LAUTECH Journal of Engineering and Technology 8(2)2014: 57 - 64

SOME PROXIMATE, PHYSICAL, MICROBIOLOGICAL AND SENSORY PROPERTIES OF BREAD PRODUCED FROM MIXES OF WHEAT, ACHA AND BAMBARA NUT FLOUR

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ABSTRACT

The proximate composition, physical, microbiological properties as well as sensory attributes of bread produced from wheat, acha and bambara nut flour mixes were investigated. Bread loaves indicated increase in protein, fat, ash and fibre as the proportions of acha and bambara nut increases while moisture and carbohydrate contents decreased significantly at $p<0.05$. Physical attributes show increasing trends in the loaf mass and loaf density whereas decreasing trends in the specific volume, loaf volume and crumb hydration with increases in the proportions of acha and bambara nut was observed. Although the total viable, yeast and mould counts increased but no coliforms were detected, an indication that the bread loaves were free from pathogenic microorganisms. The sensory attributes revealed that the control sample had the highest rating while samples with 10- 20 % level of substitution of acha and bambara nut were also acceptable.

Keywords: Bambara nut flour, Wheat flour, Microbiological, Physical and Sensory attributes

INTRODUCTION

The consumption of cereal foods such as biscuits and bread has become very popular in Nigeria; especially among children. Most of the cereals are poor sources of protein and consequently is often of poor nutritional quality (Alobo, 2001). Enrichment of cereal- based foods with other protein sources such as oil seeds and legumes has received considerable attention. This is because oil seed and legumes are high in lysine, an essential limiting amino acid in most cereals (Dhingra and Jood, 2005; Ayo and Olawale, 2003; Elkahifa and El-tinay, 2002). The use of any food raw material in processing depends on its availability.

The main problem facing the bakery industry in Nigeria is the total dependence on importation of wheat. Nigeria has unfavorable climatic condition for wheat cultivation, but suitable for other cereals (sorghum, maize, millet, "acha"); legumes (soybean, groundnut, bambara nut,cowpeas) and vegetables (Giami, 2004). Therefore, any effort made to substitute part of the wheat flour by other kinds of available flours e.g sorghum, millet; "acha" will conserve foreign exchange. Bread, is undoubtedly the major food usually produced from flour in Nigeria.

Bread, is undoubtedly the major food usually produced from flour in Nigeria. It is a product of high nutritional value and is consumed in most parts of the world providing energy, iron, calcium, vitamins and proteins (Mandala *et al.*, 2007). It is a perishable product and its production involves the cooking or baking of dough obtained by mixing wheat flour, edible salt (table salt) and portable water (drinking water), fermented by species of budding yeast used in baking such as *Saccharomyces cerevisiae,* and with or without the inclusion of any special component (Ndife *et al*., 2002).The ever-growing popularity of bread may be connected with its convenience, high acceptability, high energy content and low level of blood cholesterol associated with its consumption (Igbabul *et al*., 2014).

It is a common practice in the world- over to produce bread from a pure source of flour, and in particular wheat flour. However, carefully selected composite flour can still produce high quality bread. Composite flours are mixture of flours from tubers rich in starch (e.g. cassava, yam, sweet potato) and/or protein-rich flours (e.g. soy, peanut) and/or cereals (e.g. maize, rice, millet, buckwheat), with or without wheat flour. Bread has become the second most widely consumed non indigenous food product after rice in Nigeria. Till date, most Nigerians have not been introduced to other types of bread apart from 100% wheat flour. To cut the nation's expenses on wheat importation and find wider utilization for the increasing production of cassava root, the Federal Government mandated the use of composite cassava-wheat flour for baking by adding a minimum of 10% cassava flour to wheat for a start (Shittu *et al*., 2006). The inclusion of composite flour into wheat up to 30% could still give an acceptable fresh loaf depending on the source of flour (Taha, 2000). Therefore, this research considered the proximate, physical, microbiological and sensory properties of bread produced from composite flour comprising wheat, acha and bambara nut.

METHODS AND MATERIALS

Materials

The acha grain *(Digitaria exilis)* was purchased at Jos main market in plateau state, Nigeria. Bambara nut, (*Voandezeia subterranean L.*Thouars) , wheat flour and other ingredients such as sugar, fat and yeast were purchased from Sabo market in Ogbomoso, Nigeria.

Preparation of acha flour

Acha grains *(Digitaria exilis)* were cleaned, destoned (water sedimentation) using local calabash according to the procedure of Ayo and Nkama (2003). De- stoned grains were dried, milled, sieved, vacuum packed and kept at 40^{o}C as shown in Fig. 1

Acha
↓
Cleaning
↓
Destoning
↓
Drying
↓
Milling
↓
Packaging
↓
Acha flour

Figure 1: Flowchart for the production of acha flour

Source: (Ayo and Nkama, 2003)

Bambara nut flour

The bambara nut was cleaned, sorted to remove extraneous materials and damaged seeds using the procedure of Ayo and Olawale (2003) as shown in Fig. 2. Then bambara nut were then soaked in tap water at a ratio of 1:2 for 12 h at room temperature. It was then manually dehulled and dried at 60^{o}C for 3 h. It was milled, sieved, packed in a polythene bag and stored in a cool dry environment.

Bambara nut
↓
Sorting
↓
Steeping in water
↓
Dehulling
↓
Drying at 60^{0}C for 3h
↓
Milling
↓
Bambara nut flour

Figure 2: Flowchart for the production of bambara nut flour

Source: Ayo and Olawale, 2003

Production of Acha Bread

The composite flour was mixed with principal bread ingredients which are fat, sugar, yeast, salt and water using the procedure of Nwosu *et al.* (2014). It was later kneaded, cut into sizes(100g), moulded, panned, proofed(at 30-32^{0}C for 40 min), baked (230^{0}C) for 15 min, cooled, packed in polythene and stored at room temperature as shown in Fig.3.

Analysis of Bread Samples

Proximate compositions of the bread produced from composite flour were determined using standard procedures of AOAC (2005). The physical attributes such as loaf volume, loaf mass, density, crumb hydration and specific volume were determined using Otunola *et al.* *(*2006). Microbiological properties (total viable,mould and yeast counts) were determined using the method of Adegoke(2004) and sensory evaluation was determined by using nine point hedonic scale. The scale ranged from 9 = like extremely to 1 = dislike extremely and applied by trained panelists for: taste, aroma, appearance, texture, crumb colour, crust colour and overall acceptability.

Flour
↓
Mixing
↓
Kneading
↓
Cutting
↓
Moulding
↓

Panning
↓
Proofing (40min)
↓
Baking (230^{0}C for 15 mins)
↓
Depanning
↓
Cooling
↓
Packaging
↓
Bread

Figure 3: Flowchart for the production of bread from composite flour
Source: (Nwosu *et al.,* 2014).

RESULTS AND DISCUSSION

Proximate compositions of the bread produced from mixes of wheat, acha and bambara nut flour

The proximate compositions of the bread produced from the mixes of wheat, acha and bambara nut flour are shown in Table1. The moisture content of the composite bread decreased as 14.62 – 12.35% as the level of the substitution with bambara nut and acha flour increased. The moisture content of the bread produced from the composite flour is lower than that of the control (sample A) that had the value of 14.62%. This trend is similar to the findings of Mongi *et al.* (2011) and Mepba *et al.* (2011) on the production of bread from cocoyam-wheat flour mixes, who found out that moisture content of the composite bread decreased with increasing level of substitution of non-wheat flour. High moisture content has been associated with short shelf life of baked products, as they encourage microbial proliferation that lead to spoilage (Elleuch *et al*., 2011).

The crude protein increased as 10.00-11.33% as the level of substitution of acha and bambara nut flour increased. Sample F had the highest value of protein whereas sample A (100%wheat) had the least value of 10.00%. This result is in agreement with the findings of Agu *et al.* (2014) and Ayo (2001) on the production of biscuit from acha based fura. The result is however contrary to the findings of Nwosu *et al.* (2014) on the substitution of wheat flour with cassava flour using soybean as an improver because of the reported decrease in the protein content. This might be due to the increase in the level of substitution with cassava flour which is low in protein content. No significant differences were observed in samples B and C, and samples D, E and F at $p<0.05$.

Ash content of the bread loaves increased as 0.74-1.27% as the level of substiution with acha and bambara nut flour increases. The ash content values of the composite bread loaves are higher than that of the control sample A which has 0.74%. This trend is in accordance with the finding of Olaoye *et al.* (2006) on the use of wheat-plantain and soya beans for bread production. Ash is a non-organic compound containing mineral content of food and nutritionally aids in the metabolism of the other compounds (Igbabul *et al*., 2014). The fat content of the bread ranged as 2.45-3.59% with the control sample having the lowest value. This finding is in line with the reports of Ayo *et al.* (2014) and Olaoye *et al*. (2006) on the production of bread from composite flour. Fat is an essential component of tissues and a veritable source for fat soluble vitamins (A, D, E and K). It is able to supply thrice the amount of energy required by the body (Wardlaw, 2004).

The fibre content of produced bread increased as 0.03-0.18% with increases in the substitution level of acha and bambaranut flour. The results of the bread produced from the composite flour showed higher value compared to the control sample (100% wheat) which had the value of 0.03%. This finding is in line with what Mongi *et al.* (2011) and Olaoye *et al.* (2006) reported on the production of bread and biscuit using composite flour. The result is not in agreement with the report of Nwosu *et al.* (2014) on the substitution of wheat flour with cassava flour using soybean as an improver. Significance differences were observed in all the samples at $p<0.05$. According to Schneeman (2002), the crude fibre contributes to the health of the gastrointestinal system and metabolic system in man. By increasing intestinal mobility, fibre causes increase in the transit time for bile salt derivatives as deoxycholate, which are effective chemical carcinogen, hence reducing incidence of carcinoma of the colon (Mongi *et al.,* 2014). Carbohydrate content of the bread decreased as 71.93-71.28% with increases in the substitution level of acha and bambara nut flour. The results of the composite bread are lower than sample A (100%wheat) which had the value of 71.93%. This is in accordance with the findings of Nwosu *et al.* (2014) and Ayo *et al.* (2014) on the production of bread using cassava-wheat and acha-bambara composite flour but differs from the report of Mongi *et al*. (2011) that showed increasing trend in carbohydrate content of bread produced using cocoyam. No significant difference was observed in samples E and F whereas significant differences were observed in samples A, B and E at $p<0.05$. Carbohydrate is a macronutrient that is needed in largest amount. The relative high carbohydrate that is still contained in the product could be adequate for normal supply of daily calorie for an adult.

Physical characteristics of the composite flour bread

The results of the physical characteristics of bread loaves produced using different levels of substitution with acha and bambara nut are given in Table 2. The loaf volume of the bread decreased from 3.20 to 1.84 cm^3 as the level of substitution of bambara and acha flour increased. Sample F had the least loaf volume whereas sample A (100%wheat) had the highest value of 3.40cm^3. This trend is in line with the reports of Mongi *et al.* (2011) and Nwosu *et al.* (2014) on the production of bread using cocoyam-wheat flour and wheat - cassava flour respectively. The result is contrary to what Shittu *et al.* (2006) previously observed wherein increases in loaf volume of bread produced from wheat-cassava composite flour. No significance differences were observed in all the samples at $p<0.05$. Loaf volume is affected by the quantity and quality of protein in flour (Ragaee and Abdel-Aal, 2006). Also, loaf density of bread increased as 0.94-1.53g/cm^3 with increases in the substitution level of acha and bambara flour. The values of the bread produced from composite flour are higher than the control sample A (100%wheat) which has 0.84g/cm^3. This trend is in line with the report of Nwosu *et al*. (2014) on the production of bread using cassava- wheat flour mixes. No significant difference was observed in samples A and B. Significant differences occurred in samples C, D, E and F at $p<0.05$.

The loaf mass of the produced bread loaves increased as 281.90 -325.30 g with increases in the substitution level of acha and bambara nut flour. This trend corroborates the reports of Mongi *et al.* (2011) and Ayo *et al.* (2014) on the production of bread and biscuit using composite flour. The result is not in line with the report of Nwosu *et al.* (2014) on the production of bread using wheat- cassava flour mixes that showed decreases in loaf mass with increased in the cassava flour substitution. The increased in loaf mass is due to the addition of bambara and acha flour. No significant difference was observed in samples A and B whereas significant difference occurred in samples C, D, E and F at $p<0.05$.The observed increase in mass of composite bread samples may be as a result of less retention of carbondioxide gas in the blended dough and consequently producing denser bread texture (Rao and Hemamalini, 2009).

Specific volume of produced bread decreased as 1.07-0.62cm^3/g with increases in the substitution levels of acha and bambara nut flour. Sample A (100%wheat) has the highest value of 1.89cm^3/g while sample F has the least value of 0.62 cm^3/g. This result is in line with the findings of Makinde and Akinoso (2014) during the production of bread from wheat and black sesame. The finding is contrary to the report of Ayo *et al.* (2014) that showed increase in specific volume of bread during the production of bread and cookies from soya beans and acha composite flour. Significant differences were observed in all the samples at $p<0.05$. The decrease in the specific volume of the bread produced could be due to the dilution effects on gluten with the addition of acha and bambara to the wheat flour (Makinde andAkinoso, 2014).

The crumb hydration of the bread loaves decreased with increases in substitution level of acha and bambara nut flour as 44.00-13.00 ml. The values of the bread loaves produced from the composite flour are lower than the control sample A (100%wheat) that had the value of 44.00 ml. This result is in line with what Makinde and Akinoso (2014) reported on the production of bread using substituted wheat-sesame flour mixes. No significant difference was observed between samples D and E. Significant differences occurred in samples A, B, C and F at $p<0.05$.

Microbiological analysis on the produced bread from wheat, acha and bambara flour.

The results of microbiological analysis of the produced bread loaves from composite flour are as presented in Table 3. Total viable count increased as 5.79 $x10^5$ - 4.47$x10^7$cfu/ml with the increases in the substitution levels of acha and bambara flour. Sample F had the highest total viable count whereas sample A (100%wheat) had the least of 5.79$x10^5$ cfu/ml. This implies that total viable count increased with increase in substitution of composite flour. The result is in line with the report of Udema *et al.* (2014) on microbial and nutritional quality of bread produced from composite flour. No significant differences were observed between samples A and B, and samples E and F whereas significant difference was observed between samples C and D at $p<0.05$.

Also, the yeast count increased with the increases in the substitution levels of acha and bambara nut flour as 3.00 $x10^5$-4.45$x10^7$ cfu/ml. This findings agree with the report of Helen *et al.*(2014) on the production of bread and biscuit from wheat and potato blends. The mould count of the produced bread loaves from the composite flour increases with increment in the substitution levels of composite flour and ranged from 3.00$x10^5$ to 4.45$x10^7$cfu/ml which is in line with the findings of Helen *et al.* (2014) on the production of bread with wheat and potato blends. No significant differences were observed between samples A and

B, and samples E and F whereas significant difference occurred between samples C and D at p<0.05. Also, coliforms were not detected in any of the samples at p<0.05 The result showed that the samples are within the limit set by the Standard Organization of Nigeria, which stated that the aerobic bacteria count must not exceed 100 cfu/g and coliform growth must not be detected in bread samples for safe consumption (Udeme *et al.,* 2014).

Sensory attributes of the bread loaves produced from wheat, acha and bambara nut mixes

Selected sensory attributes evaluated on the produced bread loaves include taste, aroma, appearance, crust colour, crumb colour and overall acceptability, and is as presented in Table 4. The taste of the bread loaves decreased as 6.66 -2.10 with increases in the level of substitution with acha and bambara flour. This result is in line with the report of Udofia *et al.* (2013) on sensory evaluation of wheat-cassava-soya bean composite bread. The decrease in taste could be due to inherent compounds in bambara (Ayo *et al*., 2014).

The aroma of the bread decreased with increases in the substitution level of acha and bambara flour as 6.40 -2.23. The values obtained for the bread loaves produced from composite flour are lower than the control sample. This trend agrees with the findings by Akubor (2007) and Obiegbuna *et al.* (2013) during the production of bread with African breadfruit kernel. Also, the appearance of the bread decreased with the increases in the substitution level of acha and bambara flour as 6.40-2.20. Sample A (100%wheat) has the highest appearance with the value of 6.40 while sample F had the least value of 2.20. This is also in accordance with the report of Makinde and Akinoso *et al.* (2014) during the production of bread with wheat-sesame composite flour but contrary to what Ayo *et al.* (2014) obtained with bread from acha substituted with bambara flour. The decrease could be due to the increases in the levels of added bambara groundnut flour (Baryeh *et al;* 2001).

Texture of the bread decreased as 6.50-2.33 with increases in the substitution level of composite flour. The control sample had the highest value of 6.50 whereas sample F has a least value of 2.33. Udofia *et al.* (2013) had reported similar observation on sensory evaluation of bread produced from composite flour. Texture sometime embraces appearance (Eduordo *et al*., 2013). The observation indicated that high substitution of non-wheat flour showed low scores on texture. High substitution reduces elastic property of wheat flour dough rendering the dough incapable of retaining the gas emanating through fermentation (Giami *et al*., 2004). The crumb colour decreased with increases in the substitution level of acha and bambara flour from 6.47 to 2.37. Obiegbuna *et al.* (2013) had also previously obtained the same trend with African breadfruit kernel flour. No significant differences were observed between samples B and C, and in samples D and E. Significant differences occurred between samples A and F at p<0.05.

Colour is a very important parameter in judging properly baked bread that reflect the suitability of raw material used for the preparation and also provides information about the formation and quality of the product (Makinde and Akinoso, 2014). Crust colour of the produced bread loaves decreased with increases in the substitution level of acha and bambara flour from 6.43 to 2.37. It is evident from the results that the control sample has the highest score of 6.43 whereas sample F has the least rating as Makinde and Akinoso (2014) observed for bread produced using black sesame-wheat flour mixes.

Overall acceptability of the bread loaves decreased with increases in the substitution level of acha and bambara flour as 6.73 -1.97. Bread prepared from 100% wheat flour had maximum score of 6.73 whereas sample F has the lowest rating. This trend is in line with the report of Makinde and Akinoso (2014) for bread produced from supplemented chickpea and black sesame. No significant differences were observed between samples B and C. Significant differences occurred for samples A, D, E and F at p<0.05. In general, the baking properties of composite flour are often impaired as well as the organoleptic attributes of the products, because of the dilution of the gluten content (Jideani and Podgorski, 2009). Bread loaves produced between 10 to 20% level of substitution with acha and bambara nut flour were acceptable and had the highest rating in terms of aroma, taste, appearance, texture, crumb and crust colour.

Conclusion

From the study, it can be concluded that acceptable bread could be produced from the mixtures of wheat, acha and bambara nut flours. Increases in the substitution level increased the nutrient quality of the bread than the whole wheat bread. Also, the bread is free from pathogenic organisms and thereby safe for consumption. The sensory attributes which decreased with increases in the substitution level could be harnessed through the use of appropriate additives. The study has potential to encourage immense production of acha and bambara nut, and thus boost the economic potentials of the farmers.

Table 1: Proximate Composition of Produced Bread

Sample	Moisture Content (%)	Protein (%)	Ash (%)	Fat (%)	Fibre(%)	Carbohydrate (%)
A	14.62±0.27a	10.00±0.02a	0.74±0.10a	2.68±0.02e	0.03±0.00f	71.93±0.11c
B	14.37±0.41b	10.10±0.03b	0.93±0.02b	2.74±0.13b	0.05±0.00a	71.89±0.09d
C	14.03±0.05c	10.17±0.01b	0.94±0.01b	2.88±0.10c	0.09±0.00b	71.81±0.18bc
D	13.82±0.04c	10.28±0.00c	1.00±0.02b	3.09±0.00d	0.11±0.01c	71.70±0.16b
E	12.96±0.04d	10.99±0.14c	1.21±0.01c	3.14±0.03d	0.12±0.01d	71.58±0.62a
F	12.35±0.02e	11.33±0.02e	1.27±0.00c	3.59±0.02e	0.18±0.01e	71.28±0.18a

Mean values are obtained from the determination of three replicates.
Values with the same subscripts in the same column are not significantly different ($p<0.05$)

Table 2: Physical Attributes of Bread

Samples	Loaf mass (g)	Loaf density (g/cm^3)	Specific volume (cm^3/g)	Loaf volume (cm^3)	Crumb hydration (ml)
A	281.9e	0.84±0.00e	1.89±0.00a	3.40±1.41a	44.00±1.41a
B	285.8e	0.94±0.00e	1.07±0.00b	3.20±1.41a	41.00±0.00b
C	291.5d	1.13±0.00d	0.89±0.00c	2.40±1.41b	30.59±0.71c
D	302.5c	1.30±0.00c	0.77±0.00d	2.29±0.71b	19.99±0.71d
E	312.3b	1.41±0.00b	0.71±0.00e	1.89±1.41c	16.00±1.41d
F	325.3a	1.53±0.00a	0.62±0.00f	1.84±141c	13.00±1.41e

Mean values are obtained from the determination of three replicates. Values with the same letters in the same column are not significantly different ($p<0.05$)

Table 3: Microbiological analysis on the produced bread

Sample	TVC(cfu/ml)	Mould(cfu/ml)	Yeast (cfu/ml)	E. Coli(cfu/ml)
A	$5.79x10^5$±1.41a	$3.00x10^5$±0.00a	$1.00x10^5$±0.00a	Nil
B	$6.00x10^5$±1.14a	$5.93x10^5$±1.06a	$9.01x10^5$±1.41a	Nil
C	$5.81x10^6$±4.60b	$1.10x10^6$±1.17b	$1.93x10^6$±2.62b	Nil
D	$4.00x10^7$±5.66c	$4.04x10^7$±5.99b	$2.19x10^7$±2.84b	Nil
E	$4.45x10^7$±6.30d	$4.40x10^7$±6.36c	$4.45x10^7$±9.62b	Nil
F	$4.47x10^7$±4.95d	$4.45x10^7$±4.95c	$4.65x10^7$±7.81b	Nil

Mean values are obtained from the determination of three replicates.
Values with same superscript in the same column are not significantly different ($p<0.05$)

Table 4: Sensory evaluation of Bread

Sample	Taste	Aroma	Appearance	Texture	Crumb colour	Crust colour	Overall acceptability
A	6.66±0.55e	6.40±0.62e	6.40±0.62e	6.50±0.63d	6.47±0.51d	6.43±0.63d	6.73±0.45e
B	5.80±0.98d	5.10±0.96d	5.13±1.01d	5.13±0.90c	5.10±1.03c	5.02±0.10c	5.60±0.89d
C	5.53±0.78d	5.06±0.74d	5.00±0.74d	4.77±0.73c	4.83±0.66c	4.87±0.73c	5.17±0.75d
D	4.00±1.04c	4.10±1.03c	3.73±1.08c	3.63±0.93b	3.50±0.97b	3.43±0.97b	3.50±0.94c
E	3.40±1.03b	2.97±1.13b	3.17±1.12b	3.33±1.06b	3.27±1.17b	3.07±1.28b	2.90±1.44b
F	2.10±1.06a	2.23±0.77a	2.20±0.76a	2.33±0.76a	2.37±0.76a	2.37±0.76a	1.97±0.85a

Mean values are obtained from the determination of three replicates.
Values with the same letters in the same column are not significantly different ($p<0.05$)

Key:
A = 100 % wheat four bread.
B = 80%wheat, 10%Acha, 10%Bambaranut bread
C = 60%wheat, 20%Acha, 20% Bambaranut bread
D = 50%wheat, 30%Acha, 20% Bambara bread
E = 50%wheat, 20%Acha, 30%Bambara bread
F = 40%wheat, 30%Acha, 30%Bambara bread

REFERENCES

Adegoke, G. O. (2004). Understanding Food Microbiology 2nd Edn., Alleluia Venture Ltd., Ibadan, Nigeria.

Agu, H. O., Ezeh, G. C. and Jideani, A. I. O. (2014). Quality Assessment of Acha based Biscuit Improved with Bambara nut and Unripe Plantain. Africa Journal of Food Science. 8(5): 278-285.

Akubor, P.I. (2007). Chemical Functional and Cookies Baking Properties of Soybean/ Maize Flour Blends. Journal of Food Science Technology. 44 (6): 619 - 622.

Alobo, A.P (2001). Effect of Sesame Seed on Millet Biscuit. Plant Food Human Nutrition. (2): 195-202

AOAC (2005).Official Method of Analysis of the Association of Official Analytical Chemists.18th Edition, Association of Official Analytical Chemists, Washington, DC., USA.

Ayo, J.A. (2001). The Effect of Amaranth Grain Flour on the Quality of Bread. International Journal of Food properties. 4(2): 341-352

Ayo, J.A and Nkama, I. (2003) Effect of "Acha" (*D. exilis*) Flour on the Physicochemical and Sensory Quality of Biscuit. Journal of Nutrition and Food Science 33(3): 125 –130.

Ayo, J.A and Olawale, O.(2003). Effects of Defatted Groundnut Concentrate on the Physicochemical and Sensory Quality of Fura. Journal of Nutrition and Food Science 33:173-176.

Ayo, J.A., Ayo, V. A., Popoola, C., Omosebi, M. and Joseph, M. (2014). Production and Evaluation of Malted Soybean- Acha Composite Flour Bread and Biscuits. African Journal of Food Science Technology. 5(1): 21-28.

Baryeh, E.A. (2001). Physical Properties of Bambara Groundnuts. Journal of Food Engineering. 47(4): 321-326.

Dhingra S. and Jood S. (2005). Organoleptic and Nutritional Evaluation of Wheat Bread Supplemented with Soybean and Barley Flour. Food Chemistry. 77:479-488.

Eduardo, M., Svanberg, U., Oliveira, J. and Ahrne, L. (2013). Effect of Cassava Flour Characteristics on Properties of Cassava-Wheat-Maize Composite Bread Types. International Journal of Food Science. 1-10.

Elkhalifa, A.E. and El-Tinay, A.H. (2002). Effect of Cysteine on Bakery Products from Wheat-Sorghum Blends. Food Chemistry. 77: 133-137.

Elleuch M., Bedigian, D., Roiseux ,O., Besbes, S., Blecker, C. and Attia, H. (2011). Dietary Fibre and Fibre-Rich By-Products of Food Processing: Characterisation, Technological Functionality and Commercial Applications. Food Chemistry. 124: 411-421.

Giami S.Y., Amasisi T. and Ekiyor G. (2004).Comparison of Bread Making Properties of Composite Flour from Kernels of Roasted and Boiled African breadfruit (*Treculia africana*) Seed. Journal of Raw Material Research. 1: 16-25

Helen, O.A. and Ndidiama, A. O. (2014). Physicochemical, Sensory and Microbiological Assessments of Wheat Based Biscuit Improved with Beni Seed and Unripe Plantain. Food Science Nutrition. 2(5): 464-469.

Igbabul, B., Num, G. and Amove, J.(2014).Quality Evaluation of Composite Bread Produced from Wheat, Maize and Orange Fleshed Sweet Potato Flour. American Journal of Food Science and Technology. 2(4): 109-115.

Jideani, V.A and Podgorski, S.C. (2009). Invitro Starch Digestibility and Glycemic Property of Acha iburu and Maize Porridge. Cereal Foods World (Supplement) 54: A48.

Makinde, F.M. and Akinoso, R. (2014).Physical, Nutritional and Sensory Qualities of Bread Sample Made with Wheat and Black Sesame (Sesame indicum Linn) Flour. International Food Research Journal. 21(4): 1635-1640.

Mandala, I., Karabela, D., and Kostaropoulos, A.(2007). Physical Properties of Breads Containing Hydrocolloids Stored at Low Temperature. Food Hydrocolloids. 21: 1397–1406.

Mepba, H.D., Eboh, L. and Nwaojigwa, S.U. (2007).Chemical Composition, Functional and Baking Properties of Wheat-Plantain Composite Flours. African Journal of Food Agriculture, Nutrition and Development 7(1): 1-22.

Mongi, R.J., Ndabikunze, B.K., Chove, B.E., Mamiro, P., Ruhembe, C.C. and Ntwenya,J.G. (2011). Proximate Composition, Bread Characteristics and Sensory Evaluation of Cocoyam-Wheat Breads. 11(7): 5586- 5599

Ndife, J., AbdulRaheem, L.O. and Zakari, U. M.(2011). Evaluation of the Nutritional and Sensory Quality of Functional BreadsProduced from Whole Wheat and Soyabeans Flour Blends. African Journal of Food Science. 5(8): 466-472.

Nwosu, U.L., Elochukwu, C.U. and Onwurah, C.O. (2014). Physical Characteristics and Sensory Quality of Bread Produced from Wheat/ African Oil Bean Flour Blends. African Journal of Food Science. 8(6): 351-355.

Obiegbuna J, Akubor P, Ishiwu N and Ndife J. (2013).Effect of substituting sugar with date palm pulp meal on the physicochemical, organoleptic and storage properties of bread. *African Journal of Food Science,* 7(6): 113-11.

Olaoye.O.A., Onilude, A.A. and Idowu, O.A. (2006). Quality Characteristics of Bread Produced from Composite Flour of Wheat, Plantain and Soyabeans. African Journal of Biotechnology, 5 (11): 1102-1106.

Otunola, E.T., Olanipekun, B.F., Oyelade, O.J., Oke, M.O. and Akinbade, O.O. (2006). Nutritional, Microbiological, Sensory and Some Physical Attributes of Bread from Wheat Fermented Soybean Mixes. International Journal of Food and Agriculture Research, 3(1): 104-113.

Ragaee, S., Abdel-Aal, E.M. (2006). Pasting Properties of Starch and Protein in Selected Cereals and Quality of Their Products. Food Chemistry. 95:9-18.

Rao,H.P. and Henamalini, R. (1999). Effect of Incorporating Wheat Bran on Rheological Characteristics and Bread Making Quality of

Flour. Journal of Science and Technology. 28:92-97.

Schneeman B.O. (2002).Gastrointestinal physiology and functions. British Journal of Nutrition. 88(2):159-163.

Shittu, T.A., Raji A.O. and Sanni, L.O. (2006). Bread from Composite Cassava-Wheat flour: Effect of Baking Time and Temperature on Some Physical Properties of Bread Loaf. Food Research International Journal. 40: 280-290.

Taha, A. O. M.(2000).The Role of Sorghum Flour Starches(Amylose/ Amylopectin) in Composite Bread Quality M.Sc. Thesis, University of Khartoum, Sudan.

Udeme, J. J., Ijah, O., Helen, S. A., Mercy, O. A. and Sesan, A. A.(2014). Microbiological, Nutritional and Sensory Quality of Bread Produced from Wheat and Potato Flour Blends. International Journal of Food Science Volume (2014) 2014, Article ID 671701, 6 Pages.

Udofia, P.G., Udoudo,P.J. and Eyen, N.O.(2013). Sensory Evaluation of Wheat-

Cassava- Soybean Composite Flour Bread by the Mixture Experiment Design. African Journal of Food Science. 7(10): 368-374.

Wardlaw G.M. (2004). Perspectives in Nutrition. (6th Edition). Mc Gram Hill Companies, New York, U.S.