



Quality evaluation of “Ahuma”: A traditional breakfast porridge meal from African yam bean (*Sphenostylis sternocarpa*) sold in Makurdi metropolis

Ikala GU¹, Ochelle PO^{2*}, Idoko BO³

¹⁻³ Department of Food Science and Technology, College of Food Technology and Human Ecology, Federal University of Agriculture, Makurdi, Nigeria

Abstract

The chemical and sensory properties of “Ahuma” porridge meal prepared from African yam bean (*Sphenostylis sternocarpa*) sold in different locations by vendors in Makurdi metropolis were investigated. “Ahuma” was purchased from vendors in North Bank, Asase North bank, High level, wadata and Kanshio areas were analyzed. The proximate composition of “Ahuma” in all the locations were significantly ($P \leq 0.05$) different from each other. Mineral analysis showed phosphorus was the most abundant element in all the “Ahuma” samples. The highest phosphorus content (72.38 mg/100g) was recorded in sample E (Kanshio area), sample B had the highest content of Magnesium (45.38 mg/100g). The result of this study also revealed that sensory attributes of colour/appearance, aroma, taste, mouthfeel and overall acceptability were significantly ($P < 0.05$) higher in samples collected from Kanshio than in samples collected from other areas. The study showed African yam bean have potentials for combating protein-energy malnutrition

Keywords: chemical, sensory, porridge, Makurdi metropolis

1. Introduction

African yam bean is an important ingredient of a balanced human diet in many parts of the world due to their high protein and starch contents (Adebowale *et al.*, 2009) [4]. African yam bean has been reported to be a major source of protein, complex carbohydrates and minerals in developing countries. Africa yam bean have also been ascribed economic, cultural, physiological and medicinal roles owing to their possession of beneficial bioactive compounds. These useful bioactive compounds in African yam bean have hypocholesterolemic, antiatherogenic, anticarcinogenic and hypoglycemic properties. African yam bean is an annual climbing or prostrate-vine legume with pods containing 20-30 seeds. (Anon 1979 and Porter 1992) [6]. It is one of the lesser-known legumes and widely cultivated in the tropical and subtropical regions (mostly in the southern part of Nigeria). African yam bean good source of dietary protein grown in mixed association with yam and cassava, and is cultivated both for the seeds and the tubers which grow as the root source and the actual yam bean seeds which develops tubers, in pods above the ground. It has many seed types, which vary in seed size, shape and seed coat colour. The colour of the seed coat varies from white to various shades of valuable cream, brown and grey. This beans contain considerable amount of essential protein (Amino acid, lysine and methionine) comparable to levels found in soybean and are easily preserved through drying or stored in earthenware (Adewale *et al.*, 2012) [5]. It could be found in forests, open wooded grasslands, rocky fields, and marshy grounds as weed and cultivated crops (Porter 1992). African yam bean originated in Ethiopia, but both wild and cultivated types now

occur in tropical Africa as far as Egypt and also throughout West Africa from Guinea to southern Africa. The seeds are highly proteinous and capable of growth in marginal areas where other pulses fail to thrive. Uguru and Madukaife (2001) [26] reported higher values of lysine and methionine in AYB seeds than in pigeon pea, cowpea and Bambara ground nut. African yam bean is also valued for its satiety over several hours after consumption, especially among farmers and the resource-poor. African yam beans, thus, has high potential to contribute to curbing hunger, and alleviating protein and micronutrient malnutrition in sub-Saharan Africa, if grown on a large scale. In ethno medicine, AYBs is indicated for managing diabetes and high blood pressure. Neglected and underexploited indigenous crop such as African yam bean (AYB) have recently been receiving attention and currently being explored due to their nutritional and health potentials. With the view of creating more awareness of the nutritional and health benefits of this crop, this study therefore seek to evaluate the nutritional quality and microbiological profile of “Ahuma”: a traditional breakfast porridge meal from African yam bean sold by vendors from different locations in Makurdi Local Government.

2. Materials and Methods

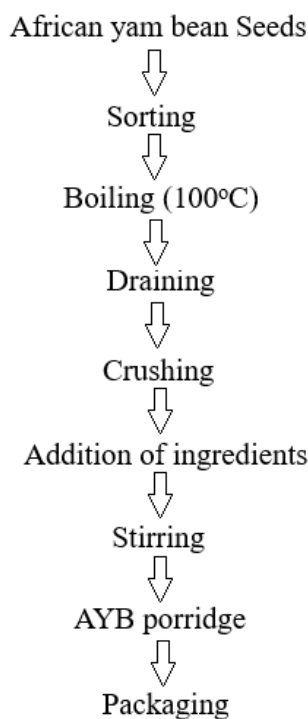
2.1 Source of Materials

“Ahuma” porridge meal were prepared by vendors mostly women of middle age between 30-40 years, in their homes overnight. The porridge meal was hawked by vendors who sell it to people and families beginning from the early hours of 7 am till 12noon when the product cannot be seen for porridge. The “Ahuma” sample used for the study were

purchased from various vendors, from different locations in Makurdi Metropolis such as: North Bank Market Area, Asase North Bank Area, High level Area, Wadata Area, and Kanshio Area in Makurdi Local Government. The samples were purchased and transported in clean plastic covered containers each day for 5 days from different locations to Food Science and Technology laboratory, University of Agriculture Makurdi, dried and milled into powder for chemical analyses. Only samples for sensory evaluation were collected on the same day in different location for sensory analysis.

2.2 Preparation of “Ahuma” porridge as described by vendors in Makurdi Metropolis.

Fresh seeds of African yam bean were thoroughly cleaned of foreign materials and immature seeds removed. They were then boiled in distilled water (100°C). After boiling, the water was drained off and boiled samples were mashed into paste using a ceramic mortar. In another smaller pot, the beniseed (*Sesamum indicum*) were fried and also mashed into paste and then added to the AYB paste in the mortar. Other ingredients (palm oil, black pepper, salt etc.) were also added for flavor and palatability. It was then stirred until fully mixed. The prepared porridge was then packaged into an air-tight container, ready for consumption.



Source: Personal Survey

Fig 1: A generalized descriptive flow chat on the preparation of the porridge by vendors in Makurdi Metropolis.

2.3 Proximate Analysis

Nutrient composition of the food samples was determined in triplicate using the standard procedures of Association of Official Analytical Chemists (AOAC, 2012)^[1].

2.3.1 Determination of Moisture Content

Two (2) g of sample was weighed inside a clean dried crucible

(W₁) and was dried at 60°C in a hot stimulating oven (Gallenkamp) for 24 hours to a constant weight. It was later cooled in desiccators for 30 minutes and weighed (W₂). The crucible was washed, dried in the oven and the weight was recorded (W₀). The Calculation was done as follows:

$$\text{Moisture content (\%)} = \frac{W_1 - W_2}{W_1 - W_0} \times \frac{100}{1}$$

Where:

W₁ = Weight of sample + empty crucible

W₀ = weight of empty crucible

W₂ = Weight of dried sample + empty crucible

2.3.2 Determination of Crude Protein

The crude protein content (N x 6.25) was determined by Kjeldhal method. A quantity of 0.5 g of each sample was added to 10 ml of conc. sulphuric acid and 1 g of the catalyst mixture. It was then heated cautiously on digestion rack under fume hood until a greenish clear solution appeared. It was allowed to cool and then made up to 50 ml with distilled water. The digested sample was transferred into distillation apparatus and distilled. 10 ml of the distillate was titrated with 0.1M HCL to first pink colour. Temperature of digester was above 420 °C for about 30 min.

$$\text{Nitrogen (\%)} = \frac{\text{Titrate} \times 14.01 \times 0.01m \times 100 \times 50}{100 \times 0.5g \times 10} \text{ \% crude protein} = N \times 6.25$$

2.3.3 Determination of Crude Fat (Soxhlet Method)

Crude fat was determined by exhaustively extracting each sample in petroleum ether in a soxhlet extractor. The weighed sample (W₀) was poured into a thimble and covered with a clean white cotton wool. Petroleum ether (200 ml) was poured into a 250 ml extraction flask which was previously dried in the oven at 105°C for 30 minutes and weighed (W₂). The porous thimble was placed into the soxhlet and the rest apparatus were assembled. Extraction was done for 5 hours. The thimble was removed carefully and the extraction flask was placed in a water bath so as to evaporate the petroleum ether and then dried in the oven at a temperature of 105°C to completely free the solvent and moisture. It was cooled in a desiccator and reweighed (W₁). The percentage crude fat was calculated using the following equation:

$$\text{Crude fat (\%)} = \frac{W_1 - W_2}{W_0} \times 100$$

Where: W₁ = weight of sample (g)

W₁ = Weight of flask + oil (g)

W₂ = Weight of flask (g)

2.3.4 Determination of Ash Content

2 g of sample (W₁) was transferred into a previously heated, cooled and weighed crucible (W₀) and the content was placed into a Gallenkamp muffle furnace at 550°C for 3 hours. It was allowed to cool in desiccators and weighed (W₂)

$$\text{\% Ash (\%)} = \frac{W_2 - W_0}{W_1 - W_0} \times \frac{100}{1}$$

2.3.5 Determination of crude fibre

2g of the sample was defatted with petroleum ether, boiled under reflux for 30 minutes with 200 ml of a solution containing 1.25 g of H₂SO₄ per 100 ml of solution. It was then filtered with Whatmann No 1 filter paper, washed with boiled water until the washing was no longer acid. The residue was transferred to a beaker and boiled for 30 minutes with 200ml of a solution containing 1.25g of carbonate free sodium hydroxide per 100ml. It was then filtered and transferred into a crucible. The residue was dried in the oven and weighed. The sample was ash at 600°C in a muffle furnace and the dried weight recorded.

The calculation was done as follows:

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

Where: W₀ = Weight of sample (g)

W₁ = Weight of dried sample (g)

W₂ = Weight of ash sample (g)

2.3.6 Determination of Carbohydrate

Carbohydrate content was determined by difference (Ihekoronye and Ngoddy, 1985) [12]. This was done by subtracting the summed up percentage composition of moisture, ash, fat, protein and fibre contents from 100 g. This was done by using the equation below:

$$\text{Carbohydrate (\%)} = 100\% - (\% \text{moisture} + \% \text{ash} + \% \text{fat} + \% \text{protein} + \% \text{fibre})$$

2.4 Sensory Evaluation (Organoleptic Properties)

Sensory evaluation of Ahuma porridge produced from African Yam Bean (AYM) was performed by descriptive analysis and sensory evaluation (Ihekoronye and Ngoddy, 1985) [12]. Fifteen panelists were used for the assessment from University of Agriculture Makurdi, from students and staff were familiar with the product. A 9 – point hedonic scale (1-dislike extremely, 9-like extremely) was used to rate the sensory attributes of appearance, taste, aroma, and overall acceptability of the products. Each panelists which was presented randomly with fresh tap water for mouth rinsing in between evaluations. The “Ahuma” porridge was stored in food flasks from where they were served to the panelists using coded transparent plastic plates and colourless transparent spoons.

2.5 Statistical Analysis

All results were subjected to Analysis of Variance (ANOVA) using a pre-packaged Computer Statistical Software (SPSS version 20). LSD was used to separate the Means.

3. Results and Discussions

3.1 Proximate Composition of “Ahuma” porridge sold by vendors from different locations in Makurdi Metropolis

Table 1 present the proximate composition of the different “ahuma” porridge collected from selected locations in Makurdi metropolis. The moisture content of African yam beans porridge samples increased (p≤0.05) non-significantly across the samples. Results trends are in line with reports by (Abebe *et al.*, 2018) [2]. Moisture content of sample E 13.89%

was higher when compared with those of other samples. SON (2004) [23] and Ezeama (2007) [7] reported that low moisture levels positively affects long shelf life of foods as they discourage microbial proliferation that lead to spoilage. Result of the moisture content is within the range recommended by the Nigerian regulatory standard for food which is 40% (SON, 2004) [23]. The crude protein content of the samples increased (p≤0.05) significantly across the samples and it ranged from 20.94-33.08%. The protein contents of the sample from North Bank area were significantly (p≤0.05) higher than other samples. Increase in the amount of African yam bean used in preparing the porridge resulted in increase in the protein content progressively. This maybe because African yam bean is not as poor as cassava and other root crops and some leguminous crops in protein content (Habtamu, 2013 and Habtamu, 2014) [9, 10]. This result also correlates with the study (Mashayekh *et al.*, 2008) [17] who also reported increase in protein content of the African yam bean as a result of heat treatment (2008). Kumari and Sangeetha, 2017 [16] reported that protein will be increased when legumes are heated. Proteins are essential for growth and maintenance of body tissues and for the production of substances such as hormones and enzymes which help to control many functions within the body. If insufficient carbohydrate and fat are available in the diet, then protein may also be used as alternative source to provide the body with energy (WHO/FOA/UNU, 1994) [27]. The crude fat content of the samples decreased (p≤0.05) significantly across the samples. The value of the crude fat ranged from 3.68-5.49%. Sample D and E (African yam bean collected from Wadata and Kanshio areas) had the highest fat content 5.49% and 5.47% respectively. This may be because of the processing system adopted by the food vendors in the areas (Kumar *et al.*, 2011 and USDA, 2011) [16]. Similar trend was reported by Owuamanam *et al* (2014) [21]. Also, Owuamanam *et al.*, 2014 [21] and Abebe, 2018 [2] reported that increasing the amount of processing time of yam porridge decreased the crude fat content of the final products. Fat also increases the absorption of fat-soluble vitamins including vitamins A, D, E and K and help maintain our body temperature. They are regarded as the most energy-dense macronutrient, providing the body with 9 calories per gram of energy (WHO/UNU, 1994) [27]. The ash content of the samples increased (p≤0.05) non-significantly for sample A, B, C, D and E. The value of the ash content ranged from 3.11-4.08%. The substitution of other condiments increased at the porridge preparation, the ash content of the “ahuma” porridge samples equally increased. This may be due to the high ash content of the water of African yam bean or the combining effects of those other condiments which indicates the high mineral contents in it. Total ash content is directly proportional to the amount of inorganic elements content of the African yam beans (Mesfin and Shimelis, 2013) [18]. Hence the samples with high percentages ash contents were expected to have high concentrations of various mineral elements, (FAO/WHO/UNU, 1994 and Habtamu, 2014) [27, 10]. The ash content of food material could be used as an index of mineral constituents of the food because ash is the organic residue remaining after the water and organic matter have been removed by heating in the presence of an oxidizing agent (Sanni *et al.*, 2008) [24]. The carbohydrate content of the

samples ranged from 54.61-65.26%. The decrease in the carbohydrate content for the samples collected from North bank area and Kanshio area of Makurdi (sample A and E) might be due to high utilization of energy by micro flora during processing, the decrease might also be due to the significant increase in the protein content. The carbohydrate contents of the samples were greater than the minimum carbohydrate requirement 37% recommend by regulatory standards in Nigeria (SON, 2004) [23].

Table 1: Proximate composition of “Ahuma” Porridge sold by vendors from different locations in Makurdi Metropolis.

Samples	Moisture content	Protein	Fat	Fiber	Ash	Carbohydrate	Energy
A	12.21 ^a	33.08 ^a	4.90 ^a	4.28 ^b	3.11 ^a	54.63 ^c	344.01
B	13.20 ^a	20.96 ^d	5.46 ^a	4.24 ^b	4.08 ^a	65.26 ^a	345.14
C	12.12 ^a	27.86 ^b	3.68 ^c	4.16 ^b	3.84 ^a	60.46 ^b	352.63
D	13.65 ^a	24.19 ^c	5.49 ^a	6.31 ^a	3.13 ^a	60.88 ^b	352.62
E	13.89 ^a	20.94 ^d	5.47 ^a	6.30 ^a	3.83 ^a	54.61 ^c	338.57
LSD	0.35	3.23	0.56	1.02	2.03	4.38	

Values are means of triplicate determinations.

Means followed by the same superscript along columns were not significantly different ($P > 0.05$)

A = North bank Market Area

B = Asase Northbank Area

C = High Level

D = Wadata Area

E = Kanshio Area

3.2 Mineral Content of “Ahuma” porridge sold by vendors from different locations in Makurdi Metropolis

The mineral composition of the “Ahuma” porridge is as shown in table 5. The samples significantly ($p < 0.05$) had higher magnesium content. The magnesium content ranged between 38.95-45.38 mg/100g. The phosphorus content of the porridge samples decreased ($p \leq 0.05$) significantly between sample A and D. There was no significant ($P \geq 0.05$) difference between sample B, C and E. The phosphorus content ranged from 63.41-72.38 mg/100g agrees with the result of Haros *et al.* (2001) [11]. The sodium content of the samples increased ($p \leq 0.05$) significantly among the samples across the different locations. The result of the sodium content of the samples ranged from 9.60-14.15 mg/100g. This agrees with work of Isaac (2012) [14]. Sodium is important for fluid balance, required for normal cell function and regulation of blood volume. The result of iron content of the porridge samples ranged from 1.84-2.20 mg/100g and agrees with Slavin (1999) [25] and Joel *et al.* (2014) [15]. The variations observed in the Iron content of the African yam porridge samples could be due to the compositional difference in terms of mineral content between the crops and other ingredients used by the vendors. Iron is a factor in red blood cell formation, is a part of other proteins and enzymes that keep the body health also important part of haemoglobin, a protein that carries oxygen to our tissues (UICEC/WHO, 2005) [27]. The potassium content of the samples increased ($p \leq 0.05$) significantly across the samples. The potassium content of African yam bean porridge ranged between 21.05-26.91mg/100g and is in agreement with Michael *et al.* (2013) [19]. Potassium is a mineral that functions as an electrolyte. It's required for muscle contraction, proper heart function and the transmission

of nerve signals. It's also needed by a few enzymes, including one that helps the body turn carbohydrate into energy (UICEC/WHO, 2005) [27]

Table 2: Mineral content (mg/100g) of “Ahuma” porridge sold by vendors from different locations in Makurdi Metropolis.

Samples	Magnesium	Phosphorus	Sodium	Iron	Potassium
A	38.95 ^d ±0.71	67.22 ^b ±0.45	13.60 ^c ±0.01	1.84 ^c ±0.01	21.23 ^b ±0.02
B	45.38 ^a ±0.09	72.16 ^a ±0.01	10.21 ^d ±0.09	1.87 ^{ab} ±0.01	26.91 ^a ±0.01
C	43.65 ^{ab} ±0.77	70.15 ^a ±0.01	9.60 ^c ±0.01	1.88 ^{ab} ±0.01	25.72 ^a ±0.01
D	45.23 ^b ±4.48	63.41 ^c ±0.01	14.15 ^a ±0.01	1.94 ^b ±0.03	21.05 ^c ±0.01
E	42.16 ^c ±0.07	72.38 ^a ±0.01	14.12 ^b ±0.02	2.20 ^a ±0.01	24.44 ^a ±0.01
LSD	5.80	0.05	0.06	0.09	0.06

Values are means of triplicate determinations.

Means followed by the same superscript along columns were not significantly different ($P > 0.05$)

A = North bank Market Area

B = Asase Northbank Area

C = High Level

D = Wadata Area

E = Kanshio Area

3.2.3 Sensory Attributes of “Ahuma” Porridge sold by vendors from different locations in Makurdi Metropolis.

Tables 3 show the sensory attributes of “Ahuma” porridge. The sensory attributes of colour/appearance, aroma, taste, mouthfeel and overall acceptability were significantly ($P < 0.05$) higher in samples collected from Kanshio than in samples collected from other areas. Sample E was rated highest in all the attributes. It also had the highest overall acceptability. It therefore meant that the sample collected from Kanshio area of Makurdi was most acceptable to the panelists. Iombor *et al.*, (2009), Mahmoud and El Alanny, (2014) worked on sensory evaluation of porridges from African yam bean, sweet potato and peanut oil. Their findings agreed with the observation of this report.

Table 3: Sensory attributes of “Ahuma” porridge sold by vendors from different locations in Makurdi Metropolis.

Samples	Colour	Aroma	Taste	Mouthful	Overall acceptability
A	6.10 ^b ±1.86	5.69 ^{bc} ±1.15	5.79 ^{ab} ±1.40	6.35 ^{ab} ±0.86	5.53 ^b ±1.30
B	5.15 ^b ±0.76	5.63 ^c ±1.40	5.43 ^b ±1.42	5.43 ^b ±0.96	5.74 ^b ±1.36
C	5.04 ^b ±0.92	6.01 ^{ab} ±1.45	6.13 ^a ±1.04	5.59 ^a ±1.06	6.29 ^{ab} ±1.10
D	6.26 ^a ±0.67	5.43 ^b ±1.15	4.88 ^b ±1.44	5.84 ^b ±0.98	5.84 ^{ab} ±0.69
E	8.39 ^a ±0.67	7.16 ^a ±0.98	8.21 ^a ±1.08	7.72 ^a ±0.93	8.63 ^a ±0.85
LSD	0.58	0.79	0.79	0.60	0.65

Values are means of triplicate determinations.

Means followed by the same superscript along columns were not significantly different ($P > 0.05$)

A = North bank Market Area

B = Asase Northbank Area

C = High Level

D = Wadata Area

E = Kanshio Area

3. Conclusion and Recommendation

3.1 Conclusion

The proximate composition of individual “ahuma” porridge meal were significantly ($P \leq 0.05$) different from each other at different locations. The results of this study showed that “ahuma” porridges were rich in protein, carbohydrate fibre

and had high low fat content. Mineral analysis showed phosphorus was the most abundant element in all the "ahuma" samples. The highest phosphorus content (72.38 mg/100g) was recorded in sample E (Kanshio area), sample B had the highest content of Magnesium (45.38 mg/100g). The various samples recorded low sodium contents. Product with high potassium and low in sodium contents recorded by the "ahuma" sample is advantage reported to protect against arterial hypertension. Inadequate intake of micronutrients (Iron) has been associated with severe malnutrition, increased disease conditions and mental impairment. The results from this study show that "ahuma" samples would contribute substantially to the recommended dietary requirements for minerals. The result of this study also revealed that sensory attributes of colour/appearance, aroma, taste, mouthfeel and overall acceptability were significantly ($P < 0.05$) higher in samples collected from location E (Kanshio Area) when compared to others.

3.2 Recommendation

Further research analysis should be carried out on the microbial quality of "ahuma" porridges sold by different vendors to ascertain compliance with high hygienic standards during its preparation

4. References

1. AOAC. Official Methods of Analysis of AOAC International. 19th edition. AOAC International, Gaithersburg, Maryland, USA, 2012.
2. Abebe H, Tesema B, Tilku D. Proximate composition, anti-nutritional factors and minerals content of composite flours and bread from blends of wheat-Anchote-Soybean flour. *Journal of advances in Nutrition and Food Science*, ISSN: 2572-5971, 2018.
3. Abioye VF, Ade-Omowaye BIO, Babarinde GO, Adesigbin MK. Chemical, physicochemical and sensory properties of soy-bean flour. *African journal of Food Science*. 2011; 5(4):176-180.
4. Adebowale YA, Henle T, Schwarzenbolz U. Acetylated and Succinylated derivatives of African yam bean (*Sphenostylis stenocarpa* Hochst. Ex A. Rich. Harms) Protein isolates. *J Mobile communicat*. 2009; 3(2):34-36.
5. Adewale BD, Dumet DJ, Vroh-Bi I, Kehinde OB, Ojo DK, Adegbite AE, *et al*. Morphological diversity analysis of African yam bean and prospect for utilization in germplasm conservation and breeding. *Genetic resources and crop evolution*. 2012; 59(5):927-936
6. Anon. Tropical legumes: Resources for the future. NAS, Washington, DC, USA, 1979, 332 pp.
7. Ezeama CF. *Food Microbiology: Fundamentals and applications*. Natural Prints Ltd. Lagos 64, 2007.
8. FAO. *Roots, Tubers, Plantains and Banana in Human Nutrition*. Food and Agricultural Organization of the United Nations. Food and Nutrition Series No. 22, Rome, 1990.
9. Habtamu FG, Nugussie R. Antinutritional Factors in Plant Foods: Potential Health Benefits and Adverse Effects. *International Journal of Nutrition and Food Sciences*. 2014; 3(4):284-289.
10. Habtamu FD. Nutritional composition, antinutritional factors and effect of boiling on nutritional composition of Anchote (*Coccina abyssina*) tubers *JSIR*. 2014; 3:177-188.
11. Haros M, Rosell CM, Benedito C. Use of fungal phytase to improve bread making performance of whole wheat bread. *Journal of Agricultural and Food Chemistry*, 49, 5450-5454.
12. Ihekoronye A. *Manual on small scale food processing 1st Ed*. Academic publishers Nsukka, 1985, p.32.
13. Ipinonoroti AA, Hall KO, Adeyeye EI. In vitro multi-enzyme digestibility of protein of six varieties of African yam bean. *J. Sci. Food and Agric*. 1995; 8:69-72.
14. Isaac BO, Sunday AM, Ezekiel OO. Quality assessment of flour and bread from sweet potato wheat composite blends. *International Journal of Biological and Chemical Sciences*, 2012.
15. Joel N, Abdulaheem LO, UM Zakari. Evaluation of the nutritional and sensory quality of functional breads produced from whole wheat and soybean flour blends. *African Journal of Food Science*. 2014; 5(8):466-472.
16. Kumari-Vasanth P, Sangeetha N. Nutritional significance of cereals and legumes based food mix- A review. *Int. J Agr. Life. Sci*. 2017; 3(1):115-122.
17. Mashayekh M, Mahmoodi MR, Enterazzi MH. Effect of fortification of defatted soy flour on sensory and rheological properties of wheat bread. *International Journal of Food Science and Technology*. 2008; 43:1693-1698.
18. Mesfin W, Shimelis A. Effect of soybean-cassava flour blend on the proximate composition of Ethiopian traditional bread prepared from quality protein maize. *African Journal of Food, Agriculture, Nutrition and Development*. 2013; 3:7985-8003.
19. Michael OM, Dick IG, Bibiana DI Physico-chemical and sensory evaluation of wheat bread supplemented with stabilized undefatted rice bran. *Journal of Food and Nutrition Science*, 2013.
20. Obatolu VA, Fasoyiro SB, Ogunsunmi IO. Processing and functional properties of African yam bean (*Sphenostylis stenocarpa*). *Journal of Food Processing and Preservation*. 2007; 31:240-249.
21. Owuamanam NJN, Omeire GCI, Eke CC. Quality parameters of bread produced from substitution of wheat flour with cassava flour using soybean as an Improver. *American Journal of Research Communication*. 2014; 2:99-118.
22. Potter D. Economic botany of *Sphenostylis* (Leguminosae). *Economic Botany*. 1992; 46:262-275.
23. SON. Standard on whole wheat bread. Standards Organization of Nigeria, ICS67.060, NIS 470, 2004.
24. Sanni OL, Adebowale AA, Filani TA, Oyewole OB, Westby A. Quality of flash and rotary dryer dried fufu flour. *J. Food Agric. Environ*. 2008; 4:74-78.
25. Slavin JL, Martini MC, Jacobs DR, Marquart L. Plausible mechanisms for the protectiveness of whole grains. *The American journal of clinical nutrition*. 1999; 70(3):459-463.
26. Uguru MI, Madukaife SO. Studies on the variability in agronomic and nutritive characteristics of African yam bean (*Sphenostylis stenocarpa* Hochst ex. A. Rich.

- Harms). *Plant Production and Research Journal*. 2001; 6:10-19.
27. WHO/FOA/UNU. *Codex Alimentarius: Foods for special dietary uses (including foods for infants and children)*. Food and Agricultural Organization of the United Nations, World Health Organization, Rome, 1994.