/100g) than that of *irvingia wombolu* (0.02mg/100g). Early studies suggest that riboflavin might help prevent cataracts damage to the lens of the eye, which can lead to cloudy vision. Vitamin B2, along with other nutrients is important for normal vision. Vitamin B6 is the family of B vitamins, which are also known as B-complex vitamins, plays an important role in converting food into energy and helping the body metabolize fats and protein. It is important for cardiovascular, digestive, immune, muscular, and nervous system function. The vitamin B6 content of *irvingia gabonensis* (0.26gm/100g) were higher than that of *irvingia wombolu* (0.14gm/100g). The B6 vitamin is needed for proper developing and function and to make the hormones serotonin and norepinephrine, which affect mood. It is also important in helping regulate your internal clock.

Conclusion

The results of this analysis and calculations showed that both *I. wombolu* and *I. gabonensis* were good sources of fat, protein, fibre and carbohydrate, essential mineral, low in anti-nutrients, moderate source of vitamins.

The study showed that the two samples contained nutritionally valuable mineral and useful quantities of vitamins. The low content of anti-nutritional factors makes it safe for mineral utilization in the body and also safe consumption in diet. Therefore *irvingia gabonensis* having the highest qualities is thereby recommended for both industrial, commercial and consumption purpose.

This work showed that both *I. Wombolu* and *I. gabonensis* contained almost the same proximate, vitamins, anti-nutrients and mineral composition but slightly higher in *I. gabonensis* because by the time of the analysis, the seed was freshly harvested. Therefore the seed would retained it's nutritionally valuable minerals when fresh. (*I gabonenesis* (August-December) and *I wombolu* (January – July). Thus both samples are recommended for domestic and industrial uses.

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