Nigerian Food Journal
Official Journal of Nigerian Institute of Food Science and Techonology www.nifst.org

NIFOJ Vol. 31 No. 1, pages 6 – 12, 2013

Bread Making Potential of Composite Flour of Wheat-Acha *(Digitaria exilis staph)* Enriched with Cowpea *(Vigna unguiculata L. walp)* Flour

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ABSTRACT

Bread-making potentials of composite flours containing 90% wheat and 10% acha enriched with 0-15% cowpea flour were investigated. Proximate composition and functional properties of the blends were studied using AOAC standard methods. Bread loaves were prepared from the blends using the straight dough method and evaluated for loaf height, loaf volume, loaf weight and sensory characteristics. Crude protein, crude fat, crude fibre and ash contents increased significantly ($p < 0.05$) with increase in level of cowpea flour addition, but moisture content was not significantly ($p > 0.05$) different among the blends. Functional properties, with exception of bulk density and swelling capacity, were significantly ($p < 0.05$) different among the blends. Average loaf height and loaf volume decreased significantly ($p < 0.05$) with increased cowpea flour but loaf weight showed opposite trend with significant ($p < 0.05$) differences as cowpea flour increased. However, the addition of cowpea flour significantly ($p < 0.05$) decreased the loaf specific volume but all enriched samples were not significantly ($p > 0.05$) different. Bread samples from composited blends were rated lower than bread from all wheat bread. Bread loaves from enriched composite flour with up to 10% cowpea flour were acceptable to the panelists.

Keywords: Bread, acha, protein, enrichment, acceptability.

Introduction

Bread is a major staple wheat based food product which has gained wide acceptance among consumers in the world especially Nigeria for many years (Badifu *et al.*, 2005; Abulude, 2005). This product is basically made from hard wheat flour, yeast, fat, sugar, salt and water. It is predominantly rich in carbohydrates and it is an appropriate vehicle for food fortification of essential macronutrients such as protein and micronutrients such as vitamins and minerals. Wheat is the choice cereal for manufacture of bread because it contains a large amount of gluten, which makes raised loaves (Badifu and Aka, 2001). Besides, cereal flours generally are limiting in lysine, an essential amino acid. Supplementation of cereal based foods with other protein sources such as legumes has gained considerable attentions in the recent time among researchers (Dhingra and Jood, 2002; Oluwole and Olapade, 2011; Olapade *et al.*, 2011). This is because legume proteins are good sources of lysine. The critical criteria for use of any food material in processing are its availability and cost. The main problem facing the bakery industry in Nigeria is overdependence on importation of wheat to sustain it, since Nigeria's climate does not favour cultivation of wheat. Therefore, any effort geared towards substituting whole or part of wheat flour with readily available cereal flours in bread making will be a welcome idea. Acha *(Digitaria exilis)*, commonly referred to as fonio or fundi is an old and underutilized cereal in Africa (Jideani and Akingbala, 1993; NRC, 1996). The cereal is uniquely rich in methionine and cystine, and evokes low sugar on consumption (Ayo *et al.*, 2007). Acha

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is noted for its high pentosans content, which gives it the property of absorbing water to produce very viscous solution, an attribute recognized for good baking operation (Lasekan, 1994). Igyor (2005) reported that substitution of wheat flour with acha flour up to 25% (w/w) produced acceptable bread that compared favourably with all wheat bread. However, substitution of acha flour for wheat flour in excess of 30% (w/w) was reported to produce significant reduction in the evaluated qualities of bread (Ayo and Nkama, 2004). Cowpea, a family of fabaceae and sub-family of faboideae, is a major legume cultivated in Nigeria (Olapade *et al.*, 2003). The usefulness of cowpea (*Vigna unguiculata*) in developing high protein foods in meeting the needs of the vulnerable groups of the population is now well recognized (Ayo *et al.*, 2007; Olapade 2010, Olapade *et al.*, 2011). Several efforts have been reported in enrichment of wheat flour for bread making including addition of fluted pumpkin flour (Giami, 2003; Giami *et al.*, 2003), yellow pea, lentil and fabia bean flours (Hsu *et al.*, 1982), mung pea flour (Finney *et al.*, 1982), chick pea flour (Fernandez and Berry, 1989), soy flour (Misra *et al.*, 1991), sunflower flour (Yue *et al.*, 1991) and winged bean flour (Kailasaptty *et al.*, 1985). There is scarcity of information on cowpea enriched bread. The present work, therefore, evaluated bread making potential of composite wheat – acha flours enriched with cowpea flour.

Materials and Methods

Creamy seed coloured cowpea cultivar was procured from Bodija food market, Ibadan while creamy coloured acha cultivar was obtained from Jos central market, Jos in Nigeria. Commercial high quality wheat flour (Golden penny, Nigerian flour mill) and other bread ingredients were purchased from Bodija market in Ibadan.

Preparation of cowpea flour

The cowpea flour was prepared as described in Figure 1. The beans were briefly soaked in water for about 5 min at the room temperature (28°C) to loosen the seed coats. The wetted seeds containing approximately 22% to 25% moisture after draining the excess water were spread in thin layer on wire mesh and dried in a forced-air oven at 60°C for 4 h. The pretreated seeds were coarsely milled using a plate mill (Apex, Germany) to detach the seed coat. The loosed seed coats were then separated from the cotyledons using a locally fabricated aspirator (FIIRO, Nigeria). The dehulled cowpea was milled into flour using a laboratory hammer mill to pass through a 0.2 mm screen.

Preparation of acha flour

Acha flour was prepared according to the procedure in Figure 2. Cream coloured acha was washed with tap water to separate stone and sand, then it was dried in the cabinet drier at 50°C for 6 h. The resultant dried acha was milled into flour using the hammer mill with 0.2 mm screen size.

Analyses of composite flours & bread

The flours were separately packaged in moisture proof polyethylene bags, sealed and stored under refrigeration for further use. Wheat and acha composite flour in ratio 9:1 (w/w) was measured and blended thoroughly using a Kenwood food blender. The composite flour was then blended with cowpea flour in ratios 95:5, 90:10, 85:15 (w/w) respectively. Proximate chemical composition of the flours was determined according to AOAC (2000) methods. Functional properties of the flours including bulk density, water absorption capacity, fat absorption capacity, swelling capacity and emulsion capacity were all determined as described earlier (Olapade *et al.*, 2003).

Straight dough preparation method was used to prepare breads from the enriched flours using bread recipe shown in Table 1. All the ingredients were mixed in a Kenwood mixer at speed 3 for 4 min. The dough was fermented for 90 min. at room temperature (28 ± 2°C), then punched back, scaled to 250 g, rolled, shaped, proofed for 90 min. at the room temperature and baked in pre-heated oven operating at 250°C for 30 min. The bread loaves were allowed to cool and then packed in low density polyethylene bags for subsequent analysis. The weights of bread samples were determined using an electronic weighing balance. Loaf volume was determined by rapeseed displacement method on the loaves.

Sensory evaluation of the coded bread samples was carried out by a twenty-five member panel consisting both students and staff of the Department of Food Technology, University of Ibadan, who were untrained but familiar with bread. The attributes evaluated were colour of crust and crumb, taste, after taste, mouth feel, aroma and overall acceptability. Scoring was done on 9-point Hedonic scale where 9 represents extremely like and 1 represents extremely dislike.

Data obtained were subjected to statistical analysis of variance and the samples' means were separated using Duncan's multiple range test. Significance was accepted at 5% level.

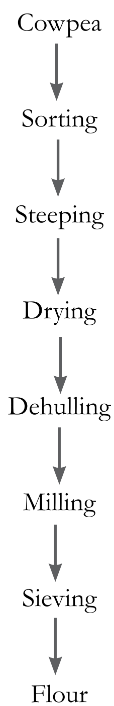

Fig. 1: Preparation of cowpea flour

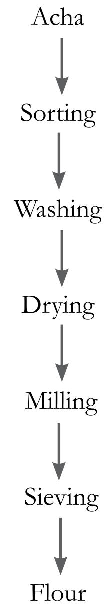

Fig. 2: Preparation of acha flour

Table 1: Bread recipe

Ingredients	Amount
Flour	200 g
Sugar	24 g
Fat	14 g
Salt	3 g
Yeast	2 g
Improver	50 g
Water	100 ml

Results and Discussion

The results of proximate analysis of the samples are presented in Table 2. Wheat-acha flour alone had 12.4% moisture content, 8.83% crude protein, 2.67% crude fat, 0.40% crude fibre, 1.02% ash and 75.6% carbohydrate. The corresponding values for enriched composite flours were 12.9 – 14.7% moisture content, 9.11 – 12.5% crude protein, 2.83 – 3.47% crude fat, 0.58 – 0.66% crude fibre, 1.33 – 2.17% ash and 68.3 – 74.2% carbohydrate. There was no significant difference in moisture content among the samples. However, crude protein, crude fibre, crude fat and ash were observed to significantly increase with increase in cowpea flour substitution. Similar trends were observed for acha/wheat flour substituted with extruded and non-extruded cowpea flours in cookies preparation (McWatters *et al.*, 2003) and acha and cowpea flours for biscuit preparation (Olapade *et al.*, 2011). The protein content (8.83%) of wheat-acha (9:1 w/w), though less, compared favourably with value of 9.90% reported for acha flour alone (Lasekan, 1994) indicating that acha possesses more protein content than wheat flour. Protein content of enriched flours was observed to significantly ($p < 0.05$) increase compared with wheat-acha flour alone. The increase in the crude protein of the blends with increase in cowpea flour substitution revealed high protein content of cowpea and significance of addition of cowpea flour, which has the potential in overcoming protein malnutrition among the people.

The results of functional properties of the samples are presented in Table 3. Bulk density values ranged from 0.71 to 0.74 g/cm^3 with wheat-acha flour alone having the highest value. The results showed that the bulk density decreased with increase in quantity of cowpea flour in the blend. Bulk density is a function of the closeness of packaging and a determinant of the handling equipment, since it is a function of mass and volume of the blend. Water absorption capacity values were 109 – 113% indicating reduction in values with addition of cowpea flour. However, no significant differences were observed among the enriched samples. The baking quality of flours had been associated with the water absorption capacity of the flour (Shittu *et al.*, 2008). On the other hand, fat absorption capacity values (116 – 132%) increased with increase in amount of added cowpea flour. Significant differences were noted with addition of cowpea flour to the blend. Similar observations were reported for wheat flour substituted with pigeon pea flour (Harinder *et al.*, 1999). There were no significant ($p > 0.05$) differences among the enriched samples. Both emulsion capacity and swelling capacity showed similar trends with fat absorption capacity in these samples. Water absorption and swelling capacities contribute to dough formation and stability, while fat absorption and emulsion capacities are important factors in baking that contribute to texture of bread.

Table 2: Proximate composition of composite flours

Sample	Moisture content (%)	Crude protein (%)	Crude fat (%)	Crude fibre (%)	Ash (%)	Carbohydrate (%)
Wheat-acha 100%: cowpea 0%	12.4^a	8.83^c	2.67^c	0.40^b	1.02^c	75.6^a
Wheat-acha 95%: cowpea 5%	14.7^a	9.11^c	2.83^c	0.58^a	1.33b	74.2^a
Wheat-acha 90%: cowpea 10%	12.9^a	10.7^b	3.10b	0.59^a	2.09^a	70.3^b
Wheat-acha 85%: cowpea 15%	12.9^a	12.5^a	3.47^a	0.66^a	2.17^a	68.3^b

Means with the same letter along column are not significantly different ($p > 0.05$)

Table 3: Functional properties of composite flours

Sample	Bulk density (g/cm^3)	Water absorption capacity (%)	Fat absorption capacity (%)	Emulsion capacity (%)	Swelling capacity (%)
Wheat-acha 100%: cowpea 0%	0.74^a	113^a	116^c	4.77^c	155^b
Wheat-acha 95%: cowpea 5%	0.72^a	110^b	122^b	4.93^c	150^b
Wheat-acha 90%: cowpea 10%	0.71^a	111^{ab}	125^b	5.50^b	160^b
Wheat-acha 85%: cowpea 15%	0.71^a	109^b	132^a	6.07^a	180^a

Means with the same letter along column are not significantly different ($p > 0.05$)

Physical properties of bread samples from composite flours are shown in Table 4. Average heights of the breads were 4.85 – 6.50 cm with 15% cowpea flour enrichment shown the least value. Also, average weight as observed in this study indicates that 15% cowpea substitution had highest value (230 g) with bread from wheat-acha flour alone having the least value (215 g). Both loaf weight and specific volume showed opposite trend with values 215 – 230 g and 0.474 – 0.595 cm^3/g respectively. Reduction in loaf specific volume as a result of blending wheat flour with legume flour (Chauhan *et al.*, 1992), oil seed flour (Sathe *et al.*, 1981) and protein concentrate (Yue *et al.*, 1991) have been reported. Gaimi (2003) also reported reduction in volume and increase in weight of bread produced from wheat flour supplemented with germinated and ungerminated pumpkin seed flours. Similar trend was reported when soybean flour was incorporated in wheat flour (Misra *et al.*, 1991).

Table 4: Physical properties of breads from composite flours

Sample	Average height (cm)	Average weight (g)	Volume (cm^3)	Specific volume (cm^3/g)
Wheat-acha 100%: cowpea 0%	6.50^{a}	215^{a}	128^{a}	0.595^{a}
Wheat-acha 95%: cowpea 5%	6.40^{ab}	220^{a}	118^{b}	0.538^{b}
Wheat-acha 90%: cowpea 10%	6.00^{b}	225^{a}	117^{b}	0.521^{b}
Wheat-acha 85%: cowpea 15%	4.85^{c}	230^{a}	109^{c}	0.474^{b}

Means with the same letter along column are not significantly different ($p > 0.05$)

All wheat flour bread had highest scores in all sensory attributes evaluated in this study followed by bread made from wheat-acha flour. Bread samples made from wheat-acha flour alone, 5% and 10% cowpea flour substitutions were scored lower but compared favourably with all wheat flour bread in all sensory attributes (Table 5). Though, bread samples from enriched composite flours were scored lower in all sensory attributes, the scores were within the acceptable limits. The values for enriched breads were crust colour 6.5 – 7.6, crumb colour 6.6 – 7.3, taste 6.1-7.6, aroma 7.2 – 7.6, mouth feel 6.2 – 7.2 and overall acceptability 6.3 – 7.5. Among the enriched bread samples, 5% cowpea flour substitution had highest sensory scores followed by 10% cowpea flour substitution sample with 15% cowpea flour substitution sample scoring the least values. Reduction in sensory quality attributes of bread was also reported as a result of blending wheat flour with more than 5% pumpkin seed flour (Giami, 2003). Inclusion of cowpea flour in the composite flour was observed to improve aroma of the bread samples but significantly reduced ($p < 0.05$) crumb colour, taste and overall acceptability.

Table 5: Sensory attributes of breads from composite flours

Sample	Crust colour	Crumb colour	Taste	Aroma	Mouth feel	Overall acceptability
Wheat-acha 100%: cowpea 0%	7.4^{b}	7.7^{b}	7.8^{b}	7.2^{b}	7.3^{b}	7.8^{b}
Wheat-acha 95%: cowpea 5%	7.6^{b}	7.2c	7.6^{b}	7.2^{b}	7.2^{b}	7.5^{bc}
Wheat-acha 90%: cowpea 10%	7.2^{b}	7.2c	7.0c	7.5^{b}	7.0^{b}	7.1^{c}
Wheat-acha 85%: cowpea 15%	6.5c	6.6d	6.1d	7.6^{b}	6.2c	6.3^{d}
Wheat 100%	8.4^{a}	8.3^{a}	8.5^{a}	8.3a	8.0a	8.3a

Means with the same letter along column are not significantly different ($p > 0.05$).

Conclusion

The study revealed that bread samples with improved protein content and acceptable sensory attributes could be produced from wheat-acha-cowpea composite flour at 10% maximum level of inclusion of cowpea flour.

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