Effect of Firm Ripe Plantain Fruit Flour Addition on the Chemical, Sensory and Microbial Quality of Fura Powder

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ABSTRACT

This study was carried out to determine the effect of firm ripe plantain fruit flour addition on the chemical, sensory and microbial quality of fura powder. Millet flour was supplemented with plantain flour at substitution levels of 0, 10, 20, 30 and 40 to obtain fura powder. The chemical composition, sensory properties and microbial quality were determined using standard methods of analysis. Addition of firm ripe plantain fruit flour significantly (p < 0.05) increased vitamin A, vitamin C, potassium, fibre and soluble solids (°Brix) levels of plantain-fura with the increasing level of plantain flour substitution. Fat content decreased from 6.0% to 3.0% with increased levels of plantain fruit flour addition. Similar trend was observed in protein content as it decreased from 13.0% to 10.0%. Microbial analysis results during three months of storage showed significant (p > 0.05) decrease in the microbial population with the increasing level of plantain flour addition. The results showed that blending of firm ripe plantain flour with millet flour would produce fura that is shelf stable, rich in natural anti-oxidant vitamins and safe for consumption.

Keywords: Plantain, millet, fura, powder, grain.

Introduction

Cereals are widely cultivated and consumed crops on a global basis especially in the Northern parts of Nigeria and are the major sources of energy in the diets of the people. Several traditional foods are produced from such cereals; one of such traditional foods is fura.

Fura is prepared principally from pearl millet (Pennisetum glaucum) grains flour blended with spices and water (Abdul-Fatah et al., 2010). Fura is traditionally made in dough form which is reconstituted in water with fermented milk, nono or yoghurt and consumed as a beverage, weaning food, refreshing drink, snacks and food for adults and children. Fura in its traditional dough form has a limited shelf life of two days, after which it shows cracks on the surface with visible mould growth (Jideani et al., 1995). Fura is predominantly starchy, high in fat and a good source of B vitamins. However, fura is deficient in protein (though complemented with the addition of nono), low in potassium, fibre, vitamin C and vitamin A, a major micronutrient problem among children.

Plantains (Musa paradisiaca) are potent sources of micronutrients especially vitamins A and C, potassium and fibre. Over 2.3 million metric tons of plantains are produced in Nigeria annually (FAO, 2009), however, about 35 to 60% post harvest losses was reported and attributed to lack of storage facilities and inappropriate technologies for food processing (Abioye et al., 2011). Adeniyi et al. (2006) reported that firm ripe plantains have
high carbohydrate content, are good sources of vitamins and minerals in addition to being low in fat. USDA (2009) reported that plantains provide a better source of vitamin A than most other staples. Plantains contain low sodium in dietary terms hence recommended for low sodium diets.

The production of food powders is on the increase due to rapid urbanization and globalization. Apart from extending the storage life of foods, powder products are easy to handle in terms of transport and convenience.

Addition of firm ripe plantain flour into fura powder could be used to address the problems of micronutrient deficiencies among fura consumers. Firm ripe plantain flour could also serve as natural sweetener in fura.

The present research therefore aimed at determining the effect of firm ripe plantain fruit flour addition on the proximate, micronutrient improvement, sensory and microbiological quality of fura powder.

Materials and Methods
Pearl millet (Pennisetum glaucum), firm ripe plantain fruits and spices (cloves, pepper, ginger) were obtained from Kabbai in Kogi State. The Department of Food, Nutrition and Home Sciences, Kogi State University, Anyigba, provided the facilities for this work.

Preparation of plantain flour
The method described by Enwere (1998) was used to prepare the plantain flour. Firm ripe plantain fruits were washed to remove adhering soil particles, peeled and sliced into thin thickness of about 2 mm. 5.25 ml of 2.0% sodium metabisulphite was added to each 500 g weighed chopped pulp and allowed to stand for 20 min and dried in the cabinet dryer at 60°C for 10 hrs. The dried grains were milled in a hammer mill and sieved through 250 μm sieve. The flour was packed and sealed in polyethylene bags.

Preparation of millet flour
Two kilograms (2.0kg) of millet was sorted, cleaned and washed with tap water. The grains were drained and dehulled using a local wooden pestle and mortar. The dehulled grains were winnowed, washed and dried in the cabinet dryer at 60°C for 10 hrs. The dried grains were milled in a hammermill and sieved through 250 μm sieve. The millet flour was mixed with 3% spices (ginger, cloves and pepper) and packaged in a polyethylene bag.

Preparation of fura powder from blends of millet-plantain flour
Millet flour was supplemented with plantain flour at substitution levels of 0, 10, 20, 30 and 40 for the production of fura powder as described by Igoye et al. (2011) shown in Fig 1.

Chemical analysis
The moisture, crude protein, fat, crude fibre and ash contents were determined following the procedure outlined by AOAC (2000), while carbohydrate was calculated by difference (Ihekoronye and Ngoddy, 1985). The soluble solids expressed as °Brix were determined using a refractometer as described by Akubor (2011). Beta carotene, vitamin C, calcium and potassium contents were determined according to the methods described by Onwuka (2005).

Microbiological analysis
Microbiological analyses were carried out according to the method described by Adegoke (2004). One gram each of fura sample was homogenized in 10 ml of sterile peptone water. Dilutions were made by mixing 1.0 ml of the homogenate in 9.0 ml of the sterile peptone water to obtain 10⁻¹ dilution. The dilution was then made to 10⁻², 10⁻³, 10⁻⁴ and 10⁻⁵.

Total viable counts of bacteria were determined by enumerating the Colony Forming Units (cfu) by pour plating on nutrient agar plates and cultured at 37°C for 2 days. Mould and yeast counts were determined by pour plating on acidified potato dextrose agar plates and incubated at room temperature (30 ± 2°C) for 5 days and total coliform counts were determined by pour plating on MacConkey agar plates and incubated at 37°C for 2 days. The experiments were carried out in duplicates.
Sensory evaluation

Sensory evaluation of samples was determined by a preference method as described by Ihekoronye and Ngoddy (1985). A 10-member panel was trained on sensory attributes for the evaluation. The scores were based on the intensity of organoleptic quality attributes of taste, colour, flavour, texture and overall acceptability using a 9-point hedonic scale, 9 for liked extremely and 1 for disliked extremely. Samples were reconstituted 1:3 (Meals: Water) in warm water (60°C) and coded for the participating judges’ ratings.

Statistical analysis

Data were subjected to analysis of variance as described by Egbekun and Akubor (2013). Least significance difference (LSD) test was used to separate means where significant. Significance was accepted at p < 0.05.

Results and Discussion

Table 1 shows the chemical composition of the samples. The protein content decreased with the increasing level of plantain flour substitution. *Fura* obtained from 100% millet had 13% protein while *fura* with 40% plantain flour substitution had 10% protein. This showed that firm ripe plantain flour is low in protein. The habit of consuming *fura* along with *nono* will augment the protein level. The fat content analyzed showed a reversed trend. There was a reduction in the fat level with the increased level of plantain flour substitution (6 – 3%). This result confirms the report of USDA (2009) that plantains have fat levels range of 0.2 to 0.5%. The low level of fat in the plantain-*fura* will enhance the storage life of the product due to the lowered chance of rancid flavour development.

The ash content of the samples increased steadily with the increased level of plantain flour (1.5 – 3.0%). This indicates high levels of minerals in the blended samples. The samples had relatively low moisture level (7.2 – 7.5%) and showed no significant difference among the samples. Moisture content of processed products gives an indication of its shelf life. The low moisture value obtained in this work for the samples is an indication that the product will have good storage stability. Crude fibre measures the cellulose, hemicellulose and lignin content of food. The fibre content significantly (p < 0.05) increased from 3.2% to 7.0% in 60:40 (Millet: Plantain) *fura*. The nutritional benefits of dietary fibre are well documented. Dietary fibre plays a role in weight management as a result of its effect on satiety and blood cholesterol (Akubor,

Table 1: Chemical composition of plantain-*fura*

<table>
<thead>
<tr>
<th>MF:PF</th>
<th>Protein (%)</th>
<th>Fat (%)</th>
<th>Ash (%)</th>
<th>Moisture (%)</th>
<th>Fibre (%)</th>
<th>CHO (%)</th>
<th>°Brix</th>
<th>Vit. C</th>
<th>Ca</th>
<th>K</th>
<th>Beta Carotene</th>
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<tr>
<td>100:0</td>
<td>13.0&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>1.5&lt;sup&gt;c&lt;/sup&gt;</td>
<td>7.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.2</td>
<td>69.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.0&lt;sup&gt;c&lt;/sup&gt;</td>
<td>5.0&lt;sup&gt;c&lt;/sup&gt;</td>
<td>50.0</td>
<td>280.0</td>
<td>0.0&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>90:10</td>
<td>12.8&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.7&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.5</td>
<td>69.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.9&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>49.2</td>
<td>300.0</td>
<td>0.0&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>80:20</td>
<td>11.5&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.0&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.0&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.0</td>
<td>71.2&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>45.0</td>
<td>350.0</td>
<td>2.2&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>70:30</td>
<td>11.0&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.5&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.2</td>
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<td>43.0</td>
<td>400.0</td>
<td>3.2&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>60:40</td>
<td>10.0&lt;sup&gt;c&lt;/sup&gt;</td>
<td>3.0&lt;sup&gt;c&lt;/sup&gt;</td>
<td>3.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.0</td>
<td>69.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>9.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>40.0</td>
<td>450.0</td>
<td>5.0&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Values are means of triplicate determinations.

Means followed by the same letter on vertical column are not significantly (p > 0.05) different.

MF = Millet flour
PF = Plantain flour
CHO = Carbohydrate
Carbohydrates levels were high for all the samples and showed no significant difference among the samples. This is an indication that plantain-fura powder is an energy food. Energy is needed for normal activities. The soluble solids measured in °Brix increased steadily from 0 – 4.2 °Brix with the increasing level of plantain flour substitution. The high °Brix level obtained in the 40% plantain flour addition is significant on the organoleptic and health implication of the consumers. It impacts natural sweetness on the product which could possibly serve as a replacement for refined or artificial sugar in fura consumption. Fruit sugar is reported to be higher in fructose which is health friendly to the diabetics. Because, fructose requires less insulin to be driven into the cell than glucose (Manoranjan and Sood, 2010). Therefore, plantain-fura could be an excellent meal for the diabetic patients.

Vitamin C increased significantly with increased level of plantain flour. This accorded the plantain-fura nutritional superiority over fura from 100% millet. Vitamin C is very vital in iron metabolism and subsequent fight against iron deficiency anaemia (Akubor, 2011). Beta carotene content showed similar trend. Beta carotene is ‘Pro-vitamin A’. Vitamin A is a powerful natural anti-oxidant and required by the body for maintaining the integrity of skin and mucus membranes. It is also an essential vitamin for good visual sight. Research studies suggest that natural foods rich in vitamin A protects against lung and oral cavity cancer (USDA 2009).

Table 2: Microbial population of plantain-fura powder during 3 months of total viable counts (CFU/g)

<table>
<thead>
<tr>
<th>Storage Periods (Months) MF:PF</th>
<th>100:0</th>
<th>90:10</th>
<th>80:20</th>
<th>70:30</th>
<th>60:40</th>
</tr>
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<tbody>
<tr>
<td>1 x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>2 1.2 x 10²a</td>
<td>1.4 x 10²b</td>
<td>1.3 x 10²a</td>
<td>1.0 x 10²a</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>3 3.8 x 10³a</td>
<td>2.9 x 10³b</td>
<td>2.8 x 10³c</td>
<td>1.7 x 10³d</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>

Mould and Yeast Counts (cfu/g)

<table>
<thead>
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<th>Storage Periods (Months) MF:PF</th>
<th>100:0</th>
<th>90:10</th>
<th>80:20</th>
<th>70:30</th>
<th>60:40</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>2 x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>3 8.2 x 10²a</td>
<td>6.4 x 10²b</td>
<td>6.1 x 10²b</td>
<td>3.8 x10²c</td>
<td>2.9 x10²c</td>
<td></td>
</tr>
</tbody>
</table>

Total Coliform Counts (cfu/g)

<table>
<thead>
<tr>
<th>Storage Periods (Months) MF:PF</th>
<th>100:0</th>
<th>90:10</th>
<th>80:20</th>
<th>70:30</th>
<th>60:40</th>
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<tr>
<td>1 x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>2 x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>3 x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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</table>

Mean followed by the same superscript along rows are not significantly (p>0.05) different. Results are means of duplicate count.

MF = Millet flour
PF = Plantain flour
x = No visible growth
The results showed a decrease in calcium content with increasing level of plantain flour addition. This is an indication that millet flour is higher in calcium than plantain flour. But the results obtained for the level of potassium showed a reversed trend. Potassium is frequently supplied in limited quantities in foods and it is readily lost by person taking diuretics (Smith, 1983). Potassium is an important component of cell and body fluids that help control heart rate and blood pressure counteracting the negative effects of sodium.

Result of microbiological analysis of the samples is shown in Table 2. No visible growth was noticed during the first month of storage for the total viable counts. This is an indication that the products were produced under a good hygienic condition. Total viable counts of all the samples showed growth after the second and third months of storage except for 60:40 (Millet: Plantain) sample. The high sugar level of this sample may have inhibited the growth of organisms (Adams and Moss, 1999). The preservative effect of sugar is well documented. The more plantain flour added, the longer the shelf life of fura powder.

All the samples did not grow mould during two months of storage. This result showed that powdered fura is much more stable microbiologically than traditional fura in dough form which becomes mouldy after two days of storage. The results of mould and yeast count after three months of storage showed a significant decrease with the increasing level of plantain flour addition. Fura from 100% millet was more susceptible to mould than plantain-fura samples. Plantain flour seemed to be more resistant to mould than millet flour.

Results of the coliform counts did not show any visible growth. This implied that addition of plantain flour to fura powder does not pose any risk to the health of consumers, it is safe for consumption.

The mean sensory result of plantain-fura powder is presented in Table 3. Fura obtained from plantain-millet flour appeared to have an edge over 100% millet fura in all the sensory attributes except the texture. There were increasing higher scores (acceptance) with the increasing level of plantain flour substitution. Sample with 40% plantain flour substitution had highest score for taste, colour, flavour and overall acceptability. The firm ripe plantain flour had some of the starches broken down to form sugars which could have influenced the taste positively. This is significant, as the sample can be consumed without the addition of table sugar. The yellowish colour of plantain partially replaced the brown-dark colour of millet. This could have influenced the higher scores for the colour of the blended samples. All the samples had the same particle size and could have accounted for the lack of significant difference for the texture. Interactions between these food constituents possibly improved the overall quality attributes of the plantain millet fura powder.

### Table 3: Mean sensory scores of plantain-fura

<table>
<thead>
<tr>
<th>Sample</th>
<th>MF: PF</th>
<th>Taste</th>
<th>Colour</th>
<th>Flavour</th>
<th>Texture</th>
<th>Overall Acceptability</th>
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<tr>
<td>100:0</td>
<td>2.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.0&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.2&lt;sup&gt;c&lt;/sup&gt;</td>
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<td></td>
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<tr>
<td>90:10</td>
<td>3.0&lt;sup&gt;c&lt;/sup&gt;</td>
<td>6.2&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>7.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.0&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>60:40</td>
<td>8.0&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>8.0&lt;sup&gt;a&lt;/sup&gt;</td>
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Mean within a column with the same superscript were not significantly different (p > 0.05). Samples were evaluated on a 9-point hedonic scale (9 = Liked extremely and 1 = Disliked extremely).

### Conclusion

Firm ripe plantain fruit flour addition to fura will improve the overall quality of fura. The presence of anti-oxidant vitamins as well as potassium and fibre in fura would be of great health benefit. Addition of plantain into fura in powdered form could
Fig. 1: Flow diagram for the production of fura from blends of millet and plantain flour
ensure food security as it reduces post harvest losses of plantain. Microbiological assessment showed that plantain-*fura* is shelf stable and safe for consumption.

**References**


