Journal of Asian Scientific Research
ISSN(e): 2223-1331
ISSN(p): 2226-5724
DOI: 10.18488/journal.2.2019.911.185.192
Vol. 9, No. 11, 185-192.

URL: www.aessweb.com

COMPARATIVE STUDIES ON THE PROXIMATE COMPOSITION AND FUNCTIONAL PROPERTIES OF MUCUNA SLOANEI BEAN FLOUR VARIETIES

Ide, P. E.[1+]
Eze, P. C.[2]
Eze, C. N.[3]

[1,2,3]*Department of Agricultural and Bioresource Engineering, Enugu State University of Science and Technology, Enugu, Nigeria.*
[1]*Email: patrick.ejike@esut.edu.ng*

(+ Corresponding author)

Article History
Received: 7 August 2019
Revised: 12 September 2019
Accepted: 15 October 2019
Published: 26 November 2019

Keywords
Horse-eye bean flour
Functional properties
and proximate
composition.

ABSTRACT

The proximate composition and functional properties of Mucuna sloanei bean flour were determined. Two sample varieties, namely; Big Sized and the Small Sized were used for the experiment. The result obtained from the functional properties of the flour showed that foaming capacity, oil absorption capacity, water absorption capacity, swelling power were 15.29 %, 2.63 %, 6.45 %, 12.79 % and 15.14 %, 2.37 %, 6.15 %, 11.54 % for Big and Small Sized Horse-Eye bean flour respectively. The results indicate that the Big Sized sample flour can be used as ingredients in paste products and also in production of baked food products than the Small Sized sample flour. Analysis showed that there was significant ($p < 0.05$) differences in the functional properties of both samples. The proximate composition recorded were protein, 23.51 %; crude fibre, 2.45 %; carbohydrate, 68.34 %; fat 7.18 % and protein, 25.33 %; crude fibre, 2.44 %; carbohydrate 61.82 %; fat, 6.89 % for Big and Small Sized Horse-Eye bean flour respectively. The result showed significant difference at ($p < 0.05$) confidence interval on proximate analysis of both samples.

Contribution/ Originality: This study contributes in the existing literature in determining the suitability of Mucuna sloanei in food and other relevant industries as a good guide to food processors and formulators in related activities in the food industries.

1. INTRODUCTION

In the recent days, interest has been given to lesser known and underutilized crop with high potential values for alternative for human and animal food and new food products development. Mucuna sloanei is among the over hundred (100) species of shrubs and climbing vines that is generally accepted due to its important benefits to humans and their environment [1]. Mucuna sloanei is a climbing shrub with twining stem that can be 6 - 8 meters long. Its young fruit is cooked and eaten as vegetable while the ripped seed is cooked and pounded, eaten preferably with soup [2]. In Nigeria Mucuna sloanei is known to have different native names with regards to their tribe and ethnic group, in Igbo, it is known as "UKPO or OKOBO", "KARASUU" in Hausa, "YEREPE" in Yoruba and "IBABAT" in Efik, [3]. In the South Eastern Nigeria, Mucuna sloanei used in making of food condiments in local soups, Eze and Eze [4]. The seed can be roasted, fermented and parboiled for easy removal of the hull and then grinded to obtain a fine powder or paste when wet milled. The paste is used as a recipe of some food items, for baking and in beverages [5]. Due to the fact that Mucuna sloanei displayed high protein content, they are used to

supplement cocoyam (high carbohydrate) and melon (high oil) in soup making [6]; [7]. Mucuna sloanei as a soup thickener also helps in tackling protein- energy deficiency which is the most common observed malnutrition in area where the people depend mainly on starch-based diets [8]. Mucuna sloanei positive health properties are nutritional composition, pharmaceutical/medical properties and functional properties while the negative properties of Mucuna sloanei are toxic at any concentration, toxic after critical concentration level and excessive or unbalanced intake, Okaka, et al. [9]. The importance of Mucuna sloanei is based on its high content of lysine and protein, these are usually limited in sulphur-containing amino acid particularly methionic, [1]. It contains phosphorus, but very little in the supply of iron and calcium [9]. It contains LDOPA [a chemical that is made and used as part of the normal biology of humans and some animals and plants] a neuro transmitter that is used to treat Parkinson disease [1]. Apart from its culinary application [10] it is also used as additives to other food products in order to impact a good desirable textural food quality on them, Akpata and Miachi [11]; Akpata and Miachi [12].

Functional properties of a food material are parameters that determine its application and end use. It usually shows how the food materials under investigation will interact with other food components directly or indirectly affecting processing applications, food quality, and ultimate acceptance [13]. Proximate analysis is set of approaches used to get facts about the nutritional significance of agricultural products. It is very important that the various agricultural products and food materials are examined to verify their natural benefits which will in turn improve the good quality of life and existence of man. There is limited literature reported on the functional characteristics and proximate composition of varieties of Mucuna sloanei. Therefore, this research is aimed at determining and comparing the functional properties and proximate composition of two varieties of Mucuna sloanei flour in order to explore its numerous potentials in the food system and increase their uses and also reduces post-harvest losses.

2. MATERIALS AND METHOD

2.1. Source of Sample

The Mucuna sloanei samples used for this research work were collected from a local farm in Amokwe, Udi Local Government Council at a stable storage moisture content. Two sample varieties were collected for the research, namely; Big-Sized and Small-Sized Mucuna sloanei.

2.2. Sample Preparation

The varieties seeds of Mucuna sloanei were properly cleaned and sorted to select viable seeds. The sample was parboiled for 60 minutes. The boiled seeds were manually dehulled, oven dried for 120 minutes at 60^0C, milled into flour using disc attrition mill and sieved with American Standard Sieve with 435 ppm aperture to obtain fine flour. The processed flour was packaged in an airtight container with proper labelling and then moved to the laboratory were proximate composition and functional properties were carried out.

2.3. Determination of the Functional Properties and the Proximate Composition of Mucuna Sloanei Flour

The functional properties such as the bulk density, swelling index, water absorption capacity, oil absorption capacity, foam and emulsion capacities as well as gelatinization temperature were all determined using the methods as described by Iwe, et al. [2]; Adeleke and Odedeji [14].

The Proximate composition of the flour of the two Mucuna sloanei samples was also determined using the AOAC [15]. Standard methods.

Table-1. Functional properties of big and small sized mucuna sloanei bean flour.

Variety	Test	Bulk density (%)	Gelation (%)	Emulsification (%)	Foaming capacity (%)	Oil absorption capacity (%)	Water absorption capacity (%)	Swelling power (%)	Solubility (%)
Big sized	A	0.62	46.10	62.26	15.20	2.08	6.44	12.72	6.60
	B	0.63	43.32	62.23	15.21	2.76	6.46	12.67	6.27
	C	0.62	48.19	58.87	15.45	3.04	6.46	12.98	6.93
	Mean value	0.62	45.87	61.12	15.29	2.63	6.45	12.79	6.03
	STD	0.0	2.4	1.9	0.1	0.5	0.01	0.2	0.3
Small sized	A	0.52	44.01	58.79	14.98	2.01	6.14	12.51	6.48
	B	0.52	43.98	52.43	14.98	2.09	6.12	12.76	6.98
	C	0.56	46.01	56.23	15.45	3.01	6.18	11.54	5.96
	Mean value	0.53	44.67	55.82	15.14	2.37	6.15	12.27	6.47
	STD	0.0	1.2	3.2	0.3	0.6	0.031	0.6	0.5

Note: A, B, and C, are replicants. STD represents the standard deviation.

Table-2. Proximate composition of big and small sized mucuna sloanei bean flour.

Variety	Test	Moisture (%)	Ash (%)	Fat (%)	Protein (%)	Crude fibre (%)	Sugar (%)	Starch (%)	CHO (%)
Big sized	A	8.36	4.82	7.18	23.73	2.45	4.31	50.05	71.45
	B	7.24	3.64	9.36	21.72	2.44	3.83	50.15	64.83
	C	9.48	5.00	5.01	25.09	2.46	3.51	49.95	68.73
	Mean value	8.36	4.49	7.18	23.51	2.45	3.88	50.05	68.34
	STD	1.1	0.7	2.2	1.7	0.0	0.4	0.1	3.3
Small sized	A	8.48	4.82	6.86	25.61	2.43	4.36	50.88	62.76
	B	8.48	3.64	6.92	25.78	2.44	4.41	50.47	63.92
	C	8.38	5.02	6.88	24.59	2.45	3.98	60.21	58.79
	Mean value	8.45	4.49	6.89	25.33	2.44	4.25	53.85	61.82
	STD	0.1	0.7	0.0	0.6	0.0	0.2	5.5	2.7

Note: A, B, and C, are replicants. STD represents the standard deviation.

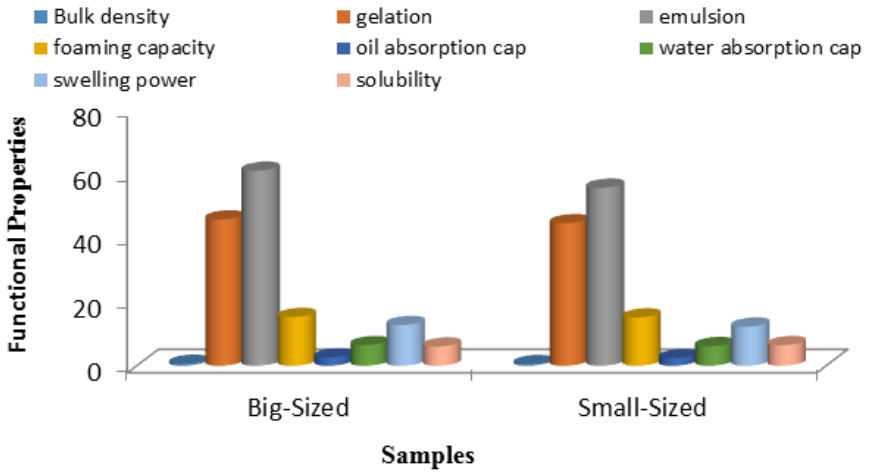

Figure-1. Graph showing functional properties of mucuna sloanei bean flour.

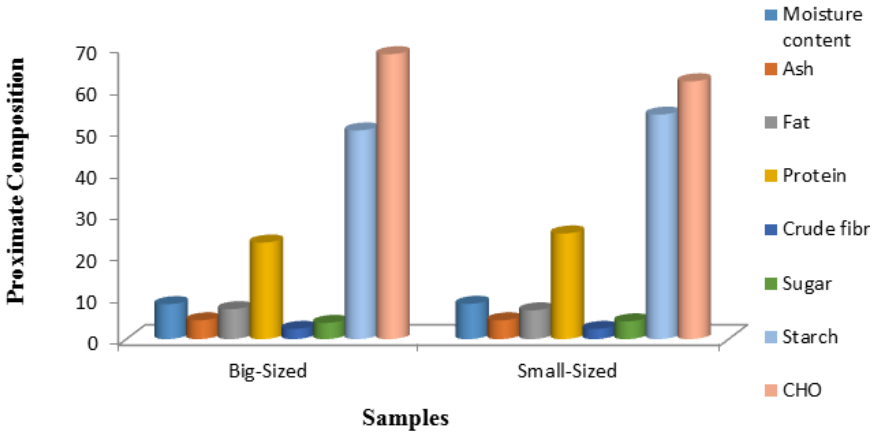

Figure-2. Graph showing proximate composition of mucuna sloanei bean flour.

3. RESULTS AND DISCUSSION

3.1. Functional Properties of Mucuna Sloanei Bean Flour

Table 1 and Figure 1 shows the functional properties of Mucuna sloanei bean flour. From the Table 1 and Figure 1, the water absorption capacity was recorded as 6.45 % and 6.15 % for both the Big Sized and the Small Sized samples. Water absorption capacity gives an insight on the ability of how the sample flour interacts with the water molecules [16]. It also describes the ability of the flour to absorb water and swell to improve consistency in new food development. The highest value was recorded in the Big-Sized sample variety, while the lowest value was observed at the Small-Sized sample variety. This may be attributed to the low protein and high carbohydrate contents of as carbohydrates have been reported to greatly influence the water absorption capacity (WAC) of foods [17]. From the result above, it was found that both varieties displayed favorable WAC thereby making them suitable raw material or functional ingredients in the development of ready-to-eat food products, soups, gravies, and baked products [13].

Bulk density (BD) is used to evaluate the flour heaviness, handling requirement and the type of packaging method suitable for storage and transportation of food materials [18]. From Table 1 and Figure 1, the bulk density of the flour samples was recorded as 0.62 g/ml and 0.53 g/ml for Big Sized and Small Sized samples respectively. It was observed that the flour of Mucuna sloanei are heavy, therefore, a small amount of flour maybe packaged within a constant volume David, et al. [18]. Iwe, et al. [2] reported that high bulk density flour is desirable for reducing paste thickness due to its low viscosity and for food products with rough textures. While low bulk density flour is properly served for food with smooth and dense textures. The slight variation in bulk density could be as a result of the variation in starch content [16].

The oil absorption capacity (OAC) was also determined. Oil absorption capacity measures the ability of food material to absorb oil. Results oil absorption capacity obtained were 2.63 % and 2.37 % for Big and Small sample flour respectively. Oil absorption is attributed to the hydrophobic character of protein in the flour. The presence of protein exposes more non-polar amino acids to the fat and enhances hydrophobicity as a result of which the flour absorbs more oil [19]. High oil absorption capacity of food improves palatability and flavor retention of food products.

Foaming capacity (FC) determined was recorded as 15.29 % and 15.14 % for both the Big Sized and the Small Sized samples respectively. The foaming capacity is used to determine the ability of the flour to foam which is dependent on the presence of the flexible protein molecules which decrease the surface tension of water [20]. From the slight variation in the result of the foaming capacity, it shows that both the sample are desirable for making flour for baking, cookies cakes and in development of new food products, Asif-Ul-Alam, et al. [20].

Solubility index of flour measures the extent the flour mixes with water. From Table 1 and Figure 1, it was observed that Big Sized sample flour had the lowest solubility value of 6.03% while the Small Sized samples recorded highest value of 6.47 % for solubility index. The high solubility value displayed by the Small Sized flour sample indicates how sticky and adhesive the food product is. The lower value displayed by the Big Sized flour sample was as a result of presents of protein and lipids in the flour as it reduces the solubility of the starch molecules [21].

Swelling capacity results of the sample flour was also presented Table 1 and Figure 1. The swelling power of Big and Small sized Mucuna sloanei flour samples were recorded as 12.79 % and 12.27 % for both samples respectively. The highest swelling power of 12.7 9% was recorded for the Big sized sample flour which indicates that the flour possesses good quality for making or for formulation of bakery products [2].

Emulsification capacity (EC) measures the maximum amount of oil emulsified by protein in a given amount of flour. From Table 1 and Figure 1, the emulsification capacity of the flour samples recorded were 61.12 % and 55.82 % for Big and Small Sized flour samples respectively. The highest value displayed by the Big Size sample flour indicates the globular nature of the protein present in the flour sample.

Gelation capacity (GC), measures the minimum amount of flour needed to form a gel in a measured volume of water. It varies from flour to flour depending on the relative ratios of their structural constituents like protein, carbohydrates, and lipids [13]. From Table 1, gelation capacity obtained were 45.87 % and 44.67 % for both Big and Small Sized flour samples respectively. The highest value of gelation capacity displayed by the Big Sized flour sample was as a result of protein concentration which promote interaction among the binding forces which in turn increases the gelling ability of the flour. It was observed that the higher the gelation capacity, the higher the quantity of flour needed to form a gel and the lower the gelation capacity, the better the gelling ability of the flour [13].

3.2. Proximate Composition of Mucuna Sloanei Bean Flour

Results of the determined parameters of the proximate composition of the Mucuna sloanei bean flour was recorded in Table 2 and Figure 2. Crude fiber was recorded as 2.45 % and 2.44 % for both the Big and Small Sized flour samples respectively. From the result, it can be observed that fiber is contained in both the samples, and this has the tendency to regulate the bowel actions and may help to guard against colon and rectal cancer as well as in diabetes, Igwenyi and Azoro [22]. Fiber is a portion of food that is not used up by the body. Fibre shortens the transit time of food through the gastrointestinal tracts, reduces low density lipoprotein and hence keeps the gut healthy, Igwenyi and Azoro [22]. Fiber supplements or fiber-rich foods may function as normal dietary agents by modulating the digestive and absorptive process [9]. They are very important in promoting a range of physiological effects, including increased fecal bulk, water-holding capacity, absorption of organic molecules such as

bile acids, cholesterol and toxic components (reduced bile acid and plasma-cholesterol levels), reduction of minerals and electrolytes [22].

The ash contents were also determined and the results obtained are in Table 2 and Figure 2. Results obtained are 4.49 % and 4.49% respectively for Big and Small Sized sample flours. The level of ash in the food is an indication of adulteration. Adulteration is the contamination of food product due to inorganic substances present in the food being analyzed [22].

The moisture content the Mucuna sloanei bean flour samples determined are 8.36 % and 8.45 %. The lower value displayed by the both samples show that the flour sample indicate storage storability and can produce shelf stable products. These low values of moisture content of the flour will discourage deterioration due to microbial attack. This is similar with what was reported by Igwenyi and Azoro [22]. Although the water content of a food is expressed as a percent, this number does not reflect how the water exists in the food. Water in food is classified according to its availability or biological activity and is either "free" or "bound." Free water is not bound to any components in a food; it can be used for microbial growth and is also available for chemical reactions. Bound water is physically bound to large (molecules) components in the food. It is not available to microorganisms for their growth and it cannot participate in chemical reactions [22].

The results recorded for the fat content were 7.18 % and 6.89 % for the Big and Small sized flour samples respectively. It was observed that the Big Sized slightly recorded the highest value for fat content at 7.18 %, while the lowest value was observed on the Small Sized sample as 6.89 %. According to Reebe, et al. [23] flour with low fat level are desirable as it promotes a longer shelf life for flour products because all the fat and fat containing food material contains an unsaturated fatty acid, and this can cause deterioration of the flour.

Crude protein was also investigated and presented in Table 2 and Figure 2. The recorded results are 23.51 % and 25.33 % for both the Big and Small sized sample flours respectively. Crude protein refers to the total protein content of a food source as determined by its nitrogen content. It was observed that Small sized flour sample recorded highest number of crude proteins with 25.33 % while the Big Sized sample flour recorded the lowest crude protein of 23.51 %. It can be observed that the Small sized flour sample contains much protein. It is therefore, recommended to use Small sized flour sample variety when protein content of the flour is necessarily needed.

Sugar content of the flour sample was investigated and presented in Table 2 and Figure 2. The sugar contained in the flour is the major cause of diabetes, the higher the sugar content the more the food becomes undesirable to the society as a any food products with high sugar content comes down with lots of health implications. The Results obtained were 3.88 % and 4.25 % for Big and Small sized flour samples respectively. It can be observed that the sugar content of Mucuna sloanei varieties has low sugar level. It can be used as an alternative in making of other flour-based food products.

The results for the carbohydrate content of the Mucuna sloanei sample varieties were also recorded in Table 2 and Figure 2 as 61.82 % and 68.34 % for both the Big and Small Sized sample flours respectively. The carbohydrate contents of any flour samples are an indicator that the products made from them will be good sources of energy. It can be concluded that, the Big Sized sample flour can be used to fortify food products more especially when energy is required because the higher the carbohydrate, the higher the energy content of the flour.

The results of the starch of Mucuna sloanei samples investigated was recorded as 53.85 % and 50.05 % for both Big and Small Sized flour samples. Results indicated that the starch processed from the Mucuna sloanei is applied as it enhances moisture retention, gelatinization of the flour, stability of flour during heating and mechanical shear stress, texturizing and thickening applications.

4. CONCLUSION

The result obtained from the functional properties of the flour showed that foaming capacity, oil absorption capacity, water absorption capacity, swelling power were 15.29 %, 2.63 %, 6.45 %, 12.79 % and 15.14 %, 2.37 %, 6.15

%, 11.54 % for Big and Small Sized Mucuna sloanei bean flour respectively. This indicates that the Big Sized sample flour can be used as ingredients in paste products and also in production of baked food products than the Small Sized sample flour. This showed that there was significant ($p < 0.05$) differences in the functional properties of both samples. The proximate composition such as protein, crude fiber, carbohydrate, and fat are recorded as 23.51%, 2.45%, 68.34%, 7.18 and 25.33%, 2.44%, 61.82%, 6.89% for Big and Small Sized Mucuna sloanei bean flour respectively. The result showed significant difference at ($p < 0.05$) confidence interval on proximate analysis of both samples. The Big Sized Mucuna sloanei bean flour displayed a better functional property than the Small Sized sample. But the Small Sized sample flour had higher protein, this showed that the sample flour can be used to improve the nutritional qualities of local staple foods.

Funding: This study received no specific financial support.
Competing Interests: The authors declare that they have no competing interests.
Acknowledgement: All authors contributed equally to the conception and design of the study.

REFERENCES

[1] J. Nwosu, "The effect of storage condition on the rheological/functional properties of Soup thickener Mucuna sloanei (Ukpo)," *Researcher*, vol. 3, pp. 6-10, 2011.

[2] M. Iwe, U. Onyeukwu, and A. Agiriga, "Proximate, functional and pasting properties of FARO 44 rice, African yam bean and brown cowpea seeds composite flour," *Cogent Food & Agriculture*, vol. 2, pp. 1-10, 2016.Available at: https://doi.org/10.1080/23311932.2016.1142409.

[3] G. Obochi, S. Malu, E. Effiom, and G. Bassey, "Efficacy and suitability of lectin from Mucuna sloanei seeds extracts as a cell receptor signal inducer," *Research Journal of Biological Sciences*, vol. 2, pp. 667-669, 2007.

[4] P. C. Eze and C. N. Eze, "Determination of some physical and mechanical properties of horse eye-bean (Mucuna Sloanei) from South East Nigeria," *Jounal of Experimental Research*, vol. 5, pp. 33 - 41, 2017.

[5] E. Wanjekeche, V. Wakasa, and J. Mureithi, "Effect of germination, alkaline and acid soaking and boiling on the nutritional value of mature and immature Mucuna (Mucuna pruriens) beans," *Tropical and Subtropical Agroecosystems*, vol. 1, pp. 183-192, 2003.

[6] B. C. Adebowale and C. Lawal, *Food gums and ingredients*, 2nd ed. Nigeria: Academic Press, 1986.

[7] C. Owuamanam, S. Obeleagu, C. Ogueke, J. Iwouno, A. Nwakaudu, and I. Nwachukwu, "Functional properties of seed flours of Detarium microcarpum and Mucuna Sloanei as affected by sodium chloride and palm oil: A response surface methodology approach," *Futo Journal of Ser*, vol. 2, pp. 361-378, 2016.

[8] S. Giwa, L. C. Abdullah, and N. M. Adam, "Investigating "Egusi"(Citrullus colocynthis L.) seed oil as potential biodiesel feedstock," *Energies*, vol. 3, pp. 607-618, 2010.Available at: https://doi.org/10.3390/en3040607.

[9] J. C. Okaka, N. T. Enoch, and A. N. Okaka, *Food and human nutrition.* Enugu Nigeria: OCJ Academic Public, 2006.

[10] I. A. Ajayi, R. A. Oderinde, D. O. Kajogbola, and J. I. Uponi, *Oil content and fatty acid composition of some underutilized legumes from Nigeria. Food Chemistry*, vol. 99, pp. 115-120, 2006.Available at: https://doi.org/10.1016/j.foodchem.2005.06.045.

[11] A. O. Akpata and E. U. Miachi, "Chemical composition and selected functional properties of sweet orange and legumes," *Flours Plant Foods Humam Nutritions*, vol. 54, pp. 353-362, 2001.

[12] M. Akpata and O. Miachi, "Proximate composition and selected functional properties of detarium microcarpum," *Plant Foods for Human Nutrition*, vol. 56, pp. 297-302, 2001.

[13] O. R. Ehimen, A. A. Adeola, M. A. Idowu, O. P. Sobukola, T. A. Afolabi, R. O. Ishola, S. O. Ayansina, T. O. Oyekale, and A. Falomo, "Nutrient composition, functional, and pasting properties of unripe cooking banana, pigeon pea, and sweetpotato flour blends," *Food Science & Nutrition*, vol. 5, pp. 750-762, 2017.Available at: https://doi.org/10.1002/fsn3.455.

[14] R. Adeleke and J. Odedeji, "Functional properties of wheat and sweet potato flour blends," *Pakistan Journal of Nutrition*, vol. 9, pp. 535-538, 2010.Available at: https://doi.org/10.3923/pjn.2010.535.538.

[15] AOAC, *Official methods of analysis*, 16th ed.: Association of Official Analysis, 2005.

[16] K. Supaluck, R. Saroat, and L. Suyong, *Physicochemical and functional properties of Thai organic rice flour. Journal of Cereal Science*, vol. 79, pp. 259-266, 2017.Available at: https://doi.org/10.1016/j.jcs.2017.10.015.

[17] N. Anthony, M. Sawi, O. Aiyelaagbe, A. Taiwo, T. Winnebah, and S. Fomba, "Proximate characteristics and complementary assessment of five organic sweetpotatoes cultivars and cowpea varieties," *The International Journal of Engineering Science*, vol. 3, pp. 38-42, 2014.

[18] O. David, E. Arthur, S. O. Kwadwo, E. Badu, and P. Sakyi, "Proximate composition and some functional properties of soft wheat flour," *International Journal of Innovative Research in Science, Engineering and Technology*, vol. 4, pp. 753-758, 2015.

[19] I. Oluwalana, M. Oluwamukomi, T. Fagbemi, and G. Oluwafemi, "Effects of temperature and period of blanching on the pasting and functional properties of plantain (Musa Parasidiaca) flour," *Journal of Stored Products and Postharvest Research*, vol. 2, pp. 164-169, 2011.

[20] S. Asif-Ul-Alam, M. Islam, M. Hoque, and K. Monalisa, "Effects of drying on the physicochemical and functional properties of green banana (Musa sapientum) flour and development of baked product," *American Journal of Food Science and Technology*, vol. 2, pp. 128-133, 2014.Available at: https://doi.org/10.12691/ajfst-2-4-4.

[21] I. Keawpeng and M. Meenune, "Physicochemical properties of organic and inorganic Phatthalung Sungyod rice," *International Food Research Journal*, vol. 19, pp. 857-861, 2012.

[22] I. Igwenyi and B. Azoro, "Proximate and phytochemical compositions of four indigenous seeds used as soup thickeners in Ebonyi state Nigeria," *Journal of Environmental Science, Toxicology and Food Technology*, vol. 8, pp. 35-40, 2014.Available at: https://doi.org/10.9790/2402-08623540.

[23] S. Reebe, V. N. Gonzalez, and J. Rengifo, "Research on trace elements in the common beans," *Food Nutrition Bulletin*, vol. 2, pp. 1387-1391, 2000.