Physical characteristics and sensory quality of bread produced from wheat/African oil bean flour blends


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Received 28 August, 2013; Accepted 19 May, 2014

The use of wheat flour and African oil bean flour blends in the production of bread was studied. The wheat flour was substituted with African oil bean flour at the following levels: 10, 20, 30 and 40% while wheat flour bread (sample WHF) served as control. The bread loaves were produced using the straight-dough procedure and subsequently evaluated for physical characteristics and sensory attributes. Results show a decrease in bread volume and dough expansion from 20.43 - 6.79% and 42.09-12.97% respectively. The sensory analysis performed showed that there was no significant difference between the wheat flour bread (control sample) and sample B (10% substitution) in the sensory attributes of crust colour, taste and overall acceptability, while significant difference ((p<0.05) was observed in texture and flavour respectively. It was concluded that a substitution of 10% African oil bean flour gave the bread with the best overall quality.

Key words: Wheat flour, African oil bean flour, bread characteristics, sensory attributes

INTRODUCTION

Many tropical underutilized crop plants have seeds that are recently attracting worldwide attention because of their high nutrient potentials especially with regards to solving the prevalent protein energy malnutrition (PEM) that has ravaged populations in the less developed parts of the world. Some of these seeds have been exploited as soups, such as Vigna unguiculata (Akanbi, 1992); others are fermented and used as condiments and seasonings, such as okpe from Prosopis Africana (Achi, 1992); and ogiri from Ricinus communis (Odunfa, 1985).

Bread is a flour confection that may be regarded as a solid foam with a multitude of pockets of carbon dioxide distributed uniformly throughout its bulk (Okoye and Okaka, 2009). It is basically a yeast-raised bakery product that has a honey comb structure. The consumption of bread and other baked goods such as biscuits, doughnuts and cakes produced from wheat flour has become very popular in Nigeria and most developing nations of the tropics especially among children (Banigo and Edward, 1977; Sanful and Darko, 2010). The low protein content of wheat flour, which is the most vital ingredient used for the product ion of different kinds of baked goods has been of major concern in its utilization. The enrichment of bread and other cereal based confections with legume flours, particularly in regions where protein utilization is inadequate has long been recognized (Okoye and Okaka, 2009; Batista et al., 2011). This is because legume proteins are high in...
lysine, an essential limiting amino acid in most cereals (McWatters and Brantly, 1982). Legumes generally contain relatively high amount of protein compared to other plant foodstuffs and can therefore complement cereals when blended at optimum ratio.

African oil bean (Penta dethra macrophylla Benth) is a native to tropical regions of Africa and contains 44% protein, with 20 essential amino acids; within the seed oils are essential fatty acids as well as many minerals, particularly magnesium, iron, manganese, copper, phosphorous, calcium and trace amounts of vitamins (Achinewhu, 1983). Onabolu et al. (1998) produced 80:20 wheat/cassava flour blend as well as 100% cassava bread in which egg was as the binding agent. Onwuka (2000) used raw as well as processed mucuna bean flour for making bread in a 50:50 composite wheat flour. Research work conducted at the International Institute of Industrial Agriculture (IITA) showed that substitution of water yam (D. alata) flour for wheat at 40% gave acceptable products (IITA, 1988). Osibanjo et al. (1997) reported that the combination of 45:30:20:5 cassava flour/wheat/sorghum/soya with quality score of 72% gave acceptable bread.

African oil bean seed is one of the well known and utilized sources of plant protein, which when used partially to replace or substitute wheat flour in the preparation of bread and other flour confectionery would help to improve their protein content and nutritional quality. Again, since the production of wheat in the tropics has been insufficient and substantial quantities must be imported and be paid for, it would therefore, to the advantage of wheat importing countries like Nigeria, if these imports could be eliminated, without reducing the consumption of the wheat-based retail products. It was against this background that this research was initiated to assess the physical characteristics and sensory attributes of bread produced with wheat/African oil bean seed flour blends at various substitution levels.

MATERIALS AND METHODS

Source of raw materials

The African oil bean seeds, wheat flour (Golden penny), yeast (valine-instant yeast), fat, sugar and salt used for this work were purchased from a local market at Nnewi, in Nnewi North Local Government Area of Anambra State, Nigeria.

Production of African oil bean seed flour

The African oil bean seed flour was prepared according to the method described by Enujiuwa and Akanbi (2008) where par-boiling of the whole seeds was done for a period of 6 h using boiling plate; this was followed by dehulling and slicing (using kitchen knife). Cooking of the dehulled cotyledons was done for 8 h and the cooked oil bean slices were soaked in tap water over night, washed in three changes of water and dried using cabinet dryer. During drying, the dehulled seeds were stirred at interval of 20 min to ensure uniform drying. The dried slices were comminuted using attrition mill and sieved to get a fine African oil bean seed flour.

Production of wheat/African oil bean seed bread

The method reported by Ihekoronye and Ngoddy (1985), was modified and used for the production of wheat/African oil bean seed bread as shown in Figure 1. The Wheat/African oil bean seed bread was produced by dissolving 10 g of sugar, 3.0 g of yeast and 1.6 g of salt in warm water (15 ml) and stirred thoroughly until all ingredients dissolved. 100 g of wheat/African oil bean seed flour were then mixed with 2 g of fats in a stainless steel bowl mixer using a wooden spoon. This was then mixed with the wet already prepared ingredients. The resultant dough was proofed in the bowl for 30 min, kneaded and transferred into an already greased aluminum loaf pan. The pan dough was rounded with a spatula, proofed again for 45 min and baked at 250°C for 15 min, removed from the pan, cooled for 10 min, and packaged in a polyethylene bag.

From the above method, five different formulations of wheat/African oil bean bread were obtained by varying the proportions of wheat/African oil bean from 10 to 40%. Bread from wheat flour only was also produced. The details of the ingredients used in the formulation are shown in Table 1.

Loaf volume determination

Loaf volume was determined by the seed displacement method outlined by SON (1976). The method involved the use of a wooden box which has wide internal volume, equilibrated millet seed, measuring cylinder, a straight edge ruler and tray. The box volume was determined by filling the box with the millet seeds until the seeds dropping from a height of ½ foot above the container are overflowing. Using a straight ruler, all seeds were edged off above the container rim such that the seeds formed a plateau with the rim of the container. Pour out the seeds and weigh them. The weight of the seeds represents the box volume. Then filling 1/3 volume of the container with the weighed seeds, lay the loaf flat at the center of the container and fill up the container to overflow from 1/2 foot above the container. Again using ruler cut off the seeds above the rim of the container as the seeds form plateau with the container rim. Collect all the seeds displaced by the loaf sample and weigh (This weight of seeds corresponds to the volume of space displaced by the loaf sample placed in the container). Therefore, Loaf volume = volume of the spilled over millet

Dough expansion

The determination of baking expansion capacity followed the procedures proposed by Maeda and Cereda (2001). The formulation was made with 50 g of sample with 40 ml boiling water for the production of the dough. The dough was divided into five balls of approximately 10 g each and baked at 200°C for 25 min in an electric oven. The diameter of each dough ball was measured with a vernier caliper before and after baking. Baking expansion capacity was calculated by using the relation between the initial average diameter of the dough balls before baking and their final average diameter after baking.

Loaf weight determination

Loaf weight was determined by measuring the weight of the loaf
Sensory evaluation of different bread products

The bread products were subjected to sensory evaluation. A total of ten panelists drawn from the federal polytechnic Oko who are familiar with bread product participated in the evaluation. The parameters evaluated include crust colour, crumb texture, taste, flavor and overall acceptability. The coded samples were served in clean white plastic plates at room temperature 25°C in individual booths with adequate fluorescent light. Sample presentation to the panelists was at random and one at a time. They were to eat the samples and check how much they liked or disliked each one and rate them as such. The panelists were given enough water to rinse their mouths between each sample. A five-point hedonic scale (Larmond, 1977) was used for the evaluation and the resulting data were analyzed using analysis of variance (ANOVA) to establish significant differences among the samples. Differences among means were separated using Duncan’s multiple range tests. Significance was accepted at 5% level (P ≤ 0.05).

RESULTS

From Table 2, it was observed that bread volume for bread sample produced with 40% African oil bean flour was the least (179.66±0.57 cm³) against the control sample (310.26±0.23 cm³). Sample WTF which was the bread sample produced with 10% African oil bean flour was the best (270.29±0.50 cm³) as it compared favourably with the control. In terms of dough expansion, sample WTF (10% African oil bean flour) was the best with a dough expansion of 410.26±0.46 cm compared to the standard (440.18±0.30 cm). This was also the case with the specific volume (cm³/g) of the bread where sample WTF had the value 0.71±0.00 cm³/g against the standard (0.76±0.00 cm³/g). The least in both dough expansion and specific volume was the bread sample prepared with 60% wheat and 40% African oil bean flour. There was an increase in bread weight in sample FFF (bread sample produced with 40% African oil bean flour) compared to the control sample.

Table 3 shows the sensory characteristics of the bread produced from wheat/African oil bean flour blends compared to the control sample (bread produced with 100% wheat flour). Sample WTF (90% wheat/10% African oil bean flour blends) was rated like moderately in terms of colour, taste, and overall acceptability which compared favourably with the control sample. The second best sample was the bread produced with 80% wheat/20% African oil bean seed flour blends which also compared favourably with the control sample, while the worst sample in terms of colour, taste, texture, flavour and overall acceptability was the bread sample produced with 40% African oil bean flour (sample FFF).

DISCUSSION

From Table 2, the bread dough expansion and bread volume decreased by a range of 20.43 to 6.79% and
Table 1. Recipe for the production of wheat and African oil bean seed bread.

<table>
<thead>
<tr>
<th>Code</th>
<th>g/100 g flour</th>
<th>Fat (g)</th>
<th>Salt (g)</th>
<th>Sugar (g)</th>
<th>Water (ml)</th>
<th>Yeast (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WHF</td>
<td>100/0</td>
<td>2</td>
<td>1.6</td>
<td>10</td>
<td>60</td>
<td>3.0</td>
</tr>
<tr>
<td>WTF</td>
<td>90/10</td>
<td>2</td>
<td>1.6</td>
<td>10</td>
<td>60</td>
<td>3.0</td>
</tr>
<tr>
<td>WWF</td>
<td>80/20</td>
<td>2</td>
<td>1.6</td>
<td>10</td>
<td>60</td>
<td>3.0</td>
</tr>
<tr>
<td>TTF</td>
<td>70/30</td>
<td>2</td>
<td>1.6</td>
<td>10</td>
<td>60</td>
<td>3.0</td>
</tr>
<tr>
<td>FFF</td>
<td>60/40</td>
<td>2</td>
<td>1.6</td>
<td>10</td>
<td>60</td>
<td>3.0</td>
</tr>
</tbody>
</table>

Value represents the details of the ingredients used in the bread formulation.

Table 2. Effects of the blends of wheat/African oil bean flour on the bread characteristics.

<table>
<thead>
<tr>
<th>Sample code</th>
<th>g/100g flour Wheat/African oil bean seed</th>
<th>Loaf volume (cm³)</th>
<th>Bread characteristics</th>
<th>Loaf weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WHF</td>
<td>100/0</td>
<td>310.26±0.22</td>
<td>Dough expansion (cm)</td>
<td>440.18±0.30</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Specific volume (cm³/g)</td>
<td>0.76±0.00</td>
</tr>
<tr>
<td>WTF</td>
<td>90/10</td>
<td>270.29±0.50</td>
<td></td>
<td>410.26±0.45</td>
</tr>
<tr>
<td>WWF</td>
<td>80/20</td>
<td>240.26±0.45</td>
<td></td>
<td>375.41±0.36</td>
</tr>
<tr>
<td>TTF</td>
<td>70/30</td>
<td>200.22±0.38</td>
<td></td>
<td>366.26±0.45</td>
</tr>
<tr>
<td>FFF</td>
<td>60/40</td>
<td>179.66±0.59</td>
<td></td>
<td>350.26±0.45</td>
</tr>
</tbody>
</table>

aDifferent superscripts along the column denote significant difference at p ≤ 0.05 level.

Table 3. Sensory characteristics of bread produced from wheat/African oil bean composite flour blends.

<table>
<thead>
<tr>
<th>Sample code</th>
<th>Crust colour</th>
<th>Taste</th>
<th>Texture</th>
<th>Flavour</th>
<th>Overall acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>WHF</td>
<td>4.5 a</td>
<td>4.3 a</td>
<td>4.2 a</td>
<td>4.6 a</td>
<td>4.5 a</td>
</tr>
<tr>
<td>WTF</td>
<td>3.8 a</td>
<td>3.9 a</td>
<td>3.4 b</td>
<td>3.4 b</td>
<td>3.8 a</td>
</tr>
<tr>
<td>WWF</td>
<td>3.4 b</td>
<td>3.2 b</td>
<td>2.5 c</td>
<td>2.4 c</td>
<td>3.0 b</td>
</tr>
<tr>
<td>TTF</td>
<td>2.7 d</td>
<td>2.5 c</td>
<td>2.0 d</td>
<td>2.0 d</td>
<td>2.1 c</td>
</tr>
<tr>
<td>FFF</td>
<td>1.7 d</td>
<td>1.8 d</td>
<td>1.3 d</td>
<td>1.6 d</td>
<td>1.9 d</td>
</tr>
</tbody>
</table>

Values with different superscripts on the same column are significantly different (p<0.05).

42.09 to 12.97% respectively as the level of substitution with African oil bean flour increased. The specific volume also reduced drastically from 44.74 to 6.57%. This confirmed with the findings of Ndife et al. (2011) which stated that progressive inclusion of soy bean flour to wheat flour decreased the bread volume and dough expansion. Mohensen et al. (2006) also reported that increased supplementation of wheat flour with defatted and non-defatted soy-flour reduced loaf volume and specific volume drastically.

The deleterious effects of addition of the African oil bean flour could be due to dilution of gluten network which in turn impaired gas retention rather than gas production. Moreover, increased substitution of the wheat flour resulted to an increase in weight of the loaf which could be as a result of the high fat content of the African oil bean flour. Potter and Hotchkiss (2005) reported that a high oil content of composite bread will affect the shelf stability of the loaf.

From Table 3, the result of the bread crust colour did not show any consistent pattern for all the bread samples. There was no significant difference (p≥0.05) in terms of colour and overall acceptability of sample WHF (100% wheat) and that of sample WTF (90% wheat/10% AOBF).

Generally, sample FFF (40% AOBF) was significantly
different (p≤0.05) from all other samples; it had a more brownish appearance than others. This could be as a result of caramelization and millard reaction as the protein contributed by the African oil bean flour must have reacted with sugar during the baking process (Dhingra and Jooel, 2001; Mohsen et al., 2009).

The sensory scores for texture and flavour of the composite bread samples decreased with increase in African oil bean flour substitution - when compared to the control sample. Sample FFF with 40% African oil bean flour recorded the lowest value for all the parameters assessed. Most of the panelists complained of bitter taste and aroma from the African oil bean flour in the composite bread samples. Nevertheless, bread samples produced with African oil bean flour substitution up to 10% (sample WTF) were generally accepted.

Conclusion and Recommendation

In Nigeria today, partial or total substitution of wheat flour with flour of other cereals, legume or oil seeds can serve as a means of diversifying and upgrading local agricultural food products. From the results of physical and sensory characteristics of bread samples from wheat/African oil bean seed composite flour blends, it was observed that the African oil bean seed flour could be used to substitute up to 10% wheat flour in bread making without adversely affecting the physical and sensory properties of the loaf. Beyond this level, the bread appeared dark, scattered and had a characteristic bitter taste which was detested by the panelists. Nevertheless, storage stability of bread produced using wheat/ African oil bean flour blends should be carried out in future so as to ascertain the level of acceptability of the loaf after the storage period.

Conflict of Interest

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

REFERENCES


