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Proximate, Minerals and Functional Properties of *Bombax buonopozense* Cclyx

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***Abstract**: The nutritional constituents of Bombax buonopozense calyx were determined using standard methods. Results obtained from proximate analysis indicated the presence of moisture (4.70±0.51 %), ash (5.50±0.47 %), crude protein (7.20±0.29 %), crude lipid (3.10±0.14 %), crude fibre (18.00±0.18 %), carbohydrate (66.20±0.27 %) and caloric value (279.85±0.31 kcal/100g). Mean concentrations of sodium, potassium, magnesium, calcium and phosphorus were 25.00±0.09, 160.00±0.13, 48.10±0.47, 28.13±0.33 and 163.00±0.21 mg/100g respectively while measured values for functional properties were bulk density (0.52±0.01 g/cm^3), water absorption capacity (2.35±0.35 %), oil absorption capacity (2.20±0.19 %), foaming capacity (13.72±0.27 %) and foaming stability (5.88±0.41 %). The results obtained compared favourable with most food materials and indicated that Bombax buonopozense calyx may be a good source of nutrients.*

Key Words: *Bombax buonopozense calyx, nutritional value, proximate, mineral and functional properties*

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1.0 Introduction

Food is one of the most basic needs and the major source of nutrient to human body; and limited access to good food can severely affects health (Havas and Salman, 2011).It is estimated that one billion people in the world lack sufficient food to meet their nutritional needs (Barrett, 2010). Competition between man and his animals for the scarce food resources further complicated by communal conflicts and insecurity has further heightened the need for already scarce food. In Nigeria and most African countries, food security is receiving serious concern because of the increasing scarcity of food due to insecurity, unfavourable climatic changes and other factors. Also diet contribution data are scarce and most home do not have diet plan and are therefore restrained to tradition choices, which may not provide balance diet (Akueshi *et al.,* 2005*)*.

Food value can be assessed through their proximate, mineral and other functional composition/properties (Eddy and Udoh, 2005). This implies that the nutritional value of less known plants materials such as calyx of *Bombax buonopozense* can be evaluated through this information.

Bombax buonopozense, is a wild plant commonly known as Gold coast Bombax tree from the family of *Bombacaceae*. Most of its parts are known to serve medicinal purposes. The edible sepals are dried and used as ingredient and vegetables for preparing soup in some parts of North Central region of Nigeria (Mann *et al.*, 2011; Mann *et al., 2003*). *B. buonopozense* is widely distributed in West African countries such as Ghana, Gambia, Côte d'Ivoire, Nigeria and others (Addo-Fordjour *et al.,* 2009; Gyasi, *et al.,*1995; Kamanzi, *et al.,* 2004; Mann *et al., 2003*)

Several researches have reported the presence of phytochemicals such as alkaloids, flavonoids, tannins, saponins, phenols and steroids, oxalates, phytates and cyanides (in small amounts) in *Bombax buonopozense* (Iroka *et al.,* 2014; Mann *et al*., 2011), which are the useful bioactive constituents for its medicinal purposes. However, little is known about the nutritional constituents of the calyx of *Bombax buonopozense*. This work seeks to determine the nutritional contents of *Bombax buonopozense* calyx.through their proximate, mineral and functional properties.

2.0 Materials and Methods

2.1 Sample Collection

B. buonopozense calyx was obtained from Ariko in Kaduna State, Nigeria. The calyx was separated from the petal, washed with plenty of distilled water to remove dirt and allowed to constant weight before grinding to powdered form.

2.2 Proximate analysis

Moisture content was determined using oven drying method (AOAC, 2006) and the percentage moisture was calculated using equation 1:

$$\text{Moisture (\%)} = \frac{W2-W3}{W2-W1} x100 \quad (1)$$

where: w_1 is the weight of empty crucible, w_2 is the weight of the crucible and the sample while w_3 is the weight of the sample after drying in a furnace to constant weight.

The ash content was determined destroying the organic content in a furnace maintained at 600 °C, after which the sample in the crucible was cooled and reweight to obtained percentage ash according to equation 2 (Ceirwyn, 1998).

$$\text{Ash(\%)} = \frac{W3-W1}{W2-W1} x100 \quad (2)$$

where w_3 is the weight of the crucible and the ash

Crude protein content of the samples was determined using the method described by Jacob *et al.* (2016). 1.0 g of the sample was transferred into a digestion flask which contained 2 tablets of selenium (catalyst) followed by addition of 12 cm^3 of sulphuric acid before heating to obtain a clear solution. The solution was transferred into 50 cm^3 volumetric flask and then made up to the mark. 10 cm^3 of the digest and 10 cm^3 of 40 % NaOH solution were pipetted into the conical flask of the Kjeldahl distiller, which contained 5 cm^3 of 2 % boric acid. 3 drops of mixed indicator (100 cm^3 0.1 % methyl red + 200 cm^3 of 0.2 % bromocresol) were placed under the condenser outlet. The gas produced was delivered to a conical flask that was filled with solutions of boric acid and the mixed indicator. The nitrogen in the distillate was determined by titrating with 0.01 M of HCl to the end point. The percentage protein was obtained by multiplying the % nitrogen (equation 3) by a conversion factor.

$$\% \text{ N} = \frac{(S-B)xNx0.014xDx100}{WxV} \quad (3)$$

where: S is the sample titration reading, B is the titration reading for the blank, N is th normality of HCl, F is the dilution factor and V is the volume taken for distillation while the constant, 0.014 represent milliequivalent weight of nitrogen.

Crude fat was determined according AOAC (2006) and the percentage crude fat was estimated using equation 4:

Crude fat (%) = $\frac{W1-W2}{W1}x100$ (4)

where w_1 is the weight of sample before extraction and w_2 is the weight of the sample after extraction.

Crude fibre content was determined using the method described by Jacob *et al*. (2016): 2 g of defatted sample was weighed into a 250 cm^3 conical flask and 200 cm^3 of 1.25 % sulphuric acid solution was added. The sample was heated for 30 minutes and filtered using poplin cloth in a Buchner funnel followed by washing with distilled water. The resultant residue was treated with 200 cm^3 of 1.25 % NaOH solution and re-heated after which the entire content was transferred into a crucible and weighed after cooling in a dessicator. The weighed sample was transferred to a furnace that was maintained at 550^o C for 12 hours. The difference in weight ($w_3 - w_2$) was recorded and the percentage fibre was calculated by difference using the formula:

Crude fibre (%) = $\frac{W3-W2}{W1}x100$ (5)

Carbohydrate content was determined by method of difference and calculated using equation 6 (AOAC, 2006):

$$Carbohydrate\ (\%) = 100 - (\%\, ash + \%\, protein\ + \%\, lipid + \%\, fibre) \quad (6)$$

The caloric value of the food was calculated using equation 7 (Asibey-Berko and Taiye, 1999):

$$Energy\ (kcal/100g) = A + B + C \quad (7)$$

A = $g\ crude\ protein\ x\ 2.44$

$B = g\ crude\ lipid\ x\ 8.37$

$C = \ g\ available\ \ carbohydrate\ x\ 3.57$

2.3 Mineral quantification

6 g of oven dried powdered sample was weighed into dry crucibles in triplicates and ignited in a muffle furnace at 600 ^{o}C until greyish white ash was obtained. The sample was removed and cooled in a desiccator. 5 cm^3 of 1.0 $moldm^{-3}$ HNO_3 was added and the sample was evaporated to dryness on a steam bath and then re-heated in a muffle furnace until the formation of greyish white ash was observed. The samples were removed, cooled in a desiccator and 10 cm^3 of 1.0 $moldm^3$ HCl was added to each ash and filtered into a 100 cm^3 volumetric flasks. Concentrations of Cu, Fe, Mn, and Ca ions were determined using Atomic Absorption Spectrophotometer (AAS Model SP9) while those of Na and K ions were evaluated using flame photometer. The concentration of phosphorus was determined using Jenway 6100 spectrophotometer at 420 nm (Ceirwyn, 1998).

The contribution of *Bombax buonopozense* Calyx to dietary intake of essential elements was evaluated through the application of equation 8 (Hassan *et al*., 2005):

$$Contribution\ to\ RDA\ (\%) = \frac{C\ (mg/100g)}{RDA} \times \frac{100}{1} \quad (8)$$

where C is the concentration and RDA is the recommended dietary allowance.

2.4 Functional properties

2.4.1 Bulk density

Bulk density was determined according to the method described by Niangoran *et al*. (2015). In this method, 10.0 cm^3 graduated measuring cylinder was gently filled with the sample and its bottom was tapped until the volume of the sample stopped decreasing.

2.4.2 Water absorption capacity (WAC)

In order to determine the water absorption capacity of the plant materials, 2.0 g of the sample was mixed with 20 cm^3 of distilled water and allowed to stand at ambient temperature for 30 minutes before applying centrifugal rate of 2000 rpm for another 30 minutes. Percent water absorption capacity (WAC) was calculated using equation (9) (Sosulski *et al*., 2002; Njintang *et al*., 2001).

WAC (%) = $\frac{V1}{V2}x100$ (9)

where, V_1 is the volume of water absorbed and V_2 is the volume of water used, both in cm^3 unit.

2.4.3 Oil absorption capacity (OAC)

OAC was analysed by mixing 2 g of the sample with 20 cm^3 of refined soybean oil of known specific gravity. It was allowed to stand at ambient temperature for 30 minutes and then centrifuged for 30 minutes at 2000 rpm. Oil absorption capacity (OAC) was expressed as percentage oil absorbed per gram sample (Sosulski *et al*., 2002; Onimawo*et al.*, 2003).

OAC (%) = $\frac{V1}{V2}x100$ (10)

where V_1 is the volume of oil absorbed and V_2 is the volume of oil used,

2.4.4 Foaming capacity (FC) and foaming Stability (FS)

The method described by Niangora *et al.* (2015); Ojo and Ade-Omowaye (2015) was used to determine FC and FS. In this method, 2.0 g of powdered *Bombax buonopozense* calyx was added to 50 cm^3 distilled water in a 100 cm^3 graduated cylinder. The suspension was then mixed and shaken for 5 min to foam. The volume of foam at 30 s after whipping was expressed as foaming capacity (FC) using equation (11):

FC (%) = $\frac{V2-V1}{V1}x100$ (11)

where V_1 is the volume of foam before whipping and V_2 is the volume of foam after whipping.

The volume of foam was recorded one hour after whipping to determine foaming stability (FS) as a percentage of the initial foam volume, Therefore,

$$S\ (\%) = \frac{V_{F,t}}{V_{i,0}} \times \frac{100}{1} \quad (12)$$

where $V_{F,t}$ is the formed volume after time and $V_{i,0}$ is the initial volume.

3.0 Results and Discussion

3.1 Proximate composition

Table 1 presents the proximate composition of *Bombax buonopozense* calyx. Mean moisture content was 4.70±0.51 %. This value is lower than the 5.00±0.02, 10.23±0.06 and 10.71 % reported for *Caesalpinia pulcherrina, Corchorus olitorus and Melochia corchorifolia* respectively (Musah *et al*. 2014; Ndamitso *et al*., 2016). Low moisture content can increase the shelf life the food materials Eddy and Ekop, 2006). Mean percentage ash was 5.50±0.47 %, which is slightly higher than 5.11 and 3.30 % obtained for *Vigna unguiculata sub spp sesquipedalis* seed and *Afzelia Africana* respectively (Musah *et al*., 2020; Nzekwe *et al*., 2016) but lower than 15.20±0.04 % reported for *Vernonia amygdalina* (Idris and Yisa, 2009). Ash content of a sample is an important factor in determining the amount of inorganic content in a food. Therefore, the studied food materials is likely richer in mineral content than some common seeds.

Table 1: Proximate composition of *Bombax buonopozense* calyx

Factor	Composition (% dry weight)
Moisture	4.70 ± 0.51
Ash	5.50 ± 0.47
Crude protein	7.20 ± 0.29
Crude lipid	3.10 ± 0.14
Crude fibre	18.00 ± 0.58
Carbohydrate	66.20 ± 0.27
Calorific value (kcal/100g)	279.85 ± 0.31

Results are recorded as mean of values obtained from triplicate analysis values ± SD

Mean crude protein content was 7.20±0.29 %, which lower than 13.25±0.13 and 14.47±0.10 % reported for *Amaranthus hybridus* and *Hibiscus sabdariffa* respectively (Oulai *et al*., 2014) but higher than the value (4.65±0.02 %) reported for *Xanthosoma sagittifolia* (Kwenin *et al*., 2011).

Crude lipid content has a mean percentage of 3.10±0.14 %. This value was slightly higher than 1.50±0.05 and 1.33±0.04 % reported for *Talinum triangulare and Moringa oleifera* respectively (Kwenin *et al.*, 2011) but lower than 13.70 % reported for *A. povoninia* (Ogbuagu *et al*., 2011). The low lipid content of *B.buonopozense* calyx can present it as a good diet for obesity patients. The value obtained for crude fibre content was 18.00±0.18 %. Fibre functions by providing roughages that can aid digestion and absorption of nutrient (Nwekwe *et al*., 2016). The crude fibre content of *B. buonopozense* calyx is higher than 10.40±0.3 % and 8.00±0.02 % reported by Kwenin *et al*. (2011) for *Amaranth cruentus* and *Talinum triangulare* respectively but lower than 31.50±1.50 % in *Ceiba petendra* (Oulai *et al*., 2014).

Carbohydrate content was 66.20±0.27 % and was higher than 39.05 % for *Momordica balsamina* leaves (Hassan and Umar, 2006). However, this means value is however lower than the 75.00 % obataind for *Corchorus tridens* (Asibey-Berko and Tayie, 1999). Carbohydrate, fat, and protein are the proximate variables that determine the energy value of any food consequently, the estimated calorific value was 279.85±0.31 kcal/100g, which is within the range of values (248.80 – 307.10 kcal/100g) reported for selected sweet potato leave in Nigeria (Antia *etal.*, 2006).

3.2 Mineral content

The mineral composition of *Bombax buonopozense* calyx is presented in Table 2. Sodium and potassium content were 25.00±0.09 mg/100g and 160.00±0.13 mg/100g respectively. These values are lower than the 195.00 mg/100g (sodium) in *Habiscus sabdariffa* (Ladan *et al.*, 1996) and 200.00 mg/100g obtained for *Tribulus terrestris* (Hassan *et al.*, 2005). Sodium and potassium are important for the regulation of plasma volume, acid-base balance, nerve and muscle contraction in the human system (Akpanyung, 2005). Mean concentration of magnesium was 48.00±0.49 mg/100g while those of calcium and phosphorus were 28.13±0.33 and 163.00±0.49 mg/100g respectively. Magnesium ions prevent muscle degeneration, growth retardation, immunologic dysfunction, congenital malfunction and bleeding disorder (Oulai *et al*., 2014; Chaturvedi *et al*., 2004). The measured mean concentration of calcium in this sample is higher than 6.33±0.01 mg/100g reported for *Vernonia amagdalina* (Idris and Yisa, 2009).

Table 2: Mineral composition of *Bombax buonopozense* calyx

Element	Concentration (mg/100g)
Sodium	2.50 ± 0.09
Potassium	160.00 ± 0.13
Magnesium	48.10 ± 0.47
Calcium	28.13 ± 0.33
Phosphorus	163.00 ± 0.21

Results are presented as mean of values obtained from triplicate analysis ± SD

The contribution of *Bombax buonopozense* calyx to the recommended dietary allowance (RDA) of the minerals studied is presented in Table 3.

Table 3: Contribution to the dietary intake of mineral elements

Element	RDA (mg)	Contribution to RDA (%)
Sodium	500	5.00
Potassium	2000	8.00
Magnesium	350	13.74
Calcium	1200	2.30
Phosphorus	1200	13.58

The results reveal that the contributions of sodium (5.00 %), potassium (8.00 %), magnesium (13.74) and calcium (2.34 %) were lower than 9.00 % (sodium), 21.00 % (magnesium) and 4.00 % (calcium) while the RDA value for phosphorus was higher than the 1.00 % reported for *Verona amagdalina* (Idris and Yisa, 2009).

3.3 Functiona1 properties

The functional properties of *Bombax buonopozense* calyx are presented in Table 4. Bulk density (BD) was 0.52±0.71 g/cm^3. This value is higher than the value of 0.24±0.04 g/cm^3 reported for *Parkia biglobosa* seed flour (Ndamitso *et al*., 2020) but lower than 0.63 g/cm^3 for *Cyperus esculentus* (Oladele and Aina, 2007). BD is a measure of heaviness of a flour sample and is significant in the food industry for the analysis of material handling and application (Adejuyitan *et al*., 2009; Shittu *et al*., 2007).

Table 4: Functiona1 properties of *Bombax buonopozense* calyx

Parameter	Values
Bulk Density (g/cm³)	0.52±0.11
Water Absorption Capacity (%)	2.35±0.35
Oil Absorption Capacity (%)	2.20±0.19
Foaming Capacity (%)	13.72±0.27
Foaming Stability (%)	5.88±0.41

The water absorption capacity (WAC) of the sample is 2.35±0.35 %, which is slightly lower than 3.17±0.92 % obtained for *Vigna unguiculata sub spp. Sesquipedalis* seed (Musah *et al*., 2020) but higher than 2.04±0.05 % reported for *Melochia corchorifolia* (Ndamitso *et al*., 2016). The OAC value obtained (2.20±0.19 %) for *B. buonopozense* calyx was lower than 2.43±1.52 % reported for *Boerhavia elegans* choisy seed flour (Al-Farga *et al*., 2016). Oil absorption stability (OAC) is attributed to the entrapment of oil to retain favour and improve the soft texture of food (Ojo and Ade-Omowaye, 2015; Niangoran *et al*., 2015).

Foaming capacity (FC) refers to increase in volume of a given food upon the introduction of gas into its slurry while foaming stability (FS) is the ability of foam formed to retain its maximum volume over a period (Ojo and Ade-Omowaye, 2015). The values of FC and FS were 13.72±0.27 % and 5.88±0.41 % respectively. The FC value obtained was higher than 3.96±0.03 – 5.77±0.29 % reported for cultivars seed flour from *Citrullus lanatus* (Niangoran *et al*., 2015).

4.0 Conclusion

The study provides an overview of the nutrient composition of *B. buonopozense* calyx. Results reveal it is a good source of carbohydrate, potassium and phosphorus. The nutritional qualities of *B. buonopozense* calyx can be explored if their antinutritional and other factors are found to be within the permissible limits. It has the potential to be a good source of mineral nutrition especially in complementing phosphorus nutrition.

5.0 References

Addo-Fordjour, P., Obeng, S., Addo, M. G. & ~~and~~ Akyeampong, S. (2009). Effects of human disturbances and plant invasion on Liana community structure and relationship with trees in the Tinte Bepo Forest Reserve, Ghana. *Forest Ecology and Management* 258(5), pp. 728-734.

Adejuyintan, D. B., Otunola, E.T., Akande, E.A., Bolarinwa, I.F. & Oladokun, F.M. (2009). Some physicochemical properties of flour obtained from fermentation of tiger nut (*Cyperus esculentus*) sourced from a market in Ogbomoso, Nigeria. *African Journal of Food Science*, 3, pp. 51-55.

Akueshi, E.U., Sabo, A.E. & Ogugbuaja, V.O. (2005). Macronutrients and Trace Elements of Calyx and Bud of *Bombax buonopobense* (P. Beav). *Journal of Bio-research*, 3(2), pp. 63-65.

Al-Farga, A., Zhang, H., Siddeeg, A., Shamoon, M.,Chamba, M. V. M. & Al-Hajj, N. (2016). Proximate composition, functional properties, amino acid, mineral and vitamin contents of a novel food: Alhydwan (*Boerhavia elegana* choisy) seed flour. *Food Chemistry*, 211, p. 268-273.

Akpanyung, E.O. (2005). Proximate and mineral composition of bouillon cubes produced in Nigeria. *Pakistan Journal of Nutrition*, 4, pp. 327-329.

Antia, B. S.,Akpan, E. J., Okon, P. A. & Umoren, I. U. (2006). Nutritive and antinutritive evaluation of sweet potatoes (*Ipomoea batatas*) leaves. *Pakistan Journal of Nutrition*, 5, pp. 166-168.

AOAC (2006). *Official methods of association of official analytical chemist, association of official analytical chemists* inc. Alington, Washington DC., USA.

Asibey-Berko, E. & Tayie, F.A.K. (1999). Proximate analysis of some underutilized Ghanian vegetables. *Ghana Journal of Science*, 39, pp.91-92.

Barrett, C.B. (2010). Measuring food insecurity. *Perspective*, 327,825-828.

Chaturvedi, V. C., Shrivastava, R. & Upreti, R. K. (2004). Viral infections and trace elements: A complex trace element. *Current Science*, 87, pp. 1536-1554.

Ceirwyn, S. J. (1998). *Analytical Chemistry of food*. Chapman and Hall publisher, London, pp. 75-77.

Eddy, N. O. & Ekop, A. S. (2006). Comparative studies of the lipid characteristics and industrial potential of *Coulaedulis* (African walnut and *Terminalia catappa (*indian almond) seeds. *Global Journal of Pure and Applied Sciences* 12(1), pp. 65-67.

Eddy, N. O. & Udoh, C. L. (2005). Proximate evaluation of the nutritional value of some soup thickeners. *CHEMCLASS Journal* 2, pp. 12-14.

Gyasi, E., Agyepong, G., Ardayfio-Schandorf, E., Enu-Kwesi, L. & Nabila, J. (1995) Production pressure and environmental change in the forestsavanna zone of Southern Ghana. *Global Journal of Environmental Change*, 5, pp.355-366.

Hassan, L. G. & Umar, K.J. (2006). Nutritional value of Balsam apple (*Momordica balsamina* L.) leaves. *Pakistan Journal of Nutrition*, 5,522-529.

Hassan, L. G., Umar, K J. & Usman, A. (2005). Nutrient content of leaves of *Tribulus terrestris* (Tsaida). *Journal of Tropical Bioscience*, 5(2), pp. 83-87.

Havas, K. A. & Salman, M. D. (2011). Food security: its components and challenges. *International Journal of Food Safety Nutrition and Public Health*, 4(1), pp.4-11.

Idris, S. & Yisa, J. (2009). Nutritional composition of leaves of *Vernonia amagdalina. Science Focus*, 14(3), pp. 286-292.

Iroka, F. C., Okereke C. N. & Okeke C. U. (2014) Comparative phytochemical and proximate analyses on Ceiba pentandra (L) Gaertn. and Bombax buonopozense (P) Beauv. *International Journal of Herbal Medicine*; 2(2), pp. 162-167.

Jacob, J. O., Mann, A., Adesina, O. I. & Ndamitso, M. M. (2016). Nutritional composition of selected wild fruits from Minna area of Niger State, Nigeria. *International Journal of Nutrition and Food Engineering*, 10(1), pp. 37-42

Kamanzi, A. K, Schmid C, Brun R, Koné M.W,et al. (2004) Antitrypanosomal and antiplasmodial activity of medicinal plants from Côte d'ivoire. J Ethnopharmacol 90: 221-227.

Kwenin, W. K. J., Wolli, M. & Dzomeku, B.M. (2011). Assessing the nutritional value of some African indigenous leafy vegetables in Ghana. *Journal of Animal & plant Science*, 10(2), pp. 1300-1205.

Ladan, M. J., Bilbis, L. S. & Ladan, M. (1996). Nutrient composition of some greenleafy vegetables consumed in Sokoto, Nigeria. *Journal of Basic and Applied Science*, 5, pp. 39-44.

Mann, A., Salawu, F. B. & Abdulrauf, I. (2011). Antimicrobial Activity of *Bombax Buonopozense P. Beauv*. Edible Floral Extracts. *European Journal of Scientific Research*, 48(4), pp. 627-630.

Mann A, Gbate M, Nda-Umar A (2003) *Medicinal and Economic plants of Nupe land*. Jube-Evans Books and publications, Bida Nigeria, p.3536.

Musah, M., Ndamitso, M.M., Yerima, H., Mathew, J.T. and Iwachukwu, G.O. (2020). Nutritional assessment of *Vigna unuiculata sub spp sesquipedalis* seeds. *Communication in Physical Science*, 5(4),446-454

Musah, M., Ndamitso, M. M., Olamide, A. O., Yerima, H. & Musa, Y. (2014). Assessment of the nutritional composition of *Caesalpinia pulcherrima* seed. *Lapai Journal of Science and Technology*, 2(2), pp. 13-23.

Ndamitso, M. M., Jagaba, M., Musah, M., Mann, A., Mohammed, E .B. & Umar, A. (2016). Chemical composition, antinutrient contents and functional properties of *Corchorus olitorius* and *Melochia corchorifolia*. *FUW Trends in Science & Technology Journal*, 1(1), pp. 96-100.

Niangoran, N. A. M., Due, A. E., Fankroma, M. T. K. & Kouame, L. P. (2015). Functional properties of seed flours of different cultivars of *Citrullus lanatus* cultivated in Cote D'Ivoire. *International Journal of Research Studies in Agricultural Science*, 1(5), pp. 32-48.

Njintang, N. Y., Mbofung, C. M. F. & Waldron, K.W. (2001). In vitro protein digestibility and physicochemical properties of dry red bean (*Phaseolus vulgaris*) flour: effect of processing and incorporation of soybean and cow pea flour. *Journal of Agricultural and Food Chemistry*, 49, pp. 2465-2471.

Nzekwe, U., Ajuziogu, J. C., Njoku, E. U., Okafor, G. I., Sani, M. B., Onyeke, C. C., Onyeonagu, C. C., Ohaneje, A. A. & Eze, C.S. (2016). Nutritional food content of seed and effects of five different growing media on seed germination and seedling growth of *Afzelia Africana SM Caesalpiniceae*. *African Journal of Biochemistry*, 15(11), pp. 384-391.

Ogbuagbu, M. N., Odoemelam, S.A. and Ano, A.O. (2011). Chemical composition of underutilized tropical African seed: *Adenanthera povonina*. *Journal of Chemical Society of Nigeria*, 36(1), pp. 23-28.

Ojo, M. A. & Ade-Omowaye, B.I.O. (2015). Some functional and physical properties of selected underutilized Hardpp.-to-cook legumes in Nigeria. *American Journal of Food Science and Nutrition*, 2(5), pp.73-81.

Oladele, A. & Aina, J. (2007). Chemical composition and functional properties of flour from two varieties of tiger nut (*Cyperus esculentus*). *African Journal of Biotechnology*,6, pp. 2473-2476.

Onimawo, I. A., Nmerole, E. C., Ndoko, P. I. & Akubor, P.I. (2003). Effects of fermentation on nutrients content and some functional properties of pumpkin seed (*Telfaria occidentalis*). *Plant Foods for Human Nutrition*, 58, 1-9.

Oulai, P., Zoue, L., Megnanou, R., Doue, R. & Niamke, S. (2014). Proximate composition and nutritive value of leafy vegetables consumed in Northern Cote D'Ivoire. *European Scientific Journal*, 10(6), pp.212-227.

Shittu, T. A., Sanni, L.O., Awonorin, S.O., Maziya-Dixon, B. & Dixon, A. (2007). Use of multivariate techniques in studying the flour making properties of CMD resistant cassava clones. *Food Chemistry*, 101, pp. 1606-1615.

Sosulski, F.W., Elkowicz, L. & Reichert, R.D. (2002). Oligosaccharides in eleven legumes and their air-classified protein and starch fractions. *Journal of Food Science*, 47, pp. 498-502.

Conflict of Interest

The authors declare no conflict of interest.