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Micronutrients and anti-nutritional composition of ‘kpaakpa’ (*Hildegardia barteri*) seed flours

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ABSTRACT: The study investigates the micronutrient and anti-nutritional composition of ‘kpaakpa’ (*Hildegardia barteri*) seed flours. Defatted and undefatted samples of ‘kpaakpa’ (*H. barteri*) seed flours were produced. The mineral, vitamin and anti-nutrient composition of the flour samples were determined. Results of mineral composition showed calcium, copper, iron and potassium contents to be 30.00 mg/100g, 0.84 mg/100g, 3.67 mg/100g and 1.62 mg/100g, respectively, for the defatted flour; 27.33 mg/100g, 0.68 mg/100g, 0.86 mg/100g and 2.40 mg/100g, respectively for the undefatted flour sample. For the defatted flour, high calcium content indicated that the seed could be a valuable calcium supplement, especially, in calcium deficient diets. Furthermore, results obtained for vitamin A, vitamin D, vitamin E and vitamin K were 1769.13 µg/100g, 8.25 µg/100g, 67.85 mg/100g and 10.31 mg/100g, respectively for the defatted flour and 5759.10 µg/100g, 15.87 µg/100g, 78.50 mg/100g and 11.53 mg/100g for the undefatted flour. The high vitamin A content revealed that the seed could be a good supplement for foods with low vitamin A and could be a remedy to blurred vision. The results of the anti-nutrient determination showed that the composition of phytate, oxalate, tannin and cyanide of defatted seed flour were 0.37, 0.14, 0.93 and 0.04%, respectively and 0.34, 0.05, 0.60 and 0.06% for the undefatted seed flour. The low anti-nutritional content particularly cyanide makes the seed more suited for food formulation.

Keywords: Anti-nutritional, defatted, flour, *Hildegardia barteri,* micronutrients, mineral, undefatted, vitamin.

INTRODUCTION

The seed of *Hildegardia barteri* (mast), also known as “Kpaakpa” in Igbo, “Kariya” in Hausa, and “Okurugbedu” in Yoruba, is widely consumed in West Africa either as raw or roasted nuts and have a flavour similar to that of peanut. *H. barteri* is a tree that grows in the region of West Africa, spanning from the Ivory Coast to Nigeria and is called the Krobo Christmas tree. It has distinct ornamental value since its flowers are conspicuous on leafless branches in the dry season. According to Hildegardia (2007) notes, the flowers which are usually borne on leafless branches mature into one seeded pod, each 50 mm in length, having a peanut like seed in a nutshell. When the pods are completely mature and dry, they drop from the tree and are dispersed as refuse in many parts of the world where they are found. Only in few West African countries are the kernels used as oil seeds in preparing traditional food condiments. It is mainly consumed in Ebonyi state, in particular, where it is eaten raw or roasted like peanuts. However, consumption of most oil seeds in the world is limited because in their raw state, they contain high levels of anti-nutrients which are potentially toxic (Akande et al., 2010). *H. barteri* seed is not an exception, according to Gbadamosi and Famuwagun (2015).

H barteri seed contains antinutritional factors like oxalate, tannins, and saponins. Oxalate bind minerals like calcium and magnesium and interfere with their metabolism which leads to muscular weakness and paralysis (Soetan and Oyewole, 2009). Tannins have been reported to affect nutritive value of food products by chelating metals such as iron and zinc thereby reducing their absorption (Akindahunsi and Oboh, 2003). Saponins have been found to cause haemolytic activity by reacting with the sterols of erythrocyte membrane. The concentration of these antinutrients in plant protein sources vary with the species of plant, cultivar, post-harvest treatments and processing methods (Khare et al., 2000). Fasoyiro et al. (2006) revealed that processing treatments such as soaking, cooking and fermentation are capable of reducing the anti-nutrients in legumes and oil seeds.

Oil seeds are generally rich in minerals and vitamins such as iron, zinc, copper, thiamine, riboflavin, niacin and panthothenic acid and, also, fat soluble vitamins. Most of these minerals and vitamins are well known as hematinic and are essential in the formation of red blood cells. This present study was therefore conducted to evaluate the micro nutrients and the anti-nutrients in *H. barteri*.

A number of oil seeds have been characterized, but the vast majority has not been completely evaluated. There has been a focus on non-conventional oil seeds for possible development and use as foods. *H. barteri* falls into this group of underutilized species of plant and, furthermore, the seeds have found limited application as food and food ingredient. Due to increasing demand for conventional seeds high in micronutrients such as soybean, peanut, rape seed and canola, there is need to source protein from the underutilized oil seeds. In order to overcome malnutrition in developing countries of the world, value can be added to *H. barteri* seeds/fruits (by utilizing it as local condiments for human consumption, as vitamin supplement as well as in animal feed formulation instead of disposing them as refuse. This will help to reduce malnutrition, increase utilization of lesser known oil seeds for food production and also reduce the cost of animal feed; thus, improving food security in Nigeria. The major problem associated with consumption of oil seeds is the high levels of anti-nutrients which is potentially toxic, *H. barteri* seed is not an exception, and as such very dangerous to health.

This work was designed to evaluate the minerals, vitamins and the anti-nutritional factors of *H. barteri* seed. The information obtained from this research will help improve the utilization of *H. barteri* seeds in food industries and also impart knowledge in the minerals, vitamins and anti-nutritional composition of *H. barteri* seeds. In this work, the *H. barteri* seeds were processed into meal; a portion of the meal was defatted, and the minerals, vitamin content and anti-nutritional composition of both the undefatted and defatted flour samples evaluated.

MATERIALS AND METHODS

Raw materials cleaning and preparation

Raw seeds of *Hildegardia barteri* used for this research were picked from Paul University, Awka, along the old road by Ukwu Orji Bus stop Anambra State, Nigeria. The seeds were removed from the pods, thoroughly cleaned by hand picking until traces of dirt covering the outer shell (flower like covering) and the pods were removed. Rotten pods and dirt materials were also removed. The seeds were dehulled, manually, using a stone and iron which was used to apply force carefully to avoid crushing of the cotyledon. The iron slightly cracked the pods for efficient separation of the seeds from the pods. The dehulled seeds were milled using an electric blender, weighed in batches and, subsequently, used for determination of vitamins, minerals and anti-nutritional composition. Detailed flow diagram of the process is presented in Figure 1.

Production of defatted flour

The defatted flour sample was prepared using the method of Gbadamosi et al. (2012). Some portion of the undefatted *H. barteri* seed flour were weighed and wrapped with a filter paper and soaked in n-hexane solvent for five (5) days, with continuous washing and changing of solvent at intervals, until a clear liquid was obtained. The process was repeated three times. At the end of the extraction process, the collected mixture of oil and solvent was separated using soxhlet apparatus. The extracted crude oil was then dried free of solvent in an air oven. And the defatted flour was spread on trays and dried to strip off the residual hexane. The defatted flour was then used for analysis. Figure 2 below showed the flow diagram for the defatted *H. barteri* seed flour:

Vitamins analysis of *H. barteri* seed flour

The vitamin contents of the *H. barteri s*eed meal were determined using various standard methods.

Vitamin A (Retinol)

The determination of vitamin A in *H. barteri* seed meal was done using the method of Okwu and Ndu (2006). The weight equivalent of 500IU (0.34g) of sample was taken into a round bottom flask. In the round bottom flask, 2 ml of potassium hydroxide solution (50%w/v), 10 ml of glycerol and 50 ml of ethanol were added and mixed very well. The mixture was refluxed for 45 minutes on a boiling water bath and cooled. The flask was washed with distilled water and transferred into a separator; then, it was extracted with 4× 25 ml diethyl ether. The ether extract was combined and was washed with water. The aqueous water was discarded then the ether layer was taken into a dry 100 ml volumetric flask by passing through a hydrous sodium sulfate and was made up to 100 ml with diethyl ether and was properly mixed. The absorbance was measured at 325 nm using a spectrophotometer and

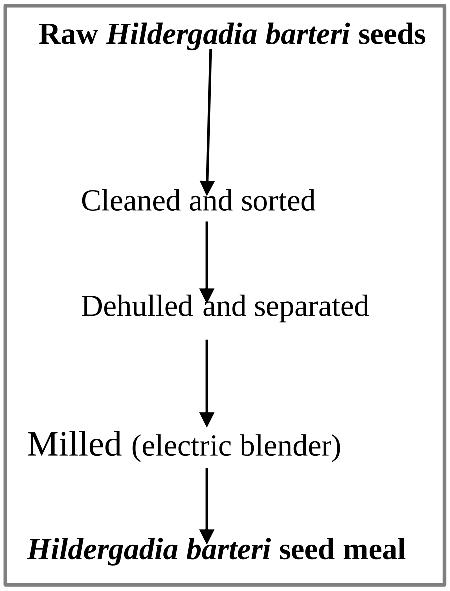

Figure 1. Production of *Hildegardia barteri* seed flour.

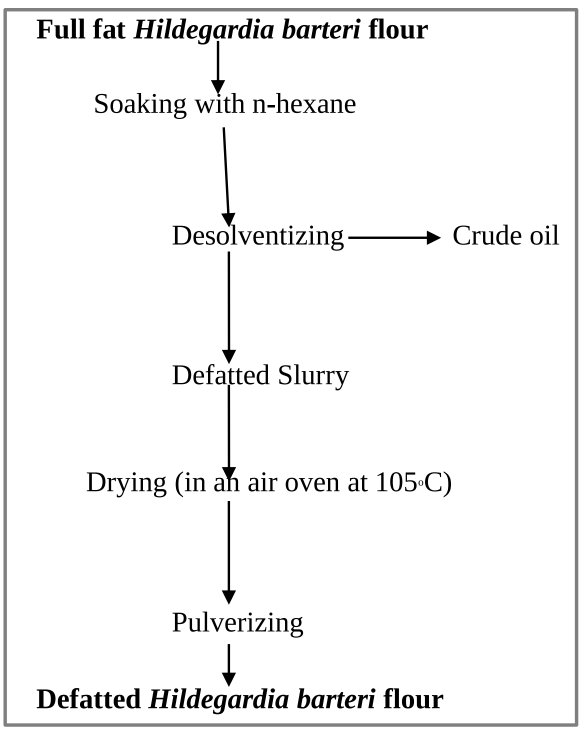

Figure 2. Production of defatted *Hildegardia barteri* flour.

recorded against the blank. The procedure was repeated for defatted seed flour.

1IU = 0.67 mg
500IU = ?
500 × 0.67 = 0.34g

$$\text{Concentration of vitamin A mg/L} = \frac{S_A \times C_S}{A_S} \quad (1)$$

Where: S_A Absorbance of sample, C_S Concentration of standard and A_S Absorbance standard

Vitamin D (Cholecalciferol)

The determination of vitamin D in *H. barteri* seed meal was done using the method of Okwu and Ndu (2006). Accurately equivalent to 40, 00000IU, vitamin D3 of sample was measured in a 25 ml volumetric flask with solution mixture (chloroform and methanol in ratio 1:9). It was dissolved and diluted with solution mixture and was properly mixed. The absorbance as recorded at 264 nm against blank. The procedure was repeated for defatted seed flour.

$$\text{Amount of vitamin D} = \frac{\text{A450} \times \text{volume of sample} \times 100 \times 4}{\text{Weight of sample}} \quad (2)$$

Vitamin E (Tocopherol)

Two grams (2g) of the *H. barteri* seed meal were weighed into a reflux flask and 100 ml of ascorbic acid methanol solution, obtained by mixing 0.5 g of ascorbic acid was added. 4 ml of water and 20 ml of ethanol was brought to 100 ml with methanol and kept in boiling water for 15 to 20 minutes. A 15 ml of 70% Potassium hydroxide solution was heated over a water bath for 40 minutes. The content of the flask was decanted into a separation flask by washing the flask with 50 ml of water. 170 ml of ethyl ether was added and stirred; the mixture was decanted and filtered on sodium sulfate. Subsequently, the mixture was again extracted with 120 ml of ethyl ether, filtered, evaporated and concentrated to 1 ml. The procedure was repeated for defatted seed flour.

Vitamin K (Menadione)

A 5 ml of standard sample and blank, solution was transferred into test tubes, each containing solutions hydrochloric acid and alcohol in the ratio of 1:5 v/v and mixed thoroughly. The test tubes were subsequently heated on a water bath until almost dry and were cooled at room temperature. 15 ml solution mixture (ammonia and alcohol, 1:1) was added in each test tube and the absorbance was recorded at 635 mm against blank. The procedure was repeated for defatted seed flour. Concentration of vitamin K in mg/100g

$$\text{Amount of vitamin K} = \frac{\text{A3.12} \times \text{A655} \times \text{volume of sample}}{\text{Weight of sample}} \text{ x } 100 \quad (3)$$

Analysis of minerals in *H. barteri* seed flour

The determination of mineral content of *H. barteri* seed meal was done using the wet-digestion method. Aquaregia (30ml of 1:3 nitric acids and hydrochloric acid) was added to 3 g of the sample and digested. The digest was cooled and diluted to 100 ml with deionized water. The blank and standards were tested and treated in the same way. The blank, the standards and the sample solutions were fed to the atomic absorption spectrophotometer. Various lamps for the metals to be determined were selected while the instrument selects characteristic wave length of interest for each metal. The instruments were put on after selecting the method and the samples, standard and blank were respectively fed to the flame through the auto-sampler which produced atomization of the sample solution. The concentration of the metal in thin sample was detected by the detector and recorded from the read out unit in the instrument. The procedure was repeated for defatted seed flour.

Anti-nutritional composition analysis of *H. barteri* seed flour

Oxalate

The determination was done as described by Zaremboski and Hodgkinson (1962). Two grams (2 g) of the sample was placed in 250 ml volumetric flask suspended in 190 ml distilled water. 10 ml of 6N HCl solution was added to the sample and the suspension digested at 100ºC for one hour. The samples were then cooled and made up to 250 ml mark of the flask with distilled water. The sample was filtered and the duplicate portion of 125 ml of the filtrate was transferred into a beaker and four drops of methyl red indicator was added, followed by the addition of NH_3 solution drops wise until the solution changed from pink to yellow. The solution was raised to 90ºC, cooled and filtered. The filtrate was again heated to 90ºC and 10 ml of $CaCl_2$ solution was added to the samples stirring consistently. The samples were allowed to stand overnight and subsequently centrifuged. The precipitate was completely dissolved in 10 ml of 20% H_2SO_4, and diluted to 200 ml with distilled water. Aliquots of 125 ml of the filtrate was heated to near boiling and filtrated against 0.05 M $KMnO_4$ solution to a pink colour which persisted for 30 seconds. The oxalate content of each sample was calculated. The procedure was repeated for defatted seed flour.

$$\%\ \text{Oxalate} = \left(\frac{100}{\text{w}}\right) \times 0.00225\text{g} \times \text{titre value} \qquad (4)$$

Where: w = weight of sample analyzed

Tannin

Tannin was determined by the method as described by Pearson (1976). One gram (1 g) of the sample was dissolved in 10 ml of distilled water, agitated and left to stand for 30 minutes at room temperature. Each sample was centrifuged and the extract recovered. 2.5 ml of the supernatant were dispersed into 50 ml volumetric flask. Similarly, 2.5 ml of standard tannic acid solution was dispersed into a separate 50 ml flask. A 1.0 ml folin-denis reagent was measured in each flask followed by the 2.5 ml of saturated Na_2CO_3 solution. The mixture was diluted to 50 ml in the flask and incubated for 90 minutes at room temperature. The absorbance of the samples was measured at 250 nm with the reagent blank at zero. The percentage tannin was calculated. The procedure was repeated for defatted seed flour.

$$\%\ \text{Tannin} = \left(\frac{100}{\text{w}}\right) \text{x} \left(\frac{\text{An}}{\text{As}}\right) \text{x} \left(\frac{\text{C}}{100}\right) \text{x} \left(\frac{\text{Vf}}{\text{Va}}\right) (5)$$

Where: w = weight of sample analyzed, An = absorbance of the test sample, As = absorbance of the standard tannin in mg/ml, Va = volume of filtrate analyzed, Vf = total filtrate (extract) volume and C = concentration of standard solution.

Phytate

The phytate of the sample was determined through phytic acid determination using the method described by Lucas and Markaka (1975). This entails weighing 2 g of the sample into 250 ml conical flask. 100 ml of 2% concentrated HCl was used to soak the samples in the conical flask for 3 hours and then filtered through double layer filter paper. 50 ml of the sample filtrate was placed in a 250 ml beaker and 10 ml of distilled water distilled water added to give or improve activity; 10 ml of 0.3% ammonium thiocyanate solution was added to the sample solution as indicator and titrated with standardized iron chloride solution containing 0.00195 g iron/ml and the end point was signified by brownish-yellow colouration that persisted for 5 minutes. The percentage phytic acid was calculated. The procedure was repeated for defatted seed flour.

$$\%\ \text{Phytic acid} = \text{y} \times 1.19 \times 100 (6)$$

Where: y = titre value × 0.00195g

Hydrogen Cyanide

The method used was alkaline picrate method of Onwuka (2005). Five grams (5 g) of the sample was weighed and added to 50 ml of distilled water in a conical flask and allowed to stand overnight and then filtered. Different concentrations of KCN solution containing 20 to 100 mg/ml cyanide standard curve. To 1 ml of the filtered sample and standard cyanide solution in a test tube, 4 ml of alkaline picrate solution was added and incubated in a water bath for 15 minutes, colour changes from yellow to reddish brown, after colour development. The absorbance was read at 490 nm against a blank containing 1 ml of distilled water and 4 ml picrate solution. The cyanide content was extrapolated from the cyanide standard curve. The procedure was repeated for defatted seed flour.

$$\text{Cyanide (mg/100g)} = \frac{A_s \text{ X } aG_f \text{ X } D_f}{W} \quad (7)$$

Where: A_s = Absorbance of sample G_f = Gradient factor D_f = Dilution factor and W = Sample weight

RESULTS AND DISCUSSION

Vitamin composition of defatted and undefatted 'kpaakpa' seed flours

The mean values of the fat soluble vitamins contents of defatted and undefatted *Hildegardia barteri* seed flours were shown on Table 2. The determined vitamins were vitamin A, vitamin D, vitamin E and vitamin K. The defatted sample had significantly ($p<0.05$) low vitamins than the undefatted samples.

The vitamin A content of the defatted *H. barteri* flour sample was 1769.13 ± 0.13 µg/100g while that of undefatted sample was 5759.10 ± 0.10 µg/100g. The values are significantly ($p<0.05$) different and the variation in the values maybe as a result of the deffating process. The vitamin A content of undefatted flour sample was significantly higher than the vitamin A content of the defatted *H. barteri* flour, and this indicates that 'kpaakpa' flour is rich in vitamin A and can be used for food formulation or supplementation.

The vitamin D content of the defatted *H. barteri* flour sample was 8.25±0.05 µg/100g and that of the undefatted *H. barteri* flour was 15.87±0.03 µg/100g. The undefatted flour was significantly high indicating that it is a good source of Vitamin D which helps in the absorption of calcium. Vitamin D helps to form and maintain healthy teeth, bones and soft tissues; it also helps in preventing impaired sight and blindness. In addition, it helps to build a stronger immune system (Institute of medicine 1999) According to Institute of medicine (1999), the daily recommended intake of vitamin D for older adults ranges from 400 to 600IU while for younger adults need about 200IU.

Vitamin E content of the defatted *H. barteri* flour sample was 67.85 ± 0.01 mg/100g and 73.50 ± 0.01 mg/100g for undefatted *H. barteri* flour. The undefatted seed is significantly high in vitamin E content making it a good source of Vitamin E. Vitamin E is an antioxidant that protects the body tissue from damage caused by substances called free radicals, it helps to keep immune system strong, it helps in the formation of red blood cells, it widens blood vessel and help in preventing blood clotting (Institute of medicine 1999).

Vitamin K contents were determined to be 10.31 ± 0.01 mg/100g for defatted *H. barteri* flour sample and 11.53±0.01mg/100g for undefatted *H. barteri* flour sample. The low vitamin content of the defatted sample maybe attributed to the deffating process. The undefatted *H. barteri* is significantly higher in vitamin K content, indicating that it is a good source of vitamin K. Vitamin K plays a role in blood clotting, aids in sound memory and supports brain and nervous system. The recommended daily intake for vitamin K by Institute of Medicine (1990) for female (19 years and above) is 90 mg/day while 120 mcg/day for male (19 years and over). *H. barteri* seed is rich in vitamins and can be used in the formulation of infant foods.

Mineral composition of defatted and undefatted 'kpaakpa' seed flours

Table 1 shows the mean values of the mineral composition of defatted and undefatted 'kpaakpa' (*H. barteri*) seed flours. The selected mineral contents that were determined were calcium, copper, iron and potassium.

Calcium

The calcium content of the defatted sample was 30.00±1.00 mg/100g which is significantly ($p<0.05$) different from that of the undefatted sample which had calcium content of 27.33±0.10 mg/100g. This shows that the variation in the value of the defatted flour maybe as a result of the defatting process, the undefatted values for the calcium content of *H. barteri* seed flour is not in agreement with the result (0.01mg/100g) for melon seeds reported by Jacob et al. (2015) and result (59.0mg/100g) for cashew kernel flour (Emenike et al., 2015). Comparing the undefatted and defatted flour, the undefatted *H. barteri* seed flour was significantly higher than the defatted seed flour in calcium. Calcium is essential in building bone, maintaining blood levels, sending and receiving nerve signals, relaxing muscles, keeping a normal heart beat and releasing hormones and other chemicals (Aliyu et al., 2008). *H. barteri* seed can be used in meal diversification and food formulation because of the high calcium content.

Copper

The copper content of the defatted sample was 0.84 ± 0.01 mg/100g which is significantly ($p<0.05$) different from that of the undefatted sample which has copper content of 0.68±0.01 mg/100g and is lower than the recommended daily allowance (RDA) of 1.5 to 3.0 mg per day for an adult (Jacob et al., 2015) . These results compared favourably with the values obtained by Abdulsalami (2010) for undefatted Bambara groundnut (0.41mg/100g) and 0.22mg/100g for processed Bambara groundnut. From the results of both samples, the undefatted flour is significantly lower than the defatted flour which implies that *H. barteri*

Table 1. Mean values for mineral composition of 'kpaakpa' (*Hildegardiabarteri*) seed flour.

Composition (mg/100g)	Defatted	Undefatted	LSD
Calcium	30.00^a ±1.00	27.33^b ± 0.10	0.65
Copper	0.84^a ±0.01	0.68^b ±0.01	0.08
Iron	3.67^a ±0.03	0.86^b ±0.04	1.64
Potassium	1.62^b±0.01	2.40^a±0.01	0.98

Values with different superscripts are significantly different (p<0.05).

Table 2. Mean values for vitamin composition of 'kpaakpa' (*Hildegardia barteri)* seed flour.

Composition (mg/100g)	Defatted	Undefatted	LSD
Vitamin A	1769.13 ^{a}± 0.13	5759.10 ^{b}± 0.10	15.02
Vitamin D	8.25^b ± 0.05	15.87 ^{a}± 0.03	1.44
Vitamin E	67.85 ^{b}± 0.01	3.50 ± 0.01	0.11
Vitamin K	10.31 ^{b}± 0.01	11.53±0.01	0.71

Values with different super scripts are significantly different (p<0.05).

seed flour would contribute significantly to RDA of copper. Copper is important for proper utilization of sugar in the body, it is necessary for bone growth and nerve function, it has a function in the metabolism of cholesterol and glucose and help stimulates immune system to fight infections. Deficiency of copper may result in anemia and osteoporosis (Jacob et al., 2015).

Iron

Iron content of the defatted *H. barteri* flour sample was 3.67 ±0.03 mg/100g and is significantly (p<0.05) different from undefatted sample which has iron content of 0.86 ± 0.04mg/100g. Comparing the defatted and undefatted *H. barteri* seed flour, the undefatted *H. barteri* flour is lower in iron content, and this means that *H. barteri* flour is not a good source of iron because according to institute of Medicine (1990), the recommended iron intake for children is 8 mg/day and for older adult (18 mg/day). Iron is an essential mineral because it helps to convert food to energy, helps in the reduction of tiredness and fatigue, and helps to maintain healthy cells, skin, hair and nails.

Potassium

The potassium content of the defatted *H. barteri* flour sample (1.62 ± 0.01mg/100g) is significantly (p<0.05) different from undefatted *H. barteri* flour (2.40 ± 0.01mg/100g). The defatted *H. barteri* flour is significantly low indicating that it is a poor source of potassium. Potassium is an important mineral with numerous functions; it is needed in the body for fluid balance, muscle contraction, regulate blood pressure and allows the heart and kidneys to function properly. High concentration of potassium in the body was reported to increase iron utilization (Adeyeye, 2002) and beneficial to people taking diuretics to control hypertension and suffer from excessive excretion of potassium through the body fluid (Arinanthan et al., 2003). From the results obtained from this study, *H. barteri* seed meal is not a good source of minerals except calcium which can be used in meal diversification.

Anti-nutritional composition of defatted and undefatted 'kpaakpa' seed flours

The defatted and undefatted samples of the *H. barteri* seed flours were examined for anti-nutrients and the result were shown on Table 3. The phytate content of the defatted *H. barter)* seed flour was not significantly (p>0.05) from the undefatted sample. The values obtained are lower than the values (1 to 2.22%) range seen in soya bean as reported by Price et al. (2001).

The oxalate content of the defatted *H. barteri* flour sample was found to be 0.14 ± 0.01%, and 0.05 ± 0.01% for undefatted *H. barteri* flour sample. The oxalate content of defatted *H. barteri* flour sample was significantly (p<0.05) different from that of the undefatted *H. barteri* flour sample. The results obtained for oxalate (0.14±0.01%, and 0.05±0.01%) in this research were lower than the values (2.1%and 0.18%) of oxalate reported by Ife and Emeruwa (2008) for *Orycles monoceros,* and rubber seed meal (Udo et al., 2016), respectively. According to Ladeji (2004), oxalate can bind to calcium present in food, thereby, rendering calcium unavailable for normal physiological and biochemical role such as the maintenance of strong bone and teeth, etc.

The tannin content of defatted *H. barteri* seed flour (0.93 ± 0.02%) were significantly (p<0.05) different from the undefatted *H. barteri* seed flour (0.60 ± 0.02%). These results are comparable to (0.05 to 1.26%) of fermented

Table 3. Mean values for anti-nutritional composition of ‘kpaakpa’ (*Hildegardia barteri)* seed flour.

Anti-nutrient (%)	Defatted	Undefatted	LSD
Oxalate	0.14^{a} ±0.01	0.05^{b} ±0.01	0.06
Phytate	0.37^{a} ±0.03	0.34^{a} ±0.01	0.08
Tannin	0.93^{a} ±0.02	0.60^{b} ±0.02	0.09
Cyanide	0.04^{a} ±0.01	0.06^{a} ±0.01	0.08

Values with different superscripts are significantly different (p<0.05).

kariya seed reported by Gbadamosi and Famuwagun (2015). The tannin content has been found to be low and within the safe levels (1.5%) for man (Health and Safety Publications, 2011). Tannin usually forms isolated complexes with protein, thereby, interfering with their bioavailability and high tannin in diets is said to bind with proteins of saliva and mucosa membrane.

The cyanide content of the defatted *H.a barteri* seed flour (0.04 ± 0.01%) was not significantly (p>0.05) different from that of undefatted *H. barteri* seed flour (0.06 ± 0.01 %). The value is lower than 39.40% reported in melon seeds by Jacob et al. (2015). The cyanide content of the defatted and undefatted seed flour was very low so there will not be much effect in the inhibition of several systems, depressing the growth through interference with certain essential amino acid and utilization of associated nutrients toxicity (Udo et al., 2018). The importance of estimating the concentrations of these secondary metabolites is to establish and advice on the quantity of kpaaka one can chew at a time. The higher the concentration of these metabolites, the more dangerous they become to health. Therefore, since *H. barteri* seed meal of both undefatted and defatted are generally low in anti-nutrients; hence, ‘kpaakpa’ seed meal would not pose a risk to health upon consumption and may also be a good source of food for human and animals.

Conclusion

The differences in the vitamin and mineral contents of the undefatted and defatted kpaaka flour was repeated with the possible advantage to man if applied in the food system. The anti-nutritional composition was found to be low; hence, this will encourage the utilization of ‘kpaakpa’ seed meal in the food system. Therefore, *Hildegardia barteri* flour should be used as food for man.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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