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Evaluation of the quality attributes of wheat composite (wheat-cassava, wheat-plantain and wheat-rice) flours in bread making

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Composite flour was produced with wheat and other crops like rice, plantain and cassava at 20% substitution. The flour mixes were evaluated for proximate, physico-chemical properties and sensory evaluation was carried out on bread samples produced from these mixes. The moisture contents of these flours ranged from 11.00 to 12.30%. Also, ash and crude fibre contents ranged from 1.03 to 1.50% and 0.70 to 1.17%, respectively. The protein content ranged between 9.30 - 10.90% with wheat- cassava flour mixes having the lowest while the sample with 100% wheat had the highest protein content. The fat content ranged from 1.50 to 1.93%. Water absorption capacity and pasting viscosity of the flours ranged from 59.50 to 66.60% and 466 to 893 RVU, respectively. The bulk density of the samples ranged between 0.48 and 0.88 g/ml while pH values ranged from 6.57 to 6.70. The sensory analysis reflected that bread produced from 100% wheat flour was much accepted by the panelists but the ratings were close indicating a probability at 20% substitution.

Key words: Bread, composite flour, proximate composition, physico-chemical properties, sensory evaluation.

INTRODUCTION

Bread is an important staple food in both developed and developing countries and it has become the second most widely consumed non-indigenous food products after rice in Nigeria (Shittu et al., 2007). Wheat (*Triticum aestivum* Desf.) flour has been the major ingredient of bread for many years because of its functional proteins (Abdelghafor et al., 2011). Wheat gluten imparts to dough physical properties that differ from those of dough made from other cereal grains. It is gluten formation, rather than any distinctive nutritive property, that gives wheat its prominence in the bread making. Wheat produces white flour having a unique property of wheat proteins, which can produce dough having the strength and elasticity required to produce low-density bread, biscuit and pastries of desirable texture and flour which makes wheat the most popular cereal grain known in the world (Ihekoronye and Ngoddy, 1985).

However, wheat is not suitable for cultivation in the tropical areas for climatic reasons (Edema et al., 2005). In an effort to help the third world countries reduce or stabilize their importation, the FAO in 1957 started a study on the technological feasibility of the use of

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composite flours for the production of biscuits, bread and pastry products (Aliyu and Sani, 2009). Several developing countries have encouraged the initiation of programs to evaluate the feasibility of alternative locally available flours as a substitute for wheat flour. Many efforts have been carried out to promote the use of composite flours, in which a portion of wheat flour is replaced by locally grown crops, to be used in bread, thereby decreasing the cost associated with imported wheat (Olaoye et al., 2006).

Plantain is a popular dietary staple due to its versatility and good nutritional value. It is starchy, less sweet variety of banana that can be used either ripe or unripe; they are invaluable source of carbohydrate, comparable in nutritive value to yam or potato and are useful as a variant on the usual staple foods (Ukhum and Ukpebor, 1991). The fruit is an excellent source of nutrient; it contains about 32% carbohydrate, 1% protein, 0.02% fat, some vitamins and mineral contents (Kure et al., 1998). It is recommended to produce plantain flour from green fruits since it has high starch content of about 35% on wet basis (Olaoye et al., 2006).

Rice (*Oryza sativa)* is one of the most important cereals of the world. It is produced locally in most part of Nigeria, namely, Abakaliki, Bida, Abeokuta, Mokwa, among others, where it is used mainly for human consumption and it is referred to as *ofada* rice. Estimated annual production of rice in Nigeria is about 3 million tonnes (Adebowale et al., 2010). *Ofada* rice is the mostly cultivated rice in Nigeria especially in the Southwestern agro ecological zone. Oko and Ugwu (2011) reported that the local rice varieties in Nigeria contained carbohydrates ranging from 76.92 to 86.03%.

Some previous studies have been conducted on the use of composite flour for bread making purposes; Olaoye et al. (2006), produced bread from wheat, plantain and soy beans; Anjum et al. (2008) produced bread from wheat-potato composite flour; Shittu et al. (2007) produced bread from cassava-wheat flour; Abdelghafor et al. (2011) produced bread from wheat and sorghum and others are Dhingra and Jood (2004), Hsu et al. (2004), Khalil et al. (2000), McWatter et al. (2004).

The limited production of wheat in the tropics due to climatic factors, as well as the prohibitive cost of importation and ever increasing demand for baked products have necessitated supplements or substitutes. The Federal Government of Nigeria has mandated the use of composite cassava-wheat flour for baking by adding a minimum of 10% cassava flour to wheat for a start.

This study, however evaluated the probability of using a local rice variety, plantain and cassava flour which are crops that are locally produced in Nigeria and have been used and reported as having probable use as composite flour in making of bread (Mepba et al., 2007; Oluwamukomi et al., 2011) above the recommended substitution level and to determine the probable uses at higher substitution rates.

This work aimed to determine the proximate composition; physico-chemical properties of the mixes; and to evaluate the consumer acceptability of bread produced from wheat composite flours (wheat-cassava, wheat-plantain and wheat- rice).

MATERIALS AND METHODS

Processed unfermented cassava flour was obtained from Federal Institute of Industrial Research, Oshodi (FIRRO) in Lagos. A local variety of rice (*ofada*) and bunch of plantains were purchased from a local market in Ogbomoso, Oyo State, Nigeria. Wheat flour, yeast, sugar, fat and salt were obtained from the Quality Control Bakery of Flour Mills of Nigeria Plc., Apapa, Lagos, Nigeria.

Preparation of plantain and rice flours

Unripe plantains were sorted and graded for quality. The plantains were washed, peeled and thinly sliced into about 2 cm thickness using the manual plantain slices. The sliced plantains were immersed in 0.03% of sodium metabisulphite solution for 10 min to obtain white flour dried in the cabinet dryer at 60°C for 24 h. They were drained out of the solution and dried. The dried plantain slices were milled into flour using a hammer mill and sieved through 250 µm aperture sieve. The flour was packed and sealed in polyethylene bags until analysis.

Rice grains were cleaned, conditioned for 5 min and then sun dried. The dried grains were milled using the plate disc mill. The flour obtained was cooled, sieved and packed in polyethylene bags until analysis.

Formulation of composite flours

Composite flours in this study were formulated by blending wheat flour with non-wheat (cassava, plantain and rice) flours in the ratio 80:20 using the Buhler flour blender to obtain homogenous wheat-cassava, wheat-plantain and wheat-rice flours.

Production of bread

Bread was produced with bulk fermentation, according to AACC (1984) which employs a bulk fermentation process. Five hundred gram of each of the composite flour sample was weighed along with the required amount of water and other ingredients; sugar (6 g), fat (5 g), yeast (2.5 g), salt (1.5 g) and water (0.5 L) to obtain dough, which was kneaded on a pastry-board to smoothen it. The dough was initially fermented for 2 h at 30°C before being subsequently knocked back by kneading to expel carbon dioxide and tighten-up the dough to improve the texture of the final product. The secondary fermentation also lasted for 2 h at 30°C. The dough were then sized and molded into the baking pans for final proving at 30°C for 2 h. Dough baking was carried out in the oven at a temperature of 230°C for 25 min. These ingredients of the same quantity were also added to the 100% wheat flour as control.

Proximate analysis

The moisture, ash, crude protein, fat, crude fibre were determined as described by AOAC methods (AOAC, 1990) while the carbohydrate was calculated by difference. Moisture content (%

Table 1. Proximate composition of flours.

Sample code	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Crude fibre (%)	Carbohydrate (%)
A	11.00^{c}	10.90^{a}	1.80^{a}	1.17^{b}	0.70^{c}	75.13^{c}
B	12.00^{b}	9.30^{b}	1.50^{b}	1.03^{c}	0.90^{b}	76.17^{a}
C	12.30^{a}	9.43^{b}	1.93^{a}	1.50^{a}	1.03^{ab}	74.84^{d}
D	12.10^{b}	9.50^{b}	1.63^{b}	1.43^{a}	1.17^{a}	75.34^{b}

Means with the same alphabet in the same column are not significantly different. ($p < 0.05$). A, 100% wheat flour; B, 80% wheat flour and 20% cassava flour; C, 80% wheat flour and 20% plantain flour; and D, 80% wheat flour and 20% rice flour.

MC) was determined by drying samples in an oven at 105°C for 16 h. Crude protein percentage (% CP) was determined by Kjeldahl method and the percentage nitrogen obtained was used to calculate the% CP using the relationship:% CP =% N × 6.25. Fat content (%) was determined using Soxhlet extraction technique and percentage ash (%) was determined by incinerating the samples in a muffle furnace at 600°C for 6 h. The ash was cooled in a desiccator and weighed. Crude fibre percentage (% CF) was determined by dilute acid and alkali hydrolysis and the carbohydrate was determined by difference that is,

% Carbohydrate = 100 - (moisture + ash + fat + protein + fiber)

Determination of physico-chemical properties

Water absorption capacity (WAC) was determined using the method of Mbofung et al. (2006). One gram of the flour was mixed with 10 ml of water in a centrifuge tube and allowed to stand at room temperature (30 ± 2°C) for 1 h. It was then centrifuged at 3000 × *g* for 10 min. The volume of water on the sediment water measured. Water absorption capacities were calculated as ml of water absorbed per gram of flour. The bulk density of the flour samples were determined by the method of Akpapunam and Markakis (1981). A 50 g flour sample was put into a 100 ml measuring cylinder and tapped to a constant volume. The bulk density (g/ml) was calculated as weight of flour (g) divided by flour volume (ml). Pasting characteristics were determined with a Rapid Visco Analyzer (RVA) (ModelRVA 3D+, Newport Scientific Australia) as described by Ikegwu et al. (2009). The pH was determined using a pH meter (cheaker 3 model).

Sensory evaluation

Sensory evaluation of the bread samples were conducted after baking by a 25-member panel, randomly selected from students of Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria. Panelists evaluated the samples for crust colour, crumb colour, flavour, texture, sweetness and general acceptability using a product-oriented test. Nine point hedonic scale ranging from 9 = like extremely to 1 = dislike extremely was used by the panelists.

Data analysis

Statistical analysis of all data was done with the statistical analysis systems (SAS) package (version 9.2 of SAS institute Inc, 2003). The statistical analysis was carried out using analysis of variance (ANOVA); significant differences ($p < 0.05$) in all data were determined by general linear model procedure (GLM) while least significant difference (LSD) was used to separate the means.

RESULTS AND DISCUSSION

Proximate analysis

The data obtained are as shown in Table 1. The moisture content of the flour samples ranged from 11.00 to 12.30% (dry basis). The sample with 20% plantain flour substitution had the highest moisture content and the control which is 100% wheat flour had the lowest. There was no significant ($p<0.05$) difference between the moisture content of the samples substituted with 20% cassava flour and 20% rice flour. The protein contents were found to be between the range of 9.00 and 10.90%. The sample with 100% wheat had the highest protein content and it was significantly ($p<0.05$) different from other samples. This is probably a reflection of gluten content in wheat flour. This value is close to the value obtained by Mepba et al. (2007), 12.86% and Ugwuona (2009) 12.93% for 100% wheat flour. The protein decreased with composite flour substitution probably due to low protein contents of the substituted flour and the decrease was in line with the protein values of these flours. Rice flour had the highest protein content among the composite flour, followed by plantain flour while the least protein value was recorded with cassava flour. The fat content of the samples ranged from 1.50 to 1.93% where sample with plantain flour substitution had the highest and the sample with 20% cassava flour had the lowest fat content. This is also a reflection of the fat components of the composite flours, the order of increase or decrease was based on the fat contents of the composite flours. The mineral contents of the flour mixes ranged between 1.03 to 1.50%. There was no significant ($p<0.05$) difference between the sample with plantain substitution and that of rice flour substitution. This is a reflection of the mineral contents of the flours. The crude fibre ranged between 0.70 and 1.17% and all the samples are significantly ($p<0.05$) different from each other. The sample with 20% rice flour had the highest crude fibre while 100% wheat flour had the lowest. The carbohydrate content ranged from 74.84 to 76.17% and are significantly ($p<0.05$) different from each other. Highest value was recorded with sample that had 20% cassava flour substitution while the sample with 20% plantain flour substitution had the lowest value.

Table 2. Physico-chemical analysis of flour.

Sample	Water absorption capacity (%)	Bulk density (g/cm^3)	Pasting viscosity (RVU)	pH	Baking time (minutes)
A	60.90^c	0.88^a	626^b	6.57^c	24^a
B	66.60^a	0.48^b	518^c	6.70^a	24^a
C	59.50^d	0.57^b	893^a	6.67^b	24^a
D	66.00^b	0.73^{ab}	466^d	6.58^c	24^a

Means with the same alphabet in the same row are not significantly different. (*p*< 0.05).). A, 100% wheat flour; B, 80% wheat flour and 20% cassava flour; C, 80% wheat flour and 20% plantain flour; and D, 80% wheat flour and 20% rice flour.

Table 3. Taste panel score of wheat and composite flours bread.

Sample	Crust colour	Crumb colour	Flavour	Texture	Sweetness	General acceptability
A	3.6_b	8.6_a	8.4_a	8.4_a	7.4_a	6.8_a
B	4.2_b	3.3_b	7.2_b	7.5_b	6.3_b	5.4_b
C	7.2_a	3.0_b	5.1_c	6.0_c	4.7_c	4.5_c
D	3.9_b	3.5_b	7.8_b	5.4_c	6.8_a	6.1_b

Mean values in the same column with different subscripts differ significantly.). A, 100% wheat flour; B, 80% wheat flour and 20% cassava flour; C, 80% wheat flour and 20% plantain flour; and D, 80% wheat flour and 20% rice flour.

Physico-chemical properties of flours

The results of physico-chemical properties are as shown in Table 2. The water absorption capacity of the flour samples ranged from 59.50 to 66.60% and the values are significantly (p<0.05) different. The sample with 20% cassava flour substitution had the highest water absorption capacity, followed by that of rice, 100% wheat while the sample with plantain flour substitution had the lowest. This is also a reflection of the protein and carbohydrate contents of these flours. Water absorption is the amount of water absorbed by the flour to produce dough of workable consistency. It is determined by the protein content of the flour, the amount of starch damaged during milling and the presence of non-starch carbohydrates. It is desirable that flours for bread-making possess a high water absorption capacity at normal working consistencies so that the yield of dough, and hence bread, will be relatively high (Ma et al., 2007).

The values obtained for bulk density of the flours ranged from 0.48 to 0.88 g/cm^3, where the sample with 100% wheat had the highest and the sample with cassava flour substitution recorded the lowest. There were significant (p<0.05) differences among the samples except the sample with 20% cassava flour substitution and 20% plantain substitution. The bulk density is generally affected by the particle size and the density of the flour and it is very important in determining the packaging requirement, material handling and application in wet processing in the food industry (Adebowale et al., 2008) indicating a lesser package requirement with 20% cassava flour substitution.

The pasting viscosity of the flours ranged between 466 and 893 RVU. The pH values ranged from 6.58 to 6.70 and the sample with cassava flour substitution had the highest value.

Sensory evaluation

The crumb colour of 100% wheat and that of 20% cassava flour substitution was not significantly different. The crust colour of the flours substituted and the 100% wheat flour were not significantly different while the flavour, texture, sweetness and general acceptability were significantly (*p*<0.05) different as presented in Table 3.

Conclusion

Though some of the quality attributes of bread were significantly (*p*<0.05) different from 100% wheat flour substitution as expected, the ratings were not really far from each other indicating that some of these attributes could be worked on and thus making substitution at 20% of these composite flours possible.

Conflict of Interests

The author(s) have not declared any conflict of interests.

REFERENCES

AACC (1984). Approved methods of analysis. St. Paul Minnesota: The

American Association of Cereal Chemists. pp. 1298.
Abdelghafor RF, Mustafa AI, Ibrahim AMH, Krishnan PG (2011). Quality of bread from composite flour of sorghum and hard white winter wheat. Adv. J. Food Sc. Technol. 3(1):9-15.
Adebowale AA, Sanni SA, Karim OR, Ojoawo JA (2010). Malting characteristics of Ofada rice: chemical and sensory qualities of malt from ofada rice grains. Int. Food Res. J. 17:83-88.
Adebowale AA, Sanni SA, Oladapo FO (2008). Chemical, functional, and sensory properties of instant yam breadfruit flour. Nig. Food J. 26(1):2-12.
Akpapunam M, Markakis P (1981). Physicochemical and nutritional aspect of cowpea flour. J. Food Sci. 46(3):972-973
Aliyu HN, Sani U (2009). Production of biscuit from composite flour as a substitute for wheat. Biosci. Res. Commun. 21(3):129-132.
Anjum FM, Pasha I, Ahmad S, Khan MI, Zafar I (2008). Effect of emulsifiers on wheat-potato composite flour for the production of leavened flat bread (naan). Nutr. Food Sci. 38(5):482-449.
AOAC (1990). Association of Official Analytical Chemist . Approved Method of the American Association of Cereal Chemist.
Dhingra S, Jood S (2004). Effect of flour blending on the functional, baking and organoleptic characteristics of bread. Int. J. Food Sci. Technol. 39:213-222.
Edema MO, Sanni LO, Sanni AI (2005). Evaluation of maize-soybean flour blends for sour maize bread production in Nigeria. Afr. J. Biotechnol. 4(9):911-918.
Hsu CL, Hurang SL, Chen W, Weng YM, Cheng CY (2004). Qualities and antioxidant properties of bread as affected by incorporation of yam flour in the formulation. Int. J. Food Sci. Technol. 39:231-238.
Ihekoronye AI, Ngoddy PO (1985). Integrated Food Science and Technology for the Tropics. Macmillian Ltd. London. pp. 265-282.
Khalil AH, Mansour EH, Dawood FM (2000). Influence of malt on rheological and baking properties of wheat-cassava composite flours. Lebensmittel Wissenchaf Technol. 33:159-164.
Kure OA, Bahago EJ, Daniel EA (1998). Studies on the proximate composition and effect of flour particle size of acceptability of biscuits produced from blends of soybeans and plantain flours. Namoda Tech. Scope J. 3(2):17-22.
Ma W, Sutherland MW, Kammholz S, Banks P, Brennan P, Bovill WD, Daggard G (2007). Wheat flour protein content and water absorption analysis in a double haploid population. J. Cereal Sci. 45(3):302-308.
Mbofung CMF, Abuobakar YN, Njintang A, Abduo B, Balaam F (2006). Physico-chemical and functional properties of six varietes of taro (*Colocasia esculenta* L. schott) flour. J. Food Technol. 4(2):135-142.
McWatter KH, Philips RD, Walker SL, McCullough SE, Mensah-Wilmot Y, Saalia FK, Hung MYC, Patterson SP (2004). Baking performance and acceptability of raw extruded cowpea flour breads. J. Food Qual. 27:337-351.
Mepba HF, Eboh I, Nwaojigwa SU (2007). Chemical composition, functional and baking properties of wheat-plantain composite flour. Afr. J. Food Nutr. Dev. 7(1):1-22.
Oko AO, Ugwu SI (2011). The proximate and mineral compositions of five major rice varieties in Abakaliki, South-Eastern Nigeria. Int. J. Plant Physiol. Biochem. 3(2):25-27.
Olaoye OA, Onilude AA, Idowu OA (2006). Quality characteristics of bread produced from composite flours of wheat, plantain and soybeans. Afr. J. Biotechnol. 5(11):1102-1106.
Oluwamukomi MO, Oluwalana IB, Akinbowale OF (2011). Physicochemical and sensory properties of wheat cassava composite biscuit enriched with soy flour. Afr. J. Food Sci. 5(2):50-56.
Shittu TA, Raji AO, Sanni LO (2007). Bread from composite cassava-wheat flour: I. Effect of baking time and temperature on some physical properties of bread loaf. Food Res. Int. 40:280-290.
Ugwuona FU (2009). Chemical and sensory evaluation of soy-fortified cassava-wheat biscuit. J. Trop. Agric. Food Environ. Ext. 8(1): 55-59.
Ukhum ME, Ukpebor IE (1991). Production of instant plantain flour, sensory evaluation and physico-chemical changes during storage. Food Chem. 42(3):287-299.