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Research Article

Nutritive and Non-Nutritive Properties of Different Processing Methods on Mucuna Flagellipes Seeds

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Abstract

The effects of processing on the chemical properties (proximate, mineral, vitamins, and anti-nutritional factors) and the physicochemical properties of *Mucuna flagellipes* seeds were assessed. *Mucuna flagellipes also known as "Ukpo" seeds were purchased from a local market and divided into three portions.* The first sample labeled with A was processed by frying and the second sample of the seeds labeled B was boiled, while the third sample labeled with C was processed by roasting. Samples were analyzed by official methods of analysis as results generated were subjected to one-way analysis of variance (ANOVA). The proximate compositions showed a significant difference at ($P< 0.05$) in some nutrients evaluated. In terms of moisture content, all the fried samples were lower (5.00±0.92%) than the boiled (14.53±0.42%) and roasted (11.87±0.23%) samples. Also, there was no significant difference ($P< 0.05$) observed in the ash content for the processed samples. The protein content of the processed samples was low and no significant difference ($P< 0.05$) was observed. The seed oil was extracted with (40 - 60°C) n-hexane and the oil was separated from the solvent using a rotary evaporator. The result of the analysis shows that the saponification value, peroxide value, and Iodine value showed significant differences ($P< 0.05$). In terms of fat content, all the processed samples had lower values 5.13±0.42, 3.87±0.12, and 4.87±0.31 for fried, boiled, and roasted *Mucuna flagellipes seed oil* respectively. No significant difference was observed. The various seed samples were found to contain no less than 0.60 mg/100 g of oxalate, 0.70 mg/kg of phytate. They were relatively high in alkaloid, terpenoid, cyanide, and flavonoid. The predominant mineral was sodium in all the processed samples with the values ranging from (119.48±10.45mg/kg) to (102. 20 ± 13.38 mg/kg) followed by magnesium 8.53± 0.13mg/100ml, 7.12±0.58mg/100ml, and 7.03±6.18 mg/100ml for fried, boiled and roasted *Mucuna flagellipes*, while all the processed samples were significantly low in potassium (0.37±0.03 to 0.30±0.14mg/kg). There was a significant difference ($P < 0.05$) observed in some of the vitamin content. These research results may offer a scientific basis for the use of the processed *Mucuna flagellipes* seeds as food for humans and oil extracts for the manufacture of industrial products.

Keywords: mucuna flagellipes seeds and oil; nutrients; anti-nutrients; boiling; roasting; frying

Introduction

Edible fruits from wild plants are often taken as food or added to food as a condiment to supplement important vitamins and minerals in human diets in many communities in South-East Nigeria. However, many of the edible legumes which could serve as sources of protein are under-utilized (Nwajagu *et al* 2021). Consideration has therefore been focused on under-utilized local seeds for possible development and use. There are several of these underexploited plant seeds in Nigeria, which include *Mucuna flagellipes* popularly called "Ukpo" by the Igbos, "Kararra" by the Hausas, and "Yerepe" by the Yorubas (Akubugwo *et al*, 2012). Global food needs for future populations require urgent and un-relented efforts in exploiting the underutilized agricultural products of high magnitude of protein, minerals, and vitamins by both food scientists and agriculturists. To be economically sustainable, however, both oil and meal from these fruit seeds must be utilized. *Mucuna flagellipes* is a family fabaceae, found worldwide in the woodlands of tropical areas. The leaves are 3-palmate, alternate, or spiral and the lowers are pea-like but larger with distractive curved petals and occur in racemes (Bressani, 2012). At

maturity, each pod produces several hard, marble-like seeds, which are used as soup thickeners and vegetable oil, beverages, and food items (Eze *et al.,* 2021).

Nutritionally, 'ukpo' are important and economic sources of protein, carbohydrates, calories as well as certain vitamins and minerals. These nutrients are essential to human nutrition but the composition of these nutrients in them differs. The protein of these foods is rich in lysine but deficient in sulfur-containing amino acids, particularly cysteine and methionine. *Mucuna flagellipes* (Ukpo) contains between 6-19% crude protein; 39.8- 61.49% carbohydrate; 1.84- 5.9% fat and 11.24-17.10% vitamins. (Ene-bong, 2014).

The difficulty encountered in processing *Mucuna flagellipes* is also an area of concern. In West Africa, seeds require cracking, extensive boiling, and soaking to eliminate toxic and inhibitory constituents. The toxicity on the consumption of *Mucuna flagellipes* seeds and the results of their preparation in dizziness, diarrhea, pathological changes in organs, growth depression, and death (Obiakor-Okeke and Anozie, 2014). Therefore, the study aims to assess the effects of different processing (cooking, roasting, and frying) on the nutritive and anti-nutritive properties of *Mucuna flagellipes* seeds.

Experimental Procedure

Sample collection

Fresh Ukpo seeds used for this study were purchased from the open market in Isiagu, Ebonyi State Nigeria. The seeds which belong to the fabaceae family are round in shape as shown in figure 1. And were identified by the head of the Department of Plant Science and Biotechnology Abia State University, Uturu. The seeds were screened to remove the bad ones.

Preparation of Samples.

The method described by Omokpariola *et al* (2021) was used for the processing of the seeds into flour. The seeds were sorted and divided into three. Boiled for 45 mins in distilled water at 100℃, roasted on a hot iron pan at a temperature of 45 – 55℃, and fried on a hot iron Pan with sand at a temperature of 45 – 55℃. The seeds were cooled in desiccators and after all processing treatments were completed all processed seed samples were sun-dried to reduce moisture content and then grounded using a mechanical grinder, put in an air-tight container at room temperature, and stored for further analysis. The chemicals used were of analytical grade.

Figure 1: *seeds of Mucuna flagellipes*

Physicochemical analysis

The percentage free fatty acid, iodine value, saponification number, peroxide, and acid values of the seed oil were determined by the Official method of analysis of the Association of Official Analytical Chemists (2016).

Proximate analysis

Standard methods were employed for the proximate analysis. Crude fat was extracted by the soxhlet extraction method with N hexane at 40-60℃ for 8 hours as described by (AOAC, 2016). Crude protein content was determined by the micro Kjeldahl method. Available carbohydrate, crude fiber, ash, and moisture contents were estimated as described by (AOAC, 2015).

Anti-nutrient analysis

Tannin, flavonoid, and cyanide were quantified according to Trease and Evan (1996) method. Alkaloid and saponin content was determined using the methods described by AOAC (2016) while oxalate was determined using the method reported by Ceiwyn (1988).

Mineral composition analysis

5g of each oven-dried powdered sample were weighed into dry crucibles in triplicates and ignited in a muffle furnace at 600℃ until greyish white ash was obtained. The ash was cooled in a desiccator and $5cm^3$ of 1 $moldm^{-3}$ HNO_3 was added and evaporated to dryness on a steam bath. The treated sample was heated in a muffle furnace until grayish ash was obtained. The sample was again removed, cooled in a desiccator, and retreated by the addition of 10 cm_3 of 1.0 $moldm_3$ HCl before filtering into 100 cm_3 volumetric flasks. Sodium and potassium ions were determined using the standard flame emission photometer while concentrations of the other minerals were determined using Atomic Absorption Spectrophotometer (AAS Model SP9) operating with standard air-acetylene flame as described by AOAC (2015). The concentration of phosphorus was determined using Jenway 6100 spectrophotometer at 470 nm (Ihekoronye *et al.,* 2015)

Vitamin content analysis

Determination of vitamins such as vitamin A, B_1, B_2, C, D, E, and K was carried out by the procedure and method of AOAC (2015).

Statistical analysis

Results were expressed as mean ± SD (standard deviation) of triplicate determinations. The software package used for the statistical analysis was version 20.0 of the SPSS. The data were evaluated for significance differences ($p< 0.05$) in their means using Analysis of Variance (ANOVA). Differences between means were separated using Duncan's

Multiple Range Test (DMRT). A p-value of < 0.05 was considered statistically significant.

Results And Discussion

Physicochemical properties

Table 1 shows the effect of the different processing methods on the physicochemical properties of oil extracted from *Mucuna flagellipes* seed.

The result showed that the percentage oil yield revealed that both the three processed samples were not oil seeds yielding with the values $5.13 \pm 0.42, 3.87 \pm 0.12,$ and 4.87 ± 0.31 for fried, boiled, and roasted *Mucuna flagellipes* seeds respectively. A significant difference ($p < 0.05$) was observed in peroxide value, Iodine value, and saponification value.

Parameters	Fried	Boiled	Roasted
% Oil Yield	5.13±0.42^a	3.87±0.12^a	4.87±0.31^a
Acid value (mgKOH/g)	1.22±0.02^a	1.21±0.01^a	1.22±0.01^a
Free Fatty Acid (%)	0.62±0.02^a	0.54±0.06^a	0.61±0.01^a
Iodine value (Wijis)	196.25±0.06^a	244.95±1.48^b	222.18±1.39^c
Peroxide value (meq/g)	0.00±0.00^a	129.11±0.53^b	124.35±0.12^b
Saponification value (mgKOH/g)	665.22±0.95^a	683.34±0.66^a	630.41±0.55^b

Table 1. *Physicochemical properties of Mucuna flagellipes Seed oil as affected by frying, boiling, and roasting*

* Values are Means ± standard deviations of triplicate determinations. Values in the same row having the same superscript letters are not significantly different ($p < 0.05$).

The iodine value of oil is a measure of its unsaturation and is a useful criterion for purity and identification which is the most important analytical characteristic of oil. The iodine values were 196.25±0.06, 224.95±0.53, and 222.18±1.39 Wij's for fried, boiled and roasted *Mucuna flagellipes* seed oil respectively, with the boiled processed sample having the highest value. Significant differences were observed. The iodine (Wij's) value of the processed samples was higher than the prescribed 75-94 Wijs for vegetable oils (Gordon *et al* 1993). The result of iodine value indicates that *Mucuna flagellipes* seed oil was composed primarily of saturated fatty acids and this can be deduced from the nature and consistency of the oil at room temperature. A decrease in this parameter is generally attributed to the destruction of the double bonds of polyunsaturated fatty acids by free radicals (Tynek *et al.*, 2001). The value for processed *Mucuna flagellipes seed oil* samples indicates that the oil was semi-drying with iodine numbers between 100 and 130 (Kochhar, 2015). Saponification values of *Mucuna flagellipes* seed oil of the different processed samples were all high ranging from 630.41±0.55 mg/g in roasted to 683.34±0.66 in boiled processed samples When compared to conventional oils such as palm oil (200.05mg/g) (Echendu., 2014) and groundnut oil (185-195mg/g) (Anderson-Foster *et al*., 2012). Significant differences (P< 0.05) were observed between the processed seed samples. The saponification value is an indication of the average molecular weight of fatty acids present in the oil. The high saponification value is an indication that the oil may be suitable for soap making, oil-based ice cream, and shampoos. It has been reported by Pearson (2014) that oils with high saponification values contain a high proportion of lower fatty acids. The acid value indicates the quality of fatty acids in the oil. From Table 1, the acid values range from $1.22 \pm 0.02, 1.21 \pm 0.01,$ and 1.22 ± 0.01 in fried, boiled and roasted *Mucuna flagellipes* seed oil respectively. The acid values of all the processed samples were generally low and no significant difference (P< 0.05) was observed. These values however accounted for the presence of free fatty acids in the oils as an indicator of the presence and extent of hydrolysis by lipolytic enzymes and oxidation (Igwenyi and Akubugwo, 2014). Therefore, the higher the free fatty acid content, the higher the acid value, the lower the free fatty acid content, the more appealing the oil is (Igwenyi *et al*, 2015). Low acid value in oil indicates that the oil will be stable over a long period of time and protect against rancidity and peroxidation. This could be attributed to the presence of natural antioxidants in the seeds such as vitamins C and A as well as other possible anti-nutrient like flavonoids. The acid value is used as an indicator for the edibility of an oil and suitability for use in the paint and soap industries (Akintayo *et al*., 2012). High acid value in *Mucuna flagellipes* oil showed that the oil may not be suitable for use in cooking (edibility), but be useful for the production of paints, liquid soap, and shampoos. Peroxide value is generally used to determine the degree of primary oxidation products (mainly peroxides) in oils (Shaide and Wanasundara, 2008). There was a significant difference (p<0.05) in the frying, boiling, and roasting of these seeds.

Proximate composition

The results of the proximate compositions of *Mucuna flagellipes seed flours* are shown in Table 2, the result of the proximate composition showed no significant difference (P <0.05) between the different processing methods expect moisture content.

Parameters	Fried	Boiled	Roasted
Moisture content	5.00±0.92[a]	14.53±0.42[b]	11.87±0.23[b]
Crude fat	5.13±0.42[a]	3.87±0.12[a]	4.87±0.31[a]
Crude fiber	8.67±0.31[a]	7.27±0.31[a]	8.67±0.12[a]
Ash	3.07±0.12[a]	2.87±0.12[a]	3.07±0.12[a]
Protein	2.48±0.93[a]	2.55±1.05[a]	2.49±0.72[a]
Carbohydrate	75.65±0.47[a]	68.91±1.76[a]	69.04±1.03[a]

Table 2: *Proximate analysis (%) of Mucuna flagellipes Seed flour as affected by frying, boiling, and roasting.*

*Values are Means ± standard deviations of triplicate determinations. Values in the same row having the same superscript letters are not significantly different ($p < 0.05$).

The percentage crude protein content of the processed samples were $2.48\pm0.93, 2.55 \pm 1.05,$ and 2.49 ± 0.72 for fried, boiled and roasted *Mucuna flagellipes* seed flour respectively. The crude protein content of the processed flour samples was low and showed no significant difference ($P < 0.05$). These values were observed to be lower than the report of Nwajagu *et al.*, (2021) on boiled, roasted, and autoclaved *Mucuna flagellipes* seeds but in line with the result of Ihekoronye and Ngoddy (2015) on Cooked *Mucuna flagellipes* who observed that excessive heat of processing causes severe protein damage which leads to the destruction of amino acids by complete decomposition or by racemization and the formation of cross-linkages forming poly-amino acids. The decrease could be a result of the processing method in the preparation of the seed samples and other environmental factors. It should be noted that proteins functionally promote growth, tissue repair, and maintenance (Igwenyi, 2015). The percentage compositions of lipids in the samples were low as revealed in Table 2 ranging from 3.87±0.12 in a boiled processed sample to 5.13±0.42 in a fried processed sample. No significant difference was observed. These values were lower than the result of Igwenyi and Azoro (2014) on cooked ukpo, Achi, Akparata, and ofo. This variation in the oil contents may be attributed to differences in climatic conditions, soil properties, and storage conditions/time of the seeds. The oil content was however lower than 59.46% as reported for *Cucumis melo* var. *agrees* scrab seeds in Nigeria (Adekunle and Olumo, 2014). The analysis of lipid contents however showed that the seed samples were not oil seeds or oil crops and cannot serve as commercial sources of vegetable oils. However, lipids are the principal form of stored energy (fat and oils) in most organisms and major constituents of cellular membranes (Nelson and Cox, 2015). The percentage crude fiber content of the processed *Mucuna flagellipes* seed flour samples were 5.13 ± 0.31, 7.27 ± 0.31, and 8.67 ± 0.12 for fried, boiled, and roasted respectively. No significant difference exists between the processed samples. These values are comparable to the values for *Detarium macrocarpum* (2.90%) and *Xylopia aethiopica* 8.66g/100g reported by Igwenyi and Azoro (2014) and Okaka *et al*., (2016) respectively. Crude fiber is the inorganic residue left after the defatted food materials have been treated with dilute hydrochloric acid, diluted sulphuric acid, and ether. Fiber supplements normal dietary agents by modulating the digestive and absorptive processes (Okaka *et al.*, 2016). The processing methods brought about a low value in crude fiber as reported by Adebayo *et al*., (2013) who also observed a decrease in crude fiber during his work on the upgrading of local technology of ogiri production. The ash contents revealed that the values were low with 3.07 ± 0.12, 2.87 ± 0.12, and 3.07 ± 0.12 for fried, boiled, and roasted *Mucuna flagellipes* respectively. No significant differences were observed. The ash contents were also comparable to values reported by Barminas *et al*., (2013) for *Xylopia aethiopica* also used as a thickener. The measure of ash content could be a measure of the food quality. The moisture contents were low ranging from 5.00±0.92, 14.53±0.42, and 11.87±0.83 for fried, boiled, and roasted *Mucuna flagellipes* respectively and a Significance difference was observed between the processed *Mucuna flagellipes* seed flour. These values were low and will discourage deterioration due to microbial attack (Okechukwu *et al.* 2021). This was also expected given the hard and dry nature of the seeds and seed coats. Although the water content of a food is expressed as a percentage. The results were generally comparable to values obtained by Igwenyi and Azoro (2014). The percentage carbohydrate content of the samples, fried, boiled and roasted *Mucuna flagellipes* were $75.65\pm0.,47$, 68.91 ± 1.76 and 69.04 ± 1.03 respectively. No significant difference ($P < 0.05$) was observed in the carbohydrate contents of the samples. The carbohydrate contents were comparable to 57 – 59% reported for *Brachystegia eurycoma* and *Detarium microcarpum* (Uhegbu *et al.*, 2011) and 50-60% reported for *Afezlia africana* (Omokpariola *et. al.* 2021a) all used as soup thickeners. Dietary carbohydrate is a primary source of energy to the body; it spares fats and proteins in the body (Omokpariola *et. al.*2021a, b).

Vitamin Contents

Table 3 shows the effect of the different processing methods on the Vitamin composition of *Mucuna flagellipes* seed flour. The results obtained showed a significant difference ($p < 0.05$) in vitamin D and vitamin B_2 in the processing methods on the Vitamin composition of *Mucuna flagellipes* seed flour.

Parameters	Fried	Boiled	Roasted
Vitamin A. mg/100ml	1.92±0.33[a]	0.83±0.20[a]	2.71±0.63[a]
Vitamin B1. mg/100ml	0.77±0.15[a]	2.14±1.51[a]	1.00±0.91[a]
Vitamin B2. mg/100ml	401.62±15.95[a]	345.41±19.78[b]	350.81±22.99[b]
Vitamin C. mg/100ml	38.76±3.37[a]	48.20±2.50[a]	42.23±9.94[a]
Vitamin D. mg/100ml	6.48±7.48[a]	36.83±31.98[b]	8.81±8.75[a]
Vitamin E. ug/g	0.21±0.33[a]	0.21.±0.19[a]	0.58±0.51[a]
Vitamin K. ug/g	5.73±4.97[a]	5.43±4.75[a]	3.09±3.33[a]

Table 3. *Vitamin contents of Mucuna flagellipes Seed flour as affected by frying, boiling, and roasting.*

* Values are Means ± standard deviations of triplicate determinations. Values in the same row having the same superscript letters are not significantly different ($p < 0.05$).

Vitamin C content of the processed *Mucuna flagellipes* seed samples were 38.76, 48.20, and 42.23 for fried, boiled, and roasted respectively. No significant difference ($P < 0.05$) was observed. This agrees with Vasudevan and Sreekumari (2013) who reported that vitamin C is generally poor in seeds but rich in citrus, guava, and leafy vegetables. The poor level of vitamin C in diets causes scurvy in animals. Vitamin A is the precursor of rhodopsin, promotes growth and repair of body tissues; reduces susceptibility to infections (immune function); regulates gene expression (Adebayo,2013). The riboflavin and thiamine contents of the processed seed samples were low compared to 4.24 and 2.75 mg/100 g of *Amaranthus hybridus* (Akubugwo *et al.,* 2012). This is in line with literature that reports that grains are poor sources of these vitamins but green leafy vegetables, yeast, and milk are rich sources of vitamins (Mc Donald *et al.,* 2014).

Vitamin E content of the processed seed samples were 0.21±0.33, 0.21 ± 0.19, and 0.58±0.51 for fried, boiled, and roasted *Mucuna flagellipes* respectively. No significant difference ($P < 0.05$) was observed. Vitamin E protects the body tissue from damage caused by a substance called free radicals, which can harm cells, tissues, and organs (Etong *et al*,2013). It serves mainly as a fat-soluble anti-oxidant.

Mineral Composition

Table 4 shows the effects of different processing methods on the mineral composition of *Mucuna flagellipes* seed flour. The results obtained showed no significant difference ($p < 0.05$) between the processing methods on the mineral composition except the Iron content which significantly differed ($p < 0.05$).

Parameters	**Fried**	**Boiled**	**Roasted**
Calcium mg/100ml	5.79±5.03[a]	8.08±2.52[a]	6.86±2.18[a]
Iron mg/100ml	4.75±1.44[b]	8.42±4.89[a]	9.61±3.33[a]
Phosphorus ug/g	3.06±0.15[a]	2.69±0.08[a]	2.88±0.06[a]
Potassium mg/100ml	0.30±0.14[a]	0.37±0.03[a]	0.30±0.13[a]
Sodium ug/g	119.48±10.45[a]	108.93±7.58[a]	102.20±13.38[a]
Magnesium ug/g	8.53±0.13[a]	7.12±0.58[a]	7.03±6.18[a]

Table 4. *Mineral contents of Mucuna flagellipes Seeds as affected by frying, boiling, and roasting.*

* Values are Means ± standard deviations of triplicate determinations. Values in the same row having the same superscript letters are not significantly different ($p < 0.05$).

The Calcium content of the processed seed samples as shown in Table 3 were 5.79±5.03, 8.08±2.52, and 6.86±2.18 for fried, boiled and roasted *Mucuna flagellipes* respectively, no significant difference were observed. The values were low compared to the values of (Obiakor *et al* 2014) for cooked and raw *Mucuna soneli*, Calcium accounts for about 75% of the weight of the mineral elements present in the body (Ogungbenle *et al* 2015). Calcium is the principal contributor to bone formation. When there is a lack of calcium in the body, it results in osteoporosis (bone thinning). Iron is nutritionally important. It is highly required for blood formation. The value of iron was 4.75±1.44 mg/100ml, 8.42±4.89 mg/100ml, and 9.61±3.33 Mg/100ml for fried, boiled, and roasted *Mucuna flagellipes* respectively. Fried *Mucuna flagellipes* differed significantly (P <0.05) from boiled and roasted *Mucuna flagellipes*. This value of iron in the sample was lower than those of spannish green olives (14.8 mg/kg) (Ogungbenle and Omaejalile 2015). Iron also facilitates the oxidation of carbohydrates, protein, and fats. The Sodium content of the processed seed samples was 119.48±10.45, 108.93±7.58, and 102.20±13.38 for fried boiled and roasted *Mucuna flagellipes*. No significant difference was observed. Feeding livestock feed that is rich in processed *Mucuna flagellipes* has the potential to maintain body fluid pH, support nerve transmission, and muscular contraction in livestock (McDonald *et al.*, 2014). Magnesium has the following values 8.53±0.13, 7.12±0.58, and 7.03±6.18 for fried, boiled, and roasted Mucuna *flagellipes*. No significant difference was observed. The Magnesium content was low compared 128-145, 92.3, 183, and 55.6 mg/100 g reported for Nigerian cowpea, M. obanensis, and mung beans respectively (Mubarak, 2015). Thus, from Table 4, it could be said that the amount of these mineral elements consumed on daily basis falls within the required daily intake, as a little quantity of the plant sample is used on daily basis either as food or drug.

Anti-Nutritional Components

Table 5 shows the effects of different processing methods on the anti-nutritional composition of *Mucuna flagellipes*. The results showed that Flavonoid, Alkaloid, and Cyanide showed a significant difference ($p < 0.05$) in the antinutritional content of the processed samples.

Parameters	Fried	Boiled	Roasted
Tannin µg/100g	9.55±0.62^a	7.25±6.19^a	6.11±6.42^a
Alkaloid µg/100g	311.67±44.09^a	348.33±31.14^b	417.78±39.52^c
Cyanide µg/100g	65.73±1.92^a	58.54±3.57^a	58.82±3.30^a
Saponin µg/100g	1.32±0.06^a	1.26±0.03^a	1.38±0.02^a
Flavonoid µg/100g	74.48±41.32^a	85.18±64.44^a	149.80±5.70^b
Terpenoid µg/100g	214.40±42.41^a	179.22±3.03^a	190.91±6.57^a
Phytate µg/100g	3.06±0.15^a	2.69±0.08^a	2.88±0.06^a
Oxalate µg/100g	0.02±0.01^a	0.01±0.00^a	0.01±0.00^a

Table 5. *Antinutritional contents of Mucuna flagellipes Seeds Produced by Processing Methods*

* Values are Means ± standard deviations of triplicate determinations. Values in the same row having the same superscript letters are not significantly different ($p < 0.05$).

Phytochemical is the term is used to describe the large number of secondary metabolic compounds from plants (Adodo, 2012). Anti-nutrients are known to protect against insect attacks and plant diseases. The concentration of alkaloids in Table 5 was 311.67±44.09ug/100g, 348.33±31.14ug/100g, and 417.78 ug/100g for fried, boiled and roasted *Mucuna flagellipes* seed flour. A significant difference ($p<0.05$) was observed between the processed samples. These values were higher than 1.28-1.64mg/100g reported in the phytochemical composition and nutritional quality of *Glycine max* and *Vigna unguiculata* (L) Walp (Okwu and Orji, 2007. Alkaloids are famous analgesics and have been utilized in a variety of ways in the treatment of diseases and during surgery due to their medicinal and pharmacological efficacy. The level of cyanide was high in both processed samples. The concentrations of cyanide were 55.50, 58.54, and 58.82 µg/100g in fried, boiled and roasted *Mucuna flagellipes* seed flour respectively which show no significant difference ($P<0.05$). These were higher than the values obtained from the same seed 10.50 mg/100g and 25.32mg/100g respectively by (Okaka *et al*, 2016), which is considered unsafe and poisonous in extreme concentrations. The concentrations of tannins were 9.55µg/100g, 7.25 µg/100g, and 6.11µg/100g for fried, boiled and roasted *Mucuna flagellipes* seed flour respectively. The values of the tannin contents were higher than 57.10% in the ethnomedicinal and phytochemical profiles of some savannah plant species in Nigeria (Bako *et al*., 2005). Tannins are astringent, bitter plant polyphenols that either bind and precipitate or shrink proteins. The astringency from the tannins is what causes the dry and puckery feeling in the mouth following the consumption of red wine or an unripened fruit (Schiavone *et al*., 2014). Oxalate in large amounts binds with calcium to form calcium oxalate, which is insoluble and not absorbed by the body. They are therefore considered poisonous but harmless when present in small amounts as shown in Table 5. The amount

of oxalate in the processed samples of *Mucuna flagellipes* seed is therefore not harmful, more so, when cooking has been reported to effect a significant reduction in total oxalate contents of seeds (Eka, 2014). Like oxalates, phytates chelates di- and trivalent metal ions like zinc, iron, magnesium, and calcium to form complex compounds that are not readily absorbed by the intestine, thereby making them unavailable for metabolism (Thompson, 2016). They are easily removed by cooking, frying, roasting, fermentation, and soaking (Igwenyi *et al* 2015). The level of phytates in the processed seed samples was 3.83 ± 0.73 µg/100g, 2.12 ± 0.10 µg/100g and 2.69 ± 0.05 µg/100g for fried boiled and roasted *Mucuna flagellipes* seed flour respectively. It is lower than 5.44 obtained by Nwaogu et al. (2015) for tropical almonds. The concentration of flavonoids in fried and boiled *Mucuna flagellipes* seed flour in Table 5 was significantly lower ($p<0.05$) than roasted *Mucuna flagellipes* seed flour. Flavonoids have been referred to as "nature's biological response modifiers" because of strong experimental evidence of their inherent ability to modify the body's reaction to allergens, viruses, and carcinogens. They show anti-allergic, anti-inflammatory, anti-microbial, and anti-cancer activity (Igwenyi and Azoro, 2014). Finally, the observed anti-nutritional factors in the seeds of the studied plant, symbolize that they are judiciously rich in anti-nutrients.

Conclusion

There is a need for readily available, high-quality, alternative vegetable protein, and energy sources that are inexpensive and capable of reducing production costs of meat and other animal products. The present study showed that some under-utilized tropical legumes, such as *Mucuna flagellipes* (Ukpo), possessed a high quantity of nutritive and antinutritive content. The low acid and saponification, as well as the moderately high iodine values of the oil samples extracted from the seed, suggest that it could be used in the manufacture of soaps and easily digestible margarine, creams, and salad oils. The oil is semi-drying due to its moderately high iodine value and thus can be used in the manufacture of surface coating agents. The low level of anti-nutrients makes the seed flour of *Mucuna flagellipes* nutritionally valuable. The results show that *Mucuna flagellipes* is a good source of protein, essential minerals, vitamins and contain little quality and quantity of oil for domestic and industrial uses. With a few exceptions, the results of the experiments presented here show that the subjection of *Mucuna flagellipes* seeds before oil extraction to different processing methods (frying, boiling, and roasting) caused no significant loss or change in the content of proximate, mineral, vitamin, anti-nutrients, and physicochemical properties.

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Conflict Of Interest

The authors declare that there is no conflict of interest whatsoever regarding this manuscript.

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