Original Research Paper

Chemical composition, physical and sensory properties of cakes supplemented with plantain peel flour

Accepted March 9, 2013

P. I. *Akubor¹
and
C. Ishiwu²,

¹Department of Food Science and Technology, University of Nigeria, Nsukka, Nigeria.
²Nnamdi Azikiwe University, Awka, Nigeria.

*Corresponding author
Email: akuborpeter@gmail.com

Unripe plantain fruits were washed peeled and the peels were cut into thin slices (1cm thick). The slices were hot-water blanched at 100°C for 15 min, sulphited (1%, w/v), oven dried, milled and then sieved. The plantain peel flour (PPF) was used to substitute 5, 10, 15, 20, 25, 30, 40 and 50% of wheat flour in cakes which were assessed for their chemical, physical and sensory properties. The results showed that the PPF contained lower moisture (8%), crude protein (7%) and carbohydrate (62.2%) but higher ash (10%), fat (4.8%) and crude fiber (8%) contents than wheat flour. The moisture, crude protein, ash, fat, crude fiber and carbohydrate contents of wheat flour were 10, 11, 0.7, 2.0, 1.0 and 75.3%, respectively. The calcium (96.5mg/100g), sodium (30mg/100g) and potassium (739mg/100g) contents of PPF were significantly higher (p <0.05) than those of the wheat flour which were 29, 3.5 and 315mg/100g, respectively. However, wheat flour had significantly higher levels (p<0.05) of phosphorous and magnesium than PPF. The length, width and height of the 100% wheat flour cake were not significantly different (p>0.05) from those of the cakes containing PPF. However, the 100% wheat cake was heavier and occupied more volume than the cakes containing PPF. The 100% PPF cake was more dense than the other cakes. The cakes containing up to 20% PPF were not significantly different (p>0.05) from the 100% wheat flour cakes in colour, taste, flavour, texture and overall acceptability. The 20% PPF cakes had higher contents of ash, fat, crude fiber, calcium, sodium and potassium than the 100% wheat flour cakes.

Key words: plantain peel, wheat, cake, chemical composition, sensory quality, physical attributes.

INTRODUCTION

Plantain fruit (Musa paradisiaca) is an important staple in Nigeria and other humid tropical countries of African, America and the Caribbean. It is a good source of income to farmers in such areas. The chemical composition of the fruit has been reported by earlier workers (Ketiku, 1973, Baiyeri and Unadike, 2007). Like most fruits, plantain fruit contributes appreciable amount of minerals and vitamins to the diets of many Nigerians. It is used as an inexpensive source of calorie. In such areas where the fruit is cultivated, it is used in various food formulations which are compactable with the local tastes and habits. Thus, it is used in different preparations such as flour, fries, chips, dodo and other value added products. Roasted unripe plantain is consumed with other delicacies such as avocado and roasted fish. Plantain flour is mixed with boiling water to prepare an elastic pastry (amala) in Nigeria and fufu in Cameroon, which is eaten with various sauces. Plantain flour has been used in making biscuits, instant flour and cakes (Ogazi, 1985; Akubor, 2003, Edema et al, 2004). Thus, plantain processing is a means of adding value, increasing product diversification, utilization and enhancing the market price of plantain. The increase in the consumption level of the crop has placed it among the economically important food crop in Nigeria.

Plantain processing generates large quantities of the peels as by-product. Plantain peels are readily available at restaurants, among plantain roasters and those that use plantain for flour, porridge, juice, chips etc. Plantain peel is...
rich in minerals like potassium and phosphorus (Omole et al., 2008). The protein content of plantain peel ranged between 8 and 11% (Tewe, 1983). The peel and trunk are utilized for various agricultural purposes (Ketiku, 1973). Fresh plantain peel is usually given to livestock especially the ruminant as a source of energy. The use of plantain peel in biogas (methanol) production and soap making has been reported (Ogazi, 1990), indicating waste to wealth prospect in plantain production. The increase in processing of plantain necessitates the determination of the potential of plantain peel utilization in human and/or animal diets. Therefore, the objective of this study was to prepare flour from plantain peel and to evaluate the performance of the flour in wheat cake.

**MATERIALS AND METHOD**

**Materials:**

About 5 kg of mature and unripe plantain (Musa paradisica) fruits were purchased from a local farm in Ajaka Township, Kogi state, Nigeria. The fruits were stored in a refrigerator at 10±2°C until used.

**Preparation of plantain peel:**

The unripe plantain fruits were washed with clean tap water, hand-peeled and the peels were cut into thin slices (1cm thick) with a sharp stainless steel knife. The slices were hot-water blanched (100°C, 15 min) and then, soaked in 1% (w/v) sodium metabisulphite solution for 30 min. The slices were oven dried at 60°C to constant weight, milled in an attrition mill, sieved through 60 mesh sieve (British standard) and then packed in high density polyethylene bags. The flour samples were stored in a refrigerator of 10±2°C until used.

**Flour blending**

The plantain peel flour was used to substitute 5, 10, 15, 20, 25, 30, 40 and 50% wheat flour in a Kenwood food processor that was operated as full speed for 10 min. The flour blends were packed in high density polyethylene bags prior to use.

**Preparation of cakes**

Cakes were prepared from the flour blends according to the method described by Ceserani et al., (1995). The recipe used for the preparation of cakes was composed of flour (30g), baking powder (0.5g), egg (12.85g), sugar (12g), vanilla flavour (1.5g), water (25ml), salt (0.15g) and margarine (18g). The dry ingredients were weighed and mixed thoroughly. Margarine was added and rubbed in until thoroughly kneaded. The dough was cut out and baked in greased pans in the oven at 160°C for 20 min.

**Analytical methods**

**Physical evaluation of cakes**

The height, length and width of the rectangular shaped cakes were measured with vernier caliper. Weight was determined with digital weighing balance. Volume of cake was calculated as length x width x height. Density was calculated as weight / volume.

**Chemical evaluation**

Moisture was determined by hot-air oven drying at 105°C to constant weight (AOAC, 2010). Ash, protein (micro-Kjeldahl, N x 6.25), crude fiber and fat (Solvent extraction) were determined by the AOAC (2010) methods. Calorie was calculated using Atwater factors of 4 x % Protein, 4 x % carbohydrate and 9 x % fat and then taking the sum. Sodium and potassium were determined by flame photometry using a flame photometer as described by the AOAC (2010) methods. Phosphorous was determined by the molybdovanadate method (AOAC, 2010). Calcium and magnesium were determined using atomic absorption spectrophotometer (AOAC, 2010).

**Statistical analysis**

Data were analyzed using analysis of variance (Steel and Torrie, 1980). Means where significant were separated by the least significant difference (LSD) test. Significance was accepted at p<0.05. Student T-test was used for paired comparison. Analyses were carried out in 3 replicates.

**RESULTS AND DISCUSSION**

**Proximate composition of flours**

The proximate composition of plantain peel and wheat flours are presented in Table 1. The moisture content of plantain peel flour (PEF) (8%) was lower than that of wheat flour (10.8%). The moisture contents of these flours were within the acceptable limit of not more than 10% for long term storage of flour (Akubor and Eze, 2012). The low moisture content of PPF would enhance its storage stability by preventing mould growth and reducing moisture dependent biochemical reactions (Onimawo and Akubor, 2012). Akubor and Eze (2012) had documented that the moisture content of a food material is of significance to shelf life, packaging and general acceptability. The reduction of moisture content of a food during production would enhance its suitability and adaptability for further use in food formulation. The PPF had significantly lower (P<0.05) protein content (7.0%) than wheat flour (11%).
Table 1: Chemical composition of plantain peel and wheat flours.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Plantain peel flour</th>
<th>Wheat flour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (%)</td>
<td>8.0±0.08</td>
<td>10.0±0.05</td>
</tr>
<tr>
<td>Crude protein (%)</td>
<td>7.0±0.09</td>
<td>11.0±0.03</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>10.0±0.04</td>
<td>0.7±0.01</td>
</tr>
<tr>
<td>Crude fat (%)</td>
<td>4.8±0.01</td>
<td>2.0±0.09</td>
</tr>
<tr>
<td>Crude fiber (%)</td>
<td>5.0±0.10</td>
<td>1.0±0.04</td>
</tr>
<tr>
<td>Carbohydrate (%)</td>
<td>62.2±0.12</td>
<td>75.3±0.10</td>
</tr>
<tr>
<td>Energy (kcal/100g)</td>
<td>320±0.03</td>
<td>363.2±0.09</td>
</tr>
</tbody>
</table>

Values are means ± SD of 3 replicates. Means within a row with the same superscript were not significantly (P > 0.05).

Table 2: Mineral composition of plantain peel and wheat flours

<table>
<thead>
<tr>
<th>Parameter (mg/100g)</th>
<th>Plantain peel flour</th>
<th>Wheat flour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>96.5±0.14</td>
<td>29.0±0.14</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>144.0±0.21</td>
<td>350±0.64</td>
</tr>
<tr>
<td>Magnesium</td>
<td>112.0±0.30</td>
<td>140±0.35</td>
</tr>
<tr>
<td>Sodium</td>
<td>30.0±0.09</td>
<td>3.5±0.08</td>
</tr>
<tr>
<td>Potassium</td>
<td>739.0±0.42</td>
<td>315±0.38</td>
</tr>
</tbody>
</table>

Values are means ± SD of 3 replicates. Means within a row with the same superscript were not significantly different (P > 0.05).

The protein content obtained in this study was lower than the range of 8-11% previously reported for plantain peel (Tewe, 1983). Baiyeri (2001) has reported that the nutritional value of Musa SPP fruit varies with cultivar, stage of ripeness, soil and climatic conditions under which the fruits were cultivated. However, the PPF contained significantly higher (P < 0.05) amounts of ash, crude fat and crude fiber than wheat flour. The ash content of PPF was 10% while that of wheat flour was 0.7%. Omole et al (2008) showed that the minerals in plantain were concentrated in the peel. The crude fiber content of the PPF (5%) was five times higher than that of wheat flour (1.0%). This value was higher than 5.7% crude fiber previously reported for unripe plantain pulp (Akubor and Ojih, 2009). The PPF could be a potential source of fiber. However, PPF offers some advantages over cereal grains and legume hulls as fiber source. The peel had low phytic acid which renders some advantages over cereal grains and vegetables have a relatively high proportion of soluble dietary fiber (Onimawo and Akubor, 2012). This kind of fiber shows some functional properties such as water holding, oil holding, swelling capacity, viscosity or gel formation, (Van Soest, 1978). These properties of fiber play an important role in the prevention and treatment of obesity, atherosclerosis, coronary heart diseases, colorectal cancer and diabetes (Trowell, 1976). The carbohydrate content of PPF (62.2%) was, however, lower than that of wheat flour (75.3%). Similarly, wheat flour (363.2 Kcal /100g) contained higher amount of energy than PPF (320 kcal /100g), because of the higher protein and carbohydrate in wheat flour.

Mineral composition of flours

The mineral composition of plantain peel flour (PPF) and wheat flour are given in Table 2. The calcium content of the PPF (96.5mg/100g) was significantly higher (P < 0.05) than that of wheat flour (29 mg/100g). The sodium and potassium contents of PPF were 30 and 739 mg/100g, respectively. These values were higher than those of wheat flour which were 3.5 mg/100g sodium and 315 mg/100g potassium. However, the amounts of phosphorus (350 mg/100g) and magnesium (140 mg/100g) in wheat flour were significantly higher (P < 0.05) than those of PPF which were 144 and 112 mg/100g for phosphorus and magnesium, respectively.

Physical characteristics of cakes

The physical properties of cakes prepared from PPF and wheat flour blends are shown in Table 3. The cake containing 100% wheat flour and those containing various levels of PPF had the same height and width. The length and width of the cakes were 15 cm and 4.8 cm, respectively. The height of the 100% wheat cake was 1.9 cm while that of the 100% PPF cake was 1.8 cm. The cakes containing up to 20% PPF had the same height of 1.9 cm as the control. Gas
retention is a property of wheat flour protein (gluten). During dough development, the gluten becomes extensive and strong. This allows the dough to rise and also prevents easy escape of the gas during baking. This property was absent in the 100% PPF and appears to explain the lower density of the 100% PPF cake compared to the 100% wheat cake.

The weight of the cakes decreased with the incorporation of PPF. The decrease in weight of the cakes was probably due to the inability of the PPF to retain oil during the baking process (Baljeef et al., 2010). The 100% wheat cake occupied more volume (136.8 cm³) than the 100 PPF cake (129.6 cm³). The 20% PPF cake had the same volume as the 100% wheat cake.

Sensory characteristics of cakes.

The sensory properties of the cakes are shown in Table 4. The 100% wheat cake was more preferred to the test samples in respect of colour, taste, flavour, texture and overall acceptability. The cakes containing 100% PPF were rated lowest with respect to other cakes for all the sensory attributes assessed. The scores for all the attributes decreased steadily as the level of PPF increased in the cakes. However, the cakes containing up to 20% PPF were not significantly different (P > 0.05) from the 100% wheat cake in the entire sensory attributes including overall acceptability. Visually, the colour of the 100% PPF cake was dull brown, while the colour of the 100% wheat cake was golden brown. This consequently affected the score given by the panelists for the cakes containing PPF. The observed
Table 5: Chemical composition of cakes prepared from plantain peel flour (PPF) and wheat flour (WF) blends

<table>
<thead>
<tr>
<th>Parameter</th>
<th>PPF</th>
<th>CAKE/WF</th>
<th>PPF/WF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (%)</td>
<td>31.0± 0.20</td>
<td>29.0±0.25</td>
<td>30.0±0.31</td>
</tr>
<tr>
<td>Crude protein (%)</td>
<td>8.3±0.09</td>
<td>12.2±0.008</td>
<td>11.4±0.01</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>11.2±0.08</td>
<td>1.0±0.1</td>
<td>4.0±0.04</td>
</tr>
<tr>
<td>Crude fat (%)</td>
<td>16.0±0.07</td>
<td>13.0±0.03</td>
<td>14.5±0.06</td>
</tr>
<tr>
<td>Crude fiber (%)</td>
<td>6.0±0.02</td>
<td>2.0±0.04</td>
<td>3.0±0.07</td>
</tr>
<tr>
<td>Carbohydrate (%)</td>
<td>27.5±0.10</td>
<td>42.8±0.21</td>
<td>37.1±0.30</td>
</tr>
<tr>
<td>Energy (kcal/100g)</td>
<td>287.2±0.41</td>
<td>337.0±0.52</td>
<td>324.5±0.81</td>
</tr>
</tbody>
</table>

Values are means ± SD of 3 replicates. Means within a row with the same superscript were not significantly different (P>0.05). The PPF/WF cake contained 20% PPF and 80% WF.

Table 6: Mineral composition of cakes prepared from plantain peel flour (PPF) and wheat flour (WF) blend

<table>
<thead>
<tr>
<th>Parameter</th>
<th>PPF</th>
<th>WF</th>
<th>PPF/WF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium (mg/100g)</td>
<td>9.85±0.23</td>
<td>30.4±0.31</td>
<td>45.0±0.80</td>
</tr>
<tr>
<td>Phosphorus (mg/100g)</td>
<td>145.8±0.49</td>
<td>351.2±0.84</td>
<td>312.0±0.81</td>
</tr>
<tr>
<td>Magnesium (mg/100g)</td>
<td>113.5±0.58</td>
<td>141.4±0.25</td>
<td>135.0±0.49</td>
</tr>
<tr>
<td>sodium (mg/100g)</td>
<td>32±0.09</td>
<td>4.8±0.04</td>
<td>9.8±0.03</td>
</tr>
<tr>
<td>Potassium (mg/100g)</td>
<td>740.6±0.81</td>
<td>317.1±0.74</td>
<td>403.0±0.81</td>
</tr>
</tbody>
</table>

Values are means ± SD of 3 replicates. Means within a row with the same superscript were not significantly different (P>0.05). The PPF/WF cake contained 20% PPF and 80% WF.

colour of the 100% PPF cake could be attributed to the presence of residual tannic substances in the processed PPF (Ahenkoro et al, 1996). The acceptability of the PPF cakes colour decreased with the addition of PPF because the PPF had dull colour. The score for taste reduced slightly with increased level of PPF possibly due to the presence of tannins having bitter taste in PPF (Izon and Omuoru, 1990).

**Proximate composition of cakes**

The proximate composition of the cakes prepared from plantain peel and wheat flour blends is shown in Table 5. The moisture content of the 100% wheat cake (29%) was lower than the 30% for the cake containing 20% PPF. This was probably due to the ability of the PPF to retain water than the wheat flour. The 20% PPF cake had comparable protein content (11.4%) with the 100% wheat flour cake (12.2%). These protein levels were significantly higher (P<0.05) than the 8.3% for the 100% PPF cake. This demonstrates the beneficial effect of blending food in food product development. This result agreed with the report of Akubor (2005) that nutritional enhancement would be the advantage in the use of composite food products. The ash content increased from 1% in the 100% wheat flour cake to 4% in the 20% PPF cake. The increase in ash content may be due to the high ash content of PPF (Table 1). The fat content increased from 13% in the control to 14.5% in the 20% PPF cake. High oil retention improves the mouthfeel and retains the favour of cakes (Kensella, 1987). Crude fiber was also higher in the 20% PPF cake (3%) than in the control (2.0%). The low fat content of the 20% PPF cake in relation to the 100% PPF cake was probably due to dilution effect. The carbohydrate content as determined by difference method was higher in the 100% wheat flour cake (13% in the 100% PPF cake) than in the 20% PPF cake due to dilution effect.

**Mineral composition of cakes**

The mineral composition of cakes prepared from plantain peel and wheat flour blends is presented in Table 6. The calcium content increased from 30.4 mg/100g in the 100% wheat flour cake to 45 mg/100g in the 20% PPF cake due to addition effect. The 20% PPF cake is a good source of calcium. Calcium is essential for proper bone and teeth formation. The phosphorus content decreased from 351.2mg/100g in the 100% wheat cake to 312 mg/100g in the 20% PPF cake due to dilution effect, wheat flour being...
higher in phosphorus than PPF. Similar trend was observed for the magnesium contents of the cakes. Magnesium is an essential constituent of all cells and is necessary for the functioning of enzymes involved in energy utilization and it is present in the bone (ADA, 2002). Deficiency of magnesium is rare and results from excessive loss in diarrhea rather than from low intakes. The sodium and potassium contents of the 100% wheat flour cake increased following the addition of PPF. The sodium content increased from 4.8mg/100g in the 100% wheat cake to 9.8mg/100g in the 20% PPF cake. On the other hand, the potassium content increased from 317mg/100g in the 100% wheat cake to 403 mg/100g in the 20% PPF cake. The American Diabetes Association (2000) reported that the amount of sodium in the diet should be limited since sodium helps to increase blood pressure and the tendency to retain fluid. The ADA (2002) recommended an average daily intake of less than 200/mg per day. Foods that contain 140mg of sodium or less are considered as low sodium foods (ADA, 2002). The required daily intake for sodium is 0.12 to 1.8g per day (ADA, 2002). The high potassium/sodium ratio (41.12:1), observed in the 20% PPF cake, is desirable because an average human diet is low in potassium but high in sodium (ADA, 2002).

Conclusion

The addition of plantain peel flour into wheat cake formulation had considerable effects on the chemical, physical and sensory properties of the cakes. It may be concluded from the present study that plantain peel flour can be incorporated into the wheat cake up to 20% to yield cakes of enhanced nutritional quality with acceptable sensory attributes. Hence, the development and utilization of such foods will improve the nutritional status of the population. However, more studies should be conducted to investigate the possibility of using plantain peel flour as an ingredient on other food products in order to increase the application of such value added food ingredient.

REFERENCES