Compositional characteristics and functional properties of instant plantain-breadfruit flour

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ABSTRACT

Instant plantain-breadfruit flour was prepared from green matured plantain and breadfruit. Substituted plantain flour with breadfruit flour at varying proportions (100: 0; 50: 50; 30: 70; 0:100) was subjected to proximate analysis, functional properties and also comparative sensory evaluation alongside its equivalent (instant yam flour) processed in a similar way. The pasting properties decreased significantly as the proportion of breadfruit flour increased. Panelists were asked to evaluate each category of sample for colour, taste, flavour, texture, mouldability, mouthfeel, and overall acceptability on a 9-point Hedonic scale. The sensory evaluation showed that there was no significant difference (P≤0.05) between 100% instant plantain paste and instant yam paste. Relatedly, there was statistical difference (P≤0.05) between the instant plantain-breadfruit paste and instant yam paste in terms of colour. The proximate analyses showed that 50:50% and 30:70% instant plantain-breadfruit flour could contribute appreciable amounts of principal nutrients to the daily nutrient requirements.

INTRODUCTION

Plantain is a staple food in the tropical regions of the world, treated in the same way as potato and yam with a similar texture and neutral flavor when the unripe fruit is cooked by steaming, boiling or frying (Aderounmu, 2006). Plantain is a staple triploid hybrid between the species Musa acuminata and Musa balbisiana. The Musa species is likely a native to India and Southern Asia. Plantain contains carbohydrates (32%), protein (1%), fat (0.02%), water (60%) and some vitamins and mineral elements. The food is extremely low in fat and protein, high in fibre and starch. It is a good source of vitamin A, B₆ and C which helps maintain vision, good skin and builds immunity against diseases. It is also rich in potassium, magnesium and phosphate when cooked green (Ogazi et al., 1996). FAO (2009) has reported that more than 2.5 million metric tons of plantains are produced in Nigeria annually, but about 40 to 60% post-harvest losses had been reported which is attributed to lack of storage facilities and inadequate technologies for food processing.

Traditionally, unripe plantain can be processed into flour (Ukhum and Ukpebor, 1991). The flour is mixed with boiling water to make a stretchable paste (known as Amala) which is eaten with various soups. However, plantain is increasingly finding a gradual application in weaning food formulation and composite flour preparations (Ogazi et al., 1996; Otegbayo et al., 2002; Olaoye et al., 2006; Mepba et al., 2007).

Many research works have been carried out in developing countries recently with the efforts focused on the improvement of protein and fat qualities of root crops and cereals. Various levels of achievement have been made in this aspect such as the fortification of cassava with soy bean or with cassava leaf as well as maize with soy bean (Adeyemi et al., 1991; Akingbala et al., 1995). Ogazi et al. (1996) have reported that feeding only on plantain cannot meet up with the recommended daily
intake requirements; hence, the need for supplementation is essential.

Breadfruit (*Artocarpus communis*) is a rich source of protein and fat compared to plantain, cereals and other root crops. Both the plantain and breadfruit can be prepared in a similar way with tuber crops.

African breadfruit is a native to Africa and more distantly related to the many varieties of Pacific Island breadfruit (*Artocarpus altillis*) than the Pacific varieties are to each other. Both are members of the mulberry family (moraceae).

In West Africa, individual breadfruit trees are found scattered throughout the southern rain forest zones (Omobuwajo and Wilcox, 1989). The tree produces fruit twice a year, from March to June and from July to September with some fruiting throughout the year.

African breadfruit is an important food item in southern part of Nigeria and other parts of West Africa but the crop is highly underutilized, especially in food industries. The fruit may be eaten after boiling or frying. Also, delicious porridge is produced from the fruit. The fruit is a rich source of oil (10%), protein (17%) and carbohydrate (40%) as well as several minerals and vitamins. The fleshy pulp can be used as fodder while the wood of the crop has potential use in paper manufacturing (Etoaimhie and Ndubueze, 2010).

The oil yield of the crop compares favourably with that of sunflower and cotton seeds; and palm kernel. The fat and oil content of the seed places it as a possible raw material for the production of vegetable oils, pharmaceuticals, soaps, perfumes and paints. The shell is rich in potash and may be used as filler, bedding for livestock and polishing of abrasives (Nwabueze et al., 2008).

Breadfruit is a very useful substitute of root crops and this has been a traditional practice among people in the south western part of Nigeria. The fruit is regarded as the poor man’s substitute for yam in Nigeria because it is used in several traditional food preparations of yam but costs less than one-third of the cost of procuring yam at the market (Mayaki et al., 2003).

Breadfruit can also be processed into flour which can be used in making bread and biscuit (Amusa and Kehinde, 2002). Reconstituted paste from plantain and breadfruit flours are gaining interest among the people in Nigeria; hence blending breadfruit with plantain may have the potential of providing a relatively cheap protein and fat source for both the children and adults. This research work took into cognizance the possibility of processing instant plantain-breadfruit flour which can serve as an alternative smooth dough food product which is similar to pounded yam. Incorporation of breadfruit flour to plantain flour will also improve its protein and fat content. In addition, production of instant plantain-breadfruit will also increase the industrial utilization of both plantain and breadfruit.

**MATERIALS AND METHODS**

Matured, green and wholesome breadfruit (*Artocarpus altillis*) and unripe plantains were purchased from Osiele market, Abeokuta, Ogun state.

**Preparation of instant plantain flour**

The modified method of Ogazi (1984) was employed. Unripe plantains (weighing 6.5 kg) were peeled using a sharp stainless steel knife and washed with portable water. These were sliced uniformly. The slices were blanched in a Clifton water bath (model: Weston-s-mabe, serial number: 15147, Nickel electro Ltd, England) at 100°C for 20 min. The cooked slices were dried in a cabinet dryer (Serial No: 3113 Leec Ltd Colwick, Nottingham) for 48 h and then milled to get the instant plantain flour. The milled flour was sieved and then packaged in an airtight polyethylene bag until ready for use.

**Production of instant breadfruit flour**

The modified method of Giami et al. (2004) was employed. Unripe breadfruits (weighing 12.28 kg) were peeled using a sharp stainless steel knife and washed with distilled water. The fruits were sliced uniformly to a slice thickness of 5 mm and immersed in sodium metabisulphite solution (800 ppm for 20 min). The sulphited slices were allowed to drain and then blanched using Clifton water bath at 100°C for 20 min. The cooked slices were dried in the cabinet dryer at 60°C for 72 h after which it was milled to obtain pre-gelatinized breadfruit flour (Instant breadfruit flour). The instant breadfruit flour was packaged in an airtight polyethylene bag until ready for use.

The pre-gelatinized breadfruit flour used in making the four experimental substitutes samples were in ratio of instant plantain flour : instant breadfruit flour of 100:0, 50:50, 30:70, 0:100. The samples were thoroughly blended.

**Proximate analysis**

Proximate composition of protein, ash, moisture content, crude fat, crude fibre and carbohydrate were determined according to the official method of analysis described by the Association of Official and Analytical Chemist (AOAC, 2004).

**Energy content determination**

The energy content (E) was calculated using Atwater
factor (Obiegbuna and Baba, 2001) as:

\[ E = (9 \times P) + (4 \times F) + (4 \times C) \]

Where;
- \( P \) = protein content (%)
- \( F \) = fat content (%)
- \( C \) = carbohydrate content (%)

**Determination of functional properties**

**Bulk density**

Bulk density was determined using the method of Akpapunam and Markakis (1981). Ten grams (10 g) of sample was weighed into 50 ml graduated measuring cylinder. The sample was packed gently by tapping the cylinder on the bench top. The volume of the sample was recorded.

**Swelling power and solubility index**

Swelling power and solubility index were determined using the method described by Takashi and Sieb (1988). It involved weighing 1 g of the sample into 50 ml centrifuge tube. 50 ml of distilled water was added and mixed gently. The slurry was heated in a water bath at 80°C for 15 min. During heating, the slurry was stirred gently to prevent clumping of the flour. On completion of 15 min, the tube containing the paste was centrifuged at 3000 rpm for 10 mins. The supernatant was decanted immediately after centrifuging. The weight of the sediment was taken and recorded. The moisture content of the sediments gel was therefore determined to get the dry matter content of the gel.

Swelling power = \( \frac{\text{Weight of wet mass sediment}}{\text{Weight of dry matter in the gel}} \)

Solubility index (%) = Weight of dry solid after drying \times \frac{100}{100}

**Water absorption index**

Water absorption index (WAI) was carried out using the modified method of Ruales et al. (1993). About 2.5 g of the flour was suspended in 10 ml of distilled water at 30°C in a centrifuge tube stirred for 30 min intermittently and then centrifuged at 3000 rpm for 10 min. The supernatant was decanted and the weight of the gel formed was recorded. The WAI was then calculated as:

\[ \text{WAI} = \frac{\text{Weight of wet mass sediment}}{\text{Weight of dry sample}} \]

**Water binding capacity**

Water binding capacity was determined by modifying the method of Elkhalifa et al. (2005). Fifteen grams (15 g) of the samples was weighed accurately and water was added. It was then centrifuged at 3250 rpm for 25 min and the supernatant decanted. The residue left was air dried and weighed.

\[ \text{WBC} = \frac{\text{Bound water (g) \times 100}}{\text{Weight of sample}} \]

**Pastin g properties**

This was determined using the Rapid Visco Analyzer (RVA) (New point Scientific). About 3.5 g of the experimental products were weighed into the text canister. Then 25 ml of distill water dispensed into the canister containing the sample. The solution was thoroughly mixed and the canister was fitted into the RVA. The slurry was heated at 50°C with 2 min holding time. The rate of heating and cooling at a constant rate of 11.2550°C/minute was recorded, where peak viscosity, trough, breakdown, final viscosity, set back, peak time and pasting temperature were read from the pasting profile with the aid of thermocline for windows software connected to a computer (Walker et al., 1998).

**Sensory evaluation**

Sensory evaluation was carried out on the reconstituted instant plantain-breadfruit paste and its equivalents (poundo yam) using a preference test. Panelists who were familiar with the sensory properties of pounded yam and mainly staff and students of Federal University of Agriculture, Abeokuta were asked to indicate their preference for the samples in terms of texture, colour, taste, stretchability, mouldability, flavour, mouth feel and overall acceptability using the nine point hedonic scale.
The samples were evaluated using 1-9 hedonic scale where 1 represented like extremely and 9 represented dislike extremely.

**Statistical analysis**

Data obtained were subjected to Analysis of Variance (ANOVA) using SPSS version 16.0 and the differences between significant mean values were evaluated at P≤0.05 probability level using Duncan’s Multiple Range Test.

**RESULTS AND DISCUSSION**

**Proximate composition**

The proximate composition of instant plantain-breadfruit is shown in Table 1. The moisture content values ranged from 9.35±0.53 to 10.75±0.53; 100% instant plantain flour had the highest mean value while 50:50% instant plantain-breadfruit flour had the lowest mean value. 100% instant plantain flour had higher crude fibre than 100% instant breadfruit flour. The fat content ranged from 11.67±0.00 to 12.17±0.17; 30:70% instant plantain-breadfruit flour had the highest mean value while 100% instant plantain flour had the lowest mean value. The ash content of all samples ranged from 0.70±0.00 to 0.80±0.00. The value of the protein contents ranged from 2.98±0.56 to 4.97±0.01; 30:70% instant plantain-breadfruit flour had the highest protein content while 100% instant plantain flour had the lowest mean value.

Increase in protein and fat contents with increased level of breadfruit flour substitution as shown in Table 1 indicates nutrients enhancement by breadfruit flour. This could be due to the significant quantity of protein and fat in breadfruit (Nwabueze et al., 2008). The high protein and fat contents in plantain-breadfruit mix could be of nutritional importance in most developing countries where many people cannot afford high proteinous foods because of the cost. The increase in fat, ash, and fiber contents also (Table 1) can be adduced to the same reason as the increase in protein and fat. The carbohydrate content of the samples ranged from 70.70±1.46 to 74.17±2.61; 100% instant breadfruit flour had the highest value while 100% instant plantain flour had the lowest mean value. However, the carbohydrate decreased with increasing level of breadfruit flour substitution supporting the claims of Akpapunam et al. (1997). Relatedly, the energy content of 100% instant breadfruit flour was higher than 100% instant plantain flour.

**Functional properties**

The functional properties determine the applications and uses of food materials for various food products. The results for functional properties of instant plantain-breadfruit flour are shown in Table 2. Bulk density values ranged from 0.87±0.00 to 0.91±0.00 g/cm³. There was no significant difference (P>0.05) in the bulk density of all the samples. The bulk density is affected by the particle size and the density of the flour which is very important in determining the packaging requirements, material handling and the application in wet processing in food industry (Adebowale et al., 2008). Generally, higher bulk density is desirable for it great ease of dispersibility and reduction of paste thickness which is an important factor in convalescent child feeding (Padmashrre et al., 1987). There was significant difference in water absorption index of the instant plantain-breadfruit flours (P<0.05). 100% instant breadfruit flour had the highest mean value of 4.10±0.29 while 100% instant plantain flour had the lowest mean value of 2.23±0.01. This observed trend is in agreement with the findings of Olatunji and Akinrele (1978) that there was an increase in water absorption by wheat flour during dough development, with increasing level of substitution with tropical tuber and breadfruit.
Table 2. Functional properties of instant plantain-breadfruit flour.

<table>
<thead>
<tr>
<th>Sample/component</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk density (g/cm³).ns</td>
<td>0.87±0.00</td>
<td>0.91±0.00</td>
<td>0.89±0.01</td>
<td>0.89±0.01</td>
</tr>
<tr>
<td>Water absorption index (g/g)</td>
<td>2.23±0.01</td>
<td>3.01±0.04</td>
<td>3.72±0.00</td>
<td>4.10±0.29</td>
</tr>
<tr>
<td>Water absorption capacity (%).ns</td>
<td>123.00±1.00</td>
<td>201.00±4.00</td>
<td>224.00±48.50</td>
<td>310.00±28.50</td>
</tr>
<tr>
<td>Water binding capacity (g/g).ns</td>
<td>19.00±6.20</td>
<td>44.00±4.00</td>
<td>66.80±20.00</td>
<td>53.00±31.40</td>
</tr>
<tr>
<td>Swelling power (g/g)</td>
<td>3.09±0.30</td>
<td>6.11±0.08</td>
<td>6.53±0.09</td>
<td>6.64±0.12</td>
</tr>
<tr>
<td>Solubility index (%).ns</td>
<td>15.00±2.00</td>
<td>16.50±4.50</td>
<td>14.50±2.50</td>
<td>14.50±0.50</td>
</tr>
</tbody>
</table>

A, 100% instant plantain flour; B, 50% instant plantain flour and 50% instant breadfruit flour; C, 30% instant plantain flour and 70% instant breadfruit flour; D, 100% instant breadfruit flour. Mean values in the same row with different superscript are significantly different at P<0.05; ns, no significant difference.

Table 3. Pasting properties of instant plantain-breadfruit flour.

<table>
<thead>
<tr>
<th>Sample/pasting property</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak viscosity (RVU)</td>
<td>267d</td>
<td>71.13c</td>
<td>40.83b</td>
<td>14.05a</td>
</tr>
<tr>
<td>Trough (RVU)</td>
<td>231d</td>
<td>70.42c</td>
<td>39.63b</td>
<td>10.46a</td>
</tr>
<tr>
<td>Breakdown (RVU)</td>
<td>36.29c</td>
<td>0.71a</td>
<td>1.21a</td>
<td>3.59b</td>
</tr>
<tr>
<td>Final viscosity (RVU)</td>
<td>366c</td>
<td>98.46c</td>
<td>60.88b</td>
<td>21.50a</td>
</tr>
<tr>
<td>Setback (RVU)</td>
<td>136c</td>
<td>28.04c</td>
<td>21.25b</td>
<td>11.04a</td>
</tr>
<tr>
<td>Peak time (min)</td>
<td>5.69b</td>
<td>6.75c</td>
<td>6.85c</td>
<td>3.31a</td>
</tr>
<tr>
<td>Pasting temp (°C).ns</td>
<td>48.23</td>
<td>48.00</td>
<td>48.10</td>
<td>47.99</td>
</tr>
</tbody>
</table>

A, 100% instant plantain flour; B, 50% instant plantain flour and 50% instant breadfruit flour; C, 30% instant plantain flour and 70% instant breadfruit flour; D, 100% instant breadfruit flour. Mean values in the same row with different superscript are significantly different at P<0.05; ns, no significant difference.

flours. WAI measures the volume occupied by the starch granule or starch polymer after swelling in excess water which can be used as an index of gelatinization (Altan et al., 2008). Water absorption characteristics represent the ability of a product to associate with water under conditions where water is limited (Singh, 2001). The water binding capacity values were found to be between 19.00±6.20 and 66.80±20.00. Water binding capacity of plantain-breadfruit increased with breadfruit substitution owing to the increase in protein and fat contents. This improves the reconstitution ability and textural ability that is obtainable from the plantain flour (Adebawale et al., 2008). There was significant difference (P<0.05) in the swelling power of the samples at 100°C. The 100% instant breadfruit flour had the highest mean of 6.64±0.12 while 100% instant plantain flour had the lowest mean of 3.09±0.30. There was no significant difference (P>0.05) in the solubility index of all the samples at 100°C. The solubility index mean value of the samples ranged from 14.50±0.50 to 16.50±4.50.

**Pasting properties**

Gelatinization and pasting are properties of flour that are significant in the food industry, because they tend to affect the texture, uses and digestibility of starchy foods (Adebawale et al., 2005). The results of the pasting properties of instant plantain-breadfruit flour are shown in Table 3. There were significant differences (p<0.05) in the pasting profile of the samples except in the pasting temperature. Peak viscosity is the ability of the starch to swell freely before its physical breakdown (Sanni et al., 2004) and it ranged from 14.05 to 267 RVU. The results of pasting properties of the samples indicates that the substitution ‘of breadfruit flour reduced the peak viscosity. The relatively low peak viscosity effect by breadfruit flour addition is an indication that the flour can be used for the production of products that require low gel strength and elasticity (Adebawale et al., 2005). The trough which ranged from 10.46 to 231 RVU is the minimum viscosity value that measures the ability of the paste to withstand breakdown during cooling. 100% instant plantain flour had the highest trough value of 10.46 RVU. The breakdown viscosity of the samples indicates an index for the stability of the starch (Fernandez and Berry, 1989). 100% instant plantain flour had the highest breakdown viscosity value of 36.29 RVU while 50:50 instant plantain-breadfruit flour had the lowest breakdown viscosity value of 0.71 RVU. Breakdown viscosity
measures the ability of paste to withstand breakdown during cooling. Large values indicate little breakdown of sample starches. The final viscosity which ranged from 21.50 to 366 RVU indicates the ability of the flour to form a gel or viscous paste after cooking and cooling as well as the resistance of the viscous paste to shear stress during stirring (Adebowale et al., 2005). The final viscosity of the samples decreased with an increase in breadfruit substitution. The final viscosity is the change in the viscosity after holding cooked starch at 50°C. It is one of the most common parameter used to define the quality of a particular starch-based sample, as it indicates the ability of the flour to form a viscous paste or gel after cooking and cooling as well as the resistance of the paste to shear force during stirring (Adeyemi and Idowu, 1990; Adebowale et al., 2008).

Final viscosity (indicates the ability of the material to form a viscous paste) have been reported as the most commonly used parameter to determine the ability of starch-based materials to form a viscous paste or gel after cooking and cooling as well as the resistance of the paste to shear force during stirring (Adebowale et al., 2005; Maziya-Dixon et al., 2007).

The setback value of the samples ranged from 11.04 to 136 RVU. 100% instant plantain flour had the highest mean value of 136 RVU while 100% instant breadfruit flour had the lowest value of 11.04 RVU. This indicates that the higher the substitution level of breadfruit flour, the more the retrogradation level during cooling and the more the staling of the products made from the flour (Delcour et al., 2000). The peak time is an indication of the cooking time and it ranged from 3.31 to 6.85 min. 30:70% instant plantain-breadfruit flour had the highest mean value of 6.85 min while 100% breadfruit flour had the lowest mean value of 3.31 min. The pasting temperature is an indication of the gelatinization time during processing. It is the temperature at which the first detectable increase in viscosity is noted and is an index associated with the initial change due to the swelling of the starch.

### Sensory evaluation

Table 4 shows the mean sensory scores for instant plantain-breadfruit paste. There were significant differences (P < 0.05) in all the sensory qualities. In terms of colour, the instant yam paste was scored 1.40 or close to ‘like extremely’ ahead of instant plantain-breadfruit paste which was close to ‘like moderately’. Furthermore, there was no significant difference (P > 0.05) in the colour and flavour of the four samples paste. The mean values obtained for flavour ranged from 3.55 to 4.30 which was slightly preferred compared to the score (2.70) obtained for instant yam paste. In terms of taste, 100% instant breadfruit paste was least preferred by the panelists compared to the instant yam paste. Furthermore, there was no significant difference (P > 0.05) in the taste of 100% instant plantain paste and instant yam paste.

The mean values for texture ranged from 3.20 to 4.15 compared to the value (2.50) obtained for instant yam paste. There was no significant difference (P > 0.05) in the texture of instant plantain paste and instant yam paste. There was significant difference (P < 0.05) in the mouldability of the pastes with the values ranging from 2.70 to 5.30; 100% instant plantain paste had the highest preference score (2.70) for mouldability. The preference scores for stretchability ranged from 3.45 to 4.85 with 100% instant plantain paste moderately preferred (3.45) compared with instant yam paste with mean value of 3.75 which was liked ‘slightly’. In terms of mouthfeel, there was no significant difference (P > 0.05) between the instant yam paste and 100% instant plantain paste. In terms of overall acceptability, there was no significant difference (P ≥ 0.05) between the 100% instant plantain paste and the instant yam paste.

### Table 4. Mean sensory evaluation scores of instant plantain-breadfruit paste.

<table>
<thead>
<tr>
<th>Sample/sensory attribute</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>YP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour</td>
<td>3.65&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.35&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.40&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Taste</td>
<td>3.15&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.94&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.75&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.65&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.20&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Texture</td>
<td>3.20&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>3.80&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.15&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.15&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.50&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Flavour</td>
<td>3.55&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.00&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.90&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.30&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.70&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Mouldability</td>
<td>2.70&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.65&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.25&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.30&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.90&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Drawiness</td>
<td>3.45&lt;sup&gt;c&lt;/sup&gt;</td>
<td>4.85&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>4.55&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>4.65&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>3.75&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Mouthfeel</td>
<td>3.45&lt;sup&gt;c&lt;/sup&gt;</td>
<td>4.85&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>4.55&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>4.65&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>3.75&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Overall acceptability</td>
<td>2.90&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.65&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.10&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

A, 100% instant plantain paste; B, 50% instant plantain paste and 50% instant breadfruit paste; C, 30% instant plantain paste and 70% instant breadfruit paste; D, 100% instant breadfruit paste; YP, instant yam paste. Mean values in the same row with different superscript are significantly different at P < 0.05.
Conclusion

The research study showed that breadfruit flour improved the chemical composition characteristics and functional properties of the instant plantain-breadfruit flour which could be an advantage for industrial use. However, the sensory panelist’s scores indicated that the instant yam paste was preferred to the instant plantain-breadfruit blends when reconstituted to make a thick paste, but 100% instant plantain flour was a potential substitute because of its high sensory appeal.

30:70% plantain-breadfruit flour resulted in obvious increase in protein and fat contents, which could be nutritionally advantageous to Nigeria, where people cannot afford high proteinous foods due to the high costs. Further research should be carried out on the storage stability and the mineral contents of instant plantain-breadfruit flour.

REFERENCES


