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Influence of Soybean or Pigeon pea on the proximate composition and sensory attributes of bread from Maize-Cassava flour blends

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Research Paper

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ABSTRACT

There is a growing global concern over the implication of gluten consumption in the ever-increasing incidence of coeliac disease (CD), and the gliadin fraction of wheat has been implicated in this life-long intolerance in genetically predisposed individuals. Bread was therefore produced from various blends of maize, cassava, soybeans and pigeon pea flour. Bread from white wheat flour served as control. The bread samples were analyzed for proximate composition and sensory attributes. The moisture, ash, fat, crude fibre, protein and carbohydrate contents of bread samples varied significantly (p≤0.05) from 30.77 to 41.68, 1.14 to 1.95, 1.62 to 5.52, 7.23 to 8.16, 3.65 to 11.18 and 40.79 to 53.29, respectively. The highest protein contents, which were also found not to be significantly different (p≤0.05) from one another, were recorded in bread samples produced from 60:10:30 (maize:soybeans:cassava), 70:10:20 (maize:pigeonpea:cassava) and 80:10:10 (maize:pigeonpea:cassava). The sensory qualities of the bread samples varied significantly (p≤0.05). The texture and taste of the bread samples, which ranged respectively from 2.7 in 90:10 (maize:cassava) to 3.80 in 60:40 (maize:cassava) and 3.50 in 90:10 (maize:cassava) to 4.60 in 60:40 (maize:cassava) improved as the quantity of cassava flour in the blends increased. Bread sample from 60:10:30 (maize: soybeans: cassava) flour blend had the highest score for overall acceptability, among the flour blends.

Key words: Bread,cassava,maize,pigeon pea, soybeans.

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INTRODUCTION

Bread had been known to man for many centuries and it supplies over half of the caloric intake of the world's population, including a high proportion of the intake of vitamins B and E (Okafor and Iwouno, 1990).Bread is a staple food of many Nigerians, being the second most widely consumed non-indigenous food products after rice in Nigeria (Shittu *et al*., 2007).

Wheat is the conventional flour used in the production of yeast bread. However, there are factors that militate against the continued use of wheat in bread. Wheat contains two insoluble proteins (gliadin and glutenin) which on hydration and mixing/manipulation form gluten (Vaclavik and Christian, 2003). Gluten, though is responsible for the elasticity attributes of dough and plays significant role in imparting desirable organoleptic attributes to bread, has been associated with the incidence of coeliac disease (CD). The gliadin fraction of wheat and prolamin of rye, barley and possibly oats are factors responsible for this life-long intolerance in genetically predisposed individuals (Krupa *et al.*, 2010; Segura and Rosell, 2011). Those peptides, released during digestion, are toxic for coeliac patients, whereas maize and rice proteins are considered to be safe (Krupa *et al.*, 2010). Ingestion of gluten by CD patients results in inflammation of the small intestine, leading to malabsorption of several important nutrients including

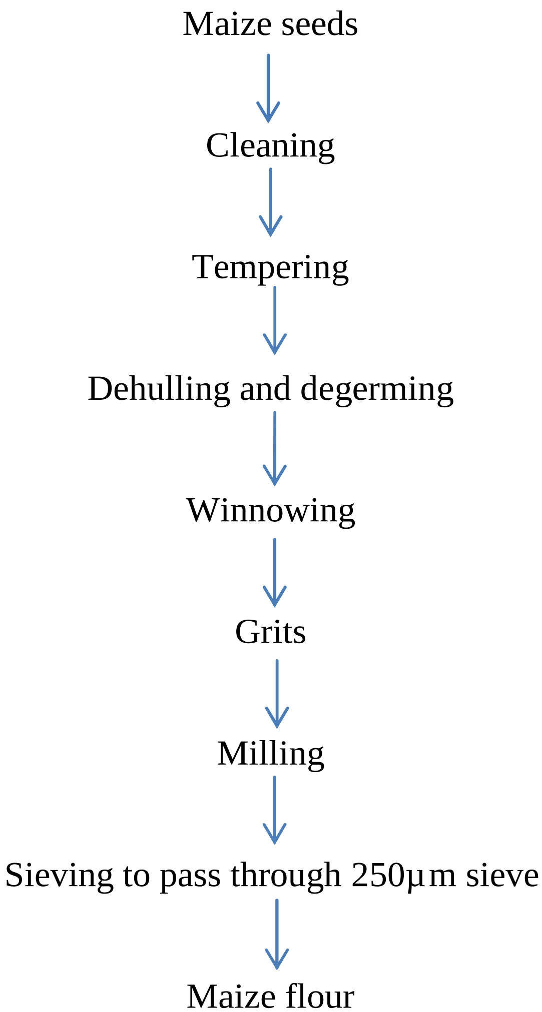

Figure 1. Production of Maize flour .Source: Houssou and Ayemor (2002).

minerals, folic acid and fat-soluble vitamins (López *et al.*, 2004; Krupa *et al.*, 2010).Furthermore, Nigeria spends huge amount of money annually in importing wheat since wheat plant does not thrive on Nigerian soils and climatic conditions (Bokanga, 1995). Hence, there is a dire need to reduce wheat in bread by using other sources of flour.

The use of non-wheat flour in bread manufacture had been advocated (Shittu *et al.,*2007, 2008; Škrbić and Filipčev,2008; Škrbić *et al.*, 2009). This will not be out of place since according to Edema *et al.* (2005) and Mesfin and Shimelis (2013) countries such as Ethiopia, Germany, France, Scotland, Norway, India and Israel have developed their own bread specialties based on their available agricultural resources.

Maize production is high in Nigeria, covering about one million hectares of the nine million hectares it occupies in Africa (Abdulrahaman and Kolawole, 2006). Many traditional foods such as 'ogi', 'agidi', 'tuwo', 'massa', are produced from maize. The use of maize in the production of bread had been reported (Mesfin and Shimelis, 2013). Mesfin and Shimelis (2013) reported that supplementation of maize flour with 10-15 % soybean improved the nutritional qualities of bread. Olaoye et al. (2006) also stated that there was no significant difference ($p \leq 0.05$) in the major sensory attributes of bread produced from 5-10 % soybean supplemented wheat flour. Cassava is the third most important source of calories in the tropics and the sixth most important food crop after sugar cane, maize, rice, wheat and potato, in terms of global annual production (Burns *et al*. 2010). Cassava, because of its low protein content and hence, low allergenic potential, is desirable as a source of energy for humans (Ceballos *et al.*, 2006). Addition of soybean (*Glycine max*), whose cultivation and consumption are gaining popularity in sub-Saharan Africa, may enhance the protein quality of cassava and maize flour (Muoki *et al.*, 2012).Pigeon pea (*Cajanuscajan*), a nutritionally important grain legume in tropical countries (Rampersad *et al.*, 2003)with a protein content of 21-26 %, is highly desirable as a protein supplement to cereal-based diets (Adeola *et al.*, 2011). Production of acceptable bread from non-wheat flour has been reported (Ciacco and D'Appolonial, 1977; Bokanga, 1995).

The purpose of this research was to investigate the proximate composition and sensory attributes of bread from composite flour of maize, cassava, soybean and pigeon pea.

MATERIALS AND METHODS

Raw materials

White maize (Zea mays), soybeans (Glycine max) and pigeon pea (Cajanuscajan) seeds were obtained from a local market in Iwo, Osun state. Fresh cassava roots were harvested from a local farm in Iwo.

Production of maize flour

The method of Houssou and Ayemor (2002) was used. Water was sprinkled on cleaned maize seeds so as to allow absorption of water by the grains, toughening the pericarp and germ so they do not splinter during milling.. The grains were left for about 10 min before dehulling and milling. The flour was sieved (using 250 µm mesh size) (Figure 1).

Production of cassava flour

Cassava flour was produced according to the method of Adekunle *et al.* (2012). Cassava roots were peeled,

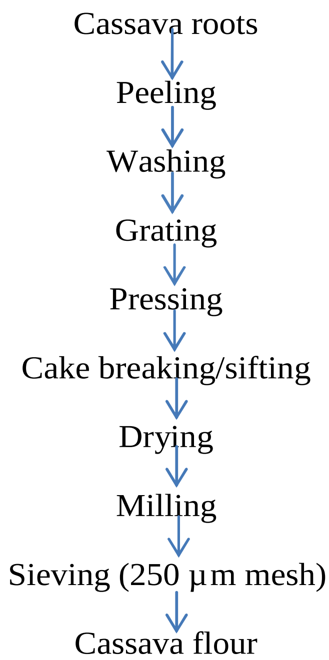

Figure 2. Production of cassava flour. Source: Adekunle *et al.* (2012).

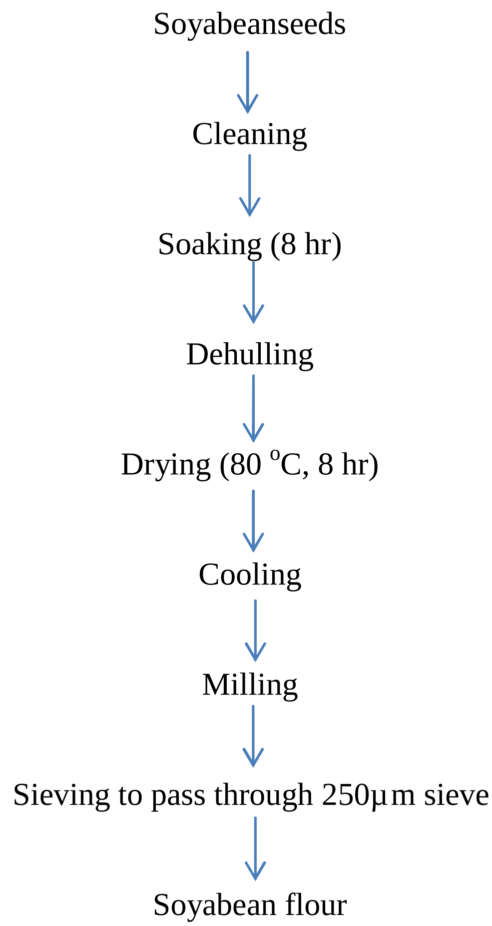

Figure 3. Production of soybean flour.

washed, grated and packed in a sack. The sack was then pressed with a hydraulic jack, until water was no more dripping from the sack. The resulting cake was pulverized manually, spread thinly on clean trays and sun-dried. The dried cake was then milled and sieved (using 250 µm mesh) (Figure 2).

Production of soybean flour

The seeds were cleaned by removing dirt and other foreign materials before being soaked in water for about 8 hours. The soaked beans were dehulled and dried in an oven at 80 ^{o}C for 8 hr. The dried soybeans were allowed to cool, milled and sieved with a 250 µm mesh (Figure 3).

Production of pigeon pea flour

The method of Mueses *et al.* (1993) was modified to produce pigeon pea flour. Pigeon pea seeds were cleaned, sorted and subjected to steaming in a retort at 120 ^{o}C for 5 min. Thereafter, the seeds were manually dehulled, cooked for 5 min using a pressure pot, dried in a locally cabinet dryer at 65 ^{o}C for 2 days, milled and sieved (using 250 µm mesh) (Figure 4).

Flour blends

Thirteen flour blends were prepared in which maize flour ranged between 60 and 90 %, cassava flour between 10 and 30 %, with the flour blends enriched with either soybean or pigeon pea flour at 10 % level. White wheat flour served as the control sample.

Production of bread

The method of Shittu *et al.* (2008) was used, with modification. The recipe used was flour (100 g), fat (4 %), sugar (5 %), yeast type (2 %), Edlen dough conditioner (1 %), salt (2 %), water (60-62 %). The percentages of the ingredients were based on the weight of flour. Flour and other ingredients were manually mixed with yeast suspension to form dough, which was thereafter covered with polyethylene and left to proof for about 2 hr. It was then divided, moulded and placed in baking pans. The pans were covered with polyethylene nylon and placed in an oven at 60 ^{o}C for 1 hr, for further proofing. The pans containing the dough were brought out of the oven and the oven pre-heated at 200 ^{o}C for about 5 min. Thereafter, the dough was baked at 200 ^{o}C for about 45 min. Bread samples were cooled to room temperature.

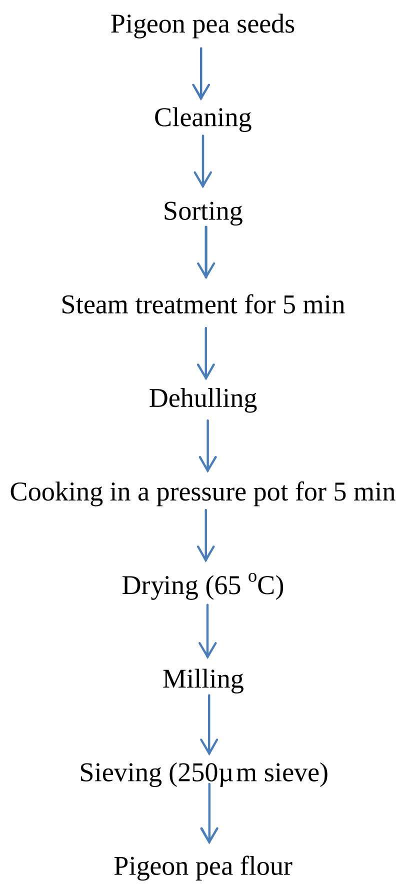

Figure 4. Production of pigeon pea flour. Source: modified Mueses *et al.* (1993).

Proximate composition

The proximate composition of the bread samples were determined by the method of A.O.A.C. (1995). Moisture was determined by drying the samples to constant in an oven at 105 °C. Ash was determined by incinerating the sample at 600 °C for 6 hr. Fat was determined by soxhlet apparatus, using petroleum ether. Crude fibre was determined by boiling samples under reflux in a digestion reagent comprising of trichloroacetic acid, nitric acid, distilled water and acetic acid, followed by filtration, drying and ashing. Protein was determined by using Kjeldhal apparatus, which involved digestion, distillation and titration. Carbohydrate was determined by deducting the percentage sum of moisture, ash, fat, crude fibre and protein from 100.

Sensory evaluation

Sixty panelists made up of students and staff of Bowen University, Iwo were asked to assess the organoleptic properties of the bread samples, using a 9-point hedonic scale where 1= dislike extremely, 5= neither like nor dislike and 9= like extremely. Samples were coded to eliminate error and code bias and presented in a random order. The panelists were supplied with water so as to wash their mouths between samples.

Data analysis

Data were subjected to descriptive analysis, using one-way analysis of variance. Data with significant difference were separated by Duncan multiple range test at 5 % level (Duncan, 1955).

RESULTS AND DISCUSSION

Proximate composition of bread samples

The moisture contents ranged between 30.77 % in control bread sample and 41.68 % in bread obtained from a flour blend of 80 % maize, 10 % soybean and 10 % cassava. Oladunmoye *et al.* (2010) reported moisture contents of 33.7 % for bread made from white wheat flour and 34.8 - 37.1 % for composite breads from blends of wheat, cowpea and maize. The ash contents of the bread samples varied from 1.14 % for 90:10 (maize:soybean) flour blend to 1.95 % for 60:10:30 (maize: pigeon pea: cassava) flour blend. There was no significant difference ($p \leq 0.05$) between the ash contents of control bread and breads from flour blends of maize, pigeon pea and cassava with ratios 80:10:10 and 70:10:20.The fat contents were between 1.62 % in bread from 70:10:20 (maize: pigeon pea: cassava) blend and 5.52 % in bread from 90:10 (maize: cassava) blend.

The fat contents of control bread and composite bread from 70:10:20 (maize: soybean: cassava) were not significantly different ($p \leq 0.05$). The crude fibre contents varied from 7.23 % in bread from white wheat flour to 8.16 % in 80:10:30 (maize: soybean: cassava) blend. Control sample and composite bread from 90:10 (maize: cassava) were not significantly different ($p \leq 0.05$), in terms of crude fibre. The protein and carbohydrate contents of the bread samples ranged respectively from 3.65 % (70:30; maize: cassava) and 40.79 % (80:10:10; maize: soybean: cassava) to 11.18 % (white wheat flour) and 53.29 % (60:40; maize: cassava). The protein contents of bread samples made from blends containing either soybeans or pigeon pea were higher than those made from blends of maize and cassava. This may be due to the fact that legumes are rated higher than tubers, in terms of protein content (Muoki *et al.*, 2012). Contrary to expectation, control bread recorded higher protein content than blends containing either soybeans or pigeon pea. This may be due to thermal treatment employed during pretreatment of the legumes. Heat treatments

Table 1. Proximate composition of bread made from blends of maize, cassava, soybean and pigeon pea flours.

Flour blends	Proximate composition					
	Moisture %	Ash %	Fat %	Crude fibre %	Crude protein %	Carbohydrate %
90% maize + 10% cassava	36.13[d]	1.80[g]	5.52[g]	7.51[ab]	5.65[d]	43.38[b]
80% maize + 20% cassava	33.13[b]	1.61[d]	2.24[e]	8.01[cde]	4.31[b]	50.70[g]
70% maize + 30% cassava	32.60[b]	1.43[c]	2.06[d]	7.71[bc]	3.65[a]	52.54[h]
60% maize + 40% cassava	30.83[a]	1.94[h]	2.14[de]	8.05[de]	3.74[a]	53.29[h]
90% maize + 10% soybean	32.88[e]	1.14[a]	2.45[f]	8.05[de]	6.66[g]	43.48[b]
80% maize + 10% soybean + 10% cassava	41.68[f]	1.18[ab]	2.04[d]	8.16[e]	6.14[f]	40.79[a]
70% maize + 10% soybean + 20% cassava	38.08[e]	1.22[b]	1.86[bc]	7.80[bcd]	5.66[d]	45.38[c]
60% maize + 10% soybean + 30% cassava	38.35[e]	1.22[b]	2.60[f]	8.07[de]	5.88[e]	43.87[b]
90% maize + 10% pigeon pea	34.60[c]	1.94[h]	2.12[de]	8.12[de]	5.19[c]	48.02[de]
80% maize + 10% pigeon pea + 10% cassava	34.06[c]	1.68[e]	2.07[de]	7.96[cde]	5.91[e]	48.31[e]
70% maize + 10% pigeon pea + 20% cassava	33.04[b]	1.76[fg]	1.62[a]	8.01[cde]	5.87[e]	49.69[f]
60% maize + 10% pigeon pea + 30% cassava	33.17[b]	1.95[h]	1.97[cd]	7.91[cde]	5.62[d]	49.38[f]
100 % wheat	30.77[a]	1.72[ef]	1.78[b]	7.23[a]	11.18[h]	47.32[d]

Means in the same column with same letters are not significantly different at $p \leq 0.05$.

Table 2. Mean hedonic scores of bread from blends of maize, cassava, soybean and pigeon pea flours.

Flour blends	Sensory scores				
	Colour	Aroma	Texture	Taste	Overall acceptability
90% maize + 10% cassava	4.30[abc]	4.00[a]	2.70[a]	3.50[a]	3.90[a]
80% maize + 20% cassava	4.10[ab]	4.85[ab]	2.90[ab]	3.55[a]	4.00[ab]
70% maize + 30% cassava	3.94[a]	4.62[ab]	3.60[abcd]	4.40[abc]	4.60[abcd]
60% maize + 40% cassava	3.80[a]	5.60[b]	3.80[bcd]	4.60[bc]	5.00[cde]
90% maize + 10% soybean	5.00[c]	4.10[a]	3.30[abc]	3.50[a]	4.30[abc]
80% maize + 10% soybean + 10% cassava	3.90[a]	4.60[ab]	3.80[bcd]	3.80[ab]	4.50[abc]
70% maize + 10% soybean + 20% cassava	3.90[a]	4.60[ab]	4.30[de]	4.80[c]	4.30[abc]
60% maize + 10% soybean + 30% cassava	4.00[ab]	5.40[b]	5.00[e]	5.70[d]	5.70[e]
90% maize + 10% pigeon pea	6.07[d]	4.60[ab]	3.93[cd]	3.93[abc]	4.60[abcd]
80% maize + 10% pigeon pea + 10% cassava	6.47[d]	5.53[b]	4.20[cde]	4.20[abc]	5.13[cde]
70% maize + 10% pigeon pea + 20% cassava	4.87[bc]	5.26[b]	3.53[abcd]	4.07[abc]	4.87[bcde]
60% maize + 10% pigeon pea + 30% cassava	5.93[d]	5.40[b]	4.20[cde]	4.4[abc]	5.53[de]
100 % wheat	8.00[e]	7.90[c]	6.60[f]	7.5[e]	7.90[f]

Means in the same column with same letters are not significantly different at $p \leq 0.05$.

have been reported to cause the formation of amino acid residues such as lysinoalanine, lanthionine and ornithinoalananine and the formation of intra- or intermolecular covalent cross-links (Cheftel and Cuq, 1985). The nutritional value of proteins in which covalent bonds of this kind are formed is often lower than that of the native proteins (Cheftel and Cuq, 1985).

Sensory attributes of bread samples

Sensory evaluation of bread is a very "hard" and sensitive task, often with contradictory results, even with the highly experienced and trained sensory panel and especially for the crumb color evaluation in the case of minor formulation and processing changes(Popov-Raljić *et al.*, 2009). The mean hedonic scores for the sensory attributes of the bread samples are shown in Tables 1 and 2.Bread from 100% white wheat bread had the highest scores for all the attributes and was significantly different ($p \leq 0.05$) from other bread samples. There was a decrease, though not significant at 5 % level, in the colour rating of bread samples made from maize-cassava and maize-soybean-cassava blends, as the level of substitution with cassava flour increased. In the case of maize-pigeon pea-cassava blend, an insignificant ($p<0.05$) increase in colour rating was followed by a significant ($p<0.05$) decrease, as the cassava flour content increased. Among the blends, bread sample from 80:10:10 (maize: pigeon pea: cassava) had the highest score for colour, although it was not significantly different ($p<0.05$) from those obtained from 90:10 (maize: pigeon pea) and 60:10:30 (maize: pigeon pea: cassava) blends. According to Popov-Raljić *et al.* (2009), the color of a product is the visual effect of subjective sensation of an observer.

Except for bread samples from 60:40 (maize: cassava) and 80:10:10 (maize: pigeon pea: cassava) blends, which had approximate score of 6 (i.e. liked slightly), other bread samples were poorly rated by the panelists, in terms of aroma. At 90:10 ratio and in comparison with maize-cassava blend, there was an improvement in all the sensory qualities of bread samples when either soybean or pigeon pea was blended with maize flour, with pigeon pea imparting more effect than soybean. The texture of bread samples obtained from all the blends were poorly rated, although there was an improvement in the texture as the cassava contents in the blends increased.

The taste of the bread samples improved as the quantity of cassava flour increased in the blends. Bread produced from 60:10:30 (maize: soybean: cassava) blend had the highest score for taste among the blends. Bread samples from 60:10:30 ratio for both maize-soybean-cassava and maize-pigeon pea-cassava blends were rated next after control sample, in terms of overall acceptability. While it could be said of maize-cassava blends that the overall acceptability of bread samples increased with increase in cassava content, the same could not be generalized for maize-soybean-cassava and maize-pigeon pea-cassava blends.

Conclusion

The outcome of this study revealed that a slight change in the quality of raw materials had the most a distinct impact on the ash, crude fat and protein contents of final quality of bread samples. While there was an increase in the protein contents of bread samples with the addition of the legumes, the carbohydrate contents decreased. The observed sensory attributes of the bread samples was mainly due to the differences in the type and quantity of flours used. The aroma, taste, texture and overall acceptability of maize-cassava bread improved with the addition of soybean and pigeon pea flour. On the other hand, the scores for colour of the bread samples decreased with soybean addition while it increased with pigeon pea addition. Bread made from 60:10:30 (maize: soybean: cassava) flour blend, containing 38.35 % moisture, 1.22 % ash, 2.60 % fat, 8.07 % crude fibre, 5.88 % protein and 43.87 % carbohydrate was the most accepted among the blends.

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