Production and Evaluation of Biscuits from Blends of Bambara Groundnut (*Vigna Subterraneae*) and Wheat (*Triticum Eastrum*) Flours

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**Abstract** - Biscuit was produced from blends of wheat flour and Bambara groundnut flour at different ratios of 90:10; 70:30; 60:40 and 50:50 (wheat flour: Bambara groundnut flour) respectively and vice versa. From the results of the proximate composition, it was observed that the moisture contents of both wheat flour and Bambara groundnut flour are closely related with a value of 12.0% and 12.30% respectively. Also the other components of ash, fat, crude fibre and protein were in the ranges of 0.70% and 3.68%; 1.53% and 0.18%, 0.70% and 6.18% and 13.24% and 20.13% for wheat and Bambara g/nut respectively. From this data, it was also observed that Bambara groundnut flour had higher protein content than wheat flour and as such could enhance the protein level of the biscuits produced from the blends. From the sensory evaluation result, it was observed that though the 100% wheat flour biscuit (A) was not accepted, the substitution of Bambara groundnut up to 40% level was also accepted by panellist. With these results, the use of Bambara groundnut to substitute wheat flour up to 40% level is advocated. This will reduce the pressure in using only wheat for baking biscuit and also diversify the use of Bambara groundnut which is only currently used as steamed bean cake.

**Index Terms** — Biscuit, proximate composition, sensory evaluation, steamed bean cake.

I. INTRODUCTION

Biscuit belong to the flour confectionery. It is flat crisp and may be sweetened or unsweetened according to preference. Biscuit can be made from hard dough e.g. crackers, hard sweet dough e.g. rich tea and short or soft dough e.g. short bread and short cake. It is produced by mixing various ingredients like flour, fat, sweeteners and water to form dough. The dough formed unlike bread is not allowed to ferment, and then it is baked in the oven [1]. It could be baked in the primitive or modern oven, but the fundamental ingredient is wheat flour. The flours that are ground from wheat have the unique ability to form a cohesive gluten network when worked with water. This simple discovery set the stage for the development of many yeast breads, biscuits, pastries, cakes, cookies and other baked products that are so popular today [2]. Biscuit and other baked food products are important items belonging to the class of food that are sold in ready to serve form.

All biscuits are nutritionals, contributing valuable quantities of iron, calcium, protein, calorie, fibre and some of the B-vitamins to our diet and daily food requirement. Composite flour has the added advantage of improving the nutrient value of biscuits and other bakery products especially when cereals are blended with legumes e.g. Bambara groundnut. Osuntogun [3] suggested the ratio of 50:50 (wheat and non-wheat) flour mixture for biscuit and other bakery products.

The food uses of Bambara groundnut include feeding of cattle and pigs with the chaff. It also serves as food for poultry. Bambara groundnut can also be used as flour for baking. Because of its nutritional value, it can be used to prepare steamed gel (moi moi) for human consumption. It can be boiled in the seed and eaten [2].

As a legume, Bambara groundnut is high in protein that play important role in human nutrition. A detailed study shows that it contains 20-26% crude protein (high in lysine; 6.6%); and makes an excellent source of supplementing proteins in the diet [4].

Bambara groundnut has high vitamin and mineral contents like iron, phosphorous and calcium. It also has a high content of crude fibre and high level of sulphur containing amino acids which are limited in cereals. These compositions gave Bambara its high nutritive and health value [4].

Virtually all the wheat used for baking in confectionery industries especially biscuits is imported. Therefore campaign on the use of composite flour is being advocated. With the ban on importation, it is hoped that these indigenous crops should be revived and used as substitutes for imported ones.
The objectives of this research work therefore are:

- To identify the proximate composition of Bambara groundnut flour.
- To blend Bambara groundnut with wheat flour in the production of biscuits.
- To determine the optimum level of Bambara groundnut flour substitution that would give an acceptable biscuit using sensory parameters.

It is hoped that the result will increase the utilization of this crop and will reduce the pressure on wheat flour for the production of biscuits and other bakery products that are of good and acceptable quality.

II. MATERIALS AND METHODS

A. Material Procurement

The Bambara groundnut seeds were purchased at Ekeonuwa market in Owerri Metropolis in Imo State, Nigeria. The equipment and chemicals were obtained from the Department of Food Science and Technology, Federal University of Technology, (FUT) Owerri, Imo State, Nigeria. The chemicals and reagents used were of analytical grade.

B. Preparation of the Flour Samples

The Bambara groundnut was sorted to remove extraneous materials and damaged seeds. The seeds (seed water) were then soaked in tap water at a ratio of 1:2 for 12h at room temperature. It was manually dehulled and dried in the Gallenkamp (United Kingdom) moisture extraction oven at 60°C for 3h. The dried seeds were finely ground using the hammer mill to obtain the flour.

The flour used for biscuit production was from blends of Bambara groundnut flour and wheat flour. The flour was obtained by blending in the ratio of (100:0; 90:10; 80:20; 70:30, 60:40; and 50:50, (wheat flour: Bambara groundnut flour) and vice versa. The 100% wheat flour biscuit was used as the control sample.

The method used for the preparation of dough was the creaming method where fat and sugar were creamed together using the Kenwood mixer (United Kingdom) at medium speed for two min. After creaming flour, baking powder and milk were added and mixed until dough was well mixed. The dough was manually kneaded to ensure uniformity. The dough was then transferred to a clean tray and gently rolled using a roller. The dough sheath was cut into round shapes using a cutter. Shaped dough pieces were placed into a greased pan and baked in the oven at 200°C for 15min. The baked biscuits were placed on a cooling rack for 30min to cool before packaging.

![Flow diagram for the preparation of Bambara groundnut flour](image-url)
C. **Proximate Analysis**

The proximate analysis of the flour samples was carried out according to the method of [5].

D. **Sensory Evaluation**

Sensory evaluation of biscuit samples from various flour blends was conducted using a 25 member untrained panellists drawn from the general public. The test was conducted while the samples were still fresh. The panellists were required to observe the sample, taste and score. Then rinse their mouth with water before tasting another sample/product. The products were analysed based on the following parameters of appearance, texture, crispness, flavour and overall quality using a nine-point hedonic scale of 9 = liked extremely down to 1 = disliked extremely as described by [6].

III. **RESULTS AND DISCUSSION**

The result of the proximate composition of the flour samples is shown in Table I below. From the Table I; it was observed that the protein content of Bambara groundnut was 20.13% which was higher than that of wheat flour (13.24%). This was expected because Bambara groundnut is a legume while wheat is a cereal grain and legumes naturally have more protein than cereals although the prevalent protein in wheat occurs as gluten which is needed in baking. The high protein content of food legumes generally constitute the natural protein supplements to staple diet and Bambara groundnut in Africa at least represent the legume of choice for many such population. Also the nutritive value of Bambara groundnut is similar to that of most edible legumes.

Massawe et al [7] reported that it contains about 24% protein and 62% soluble carbohydrates and small amount of other nutrients which is in correspondence with our findings. Most of its nutritional value is provided by carbohydrate, protein and fibre. This variation in protein percentage could be influenced by environmental factors as reported by [8; 9; 10].
The result of the sensory evaluation is shown in Table II below. From the result; the appearance of the biscuit samples was fairly good. From the results; it was observed that the best crispness as indicated by the panellist was from the 100% wheat flour biscuit which had a mean value of 7.64 closely followed by the product from 10% and 20% substitutions with Bambara g/nut which had 7.56 and 7.27 respectively, though there was no significant difference (P ≥ 0.05) between them. There occurred a significant difference (P ≤ 0.05) at 30% substitution though no significant difference (P ≥ 0.05) occurred from 30% up to 50% substitution with Bambara g/nut flour. Panellists accepted the crispness at up to 50% substitution of a mean value of 5.84 which could be liked slightly.

From the result, the crispness of the biscuits decreased with increase in the level of bambara g/nut flour. This could be attributed to the lower gluten content of bambara g/nut since gluten is responsible for the extensibility of the dough. Flour for biscuit should be more extensible but less springy as reported by [11] such that when masticated, such biscuits would be crispy.

Based on appearance, the sample with 100% wheat flour ranked highest with a mean value of 8.2. This was very close to 20% and 30% substitutions of 7.84 and 7.51 and there was no significant difference (P ≥ 0.05) between the three samples. Substitution up to 40:60 and even up to 50:50 (Bambara: wheat flour) were fairly accepted by the panellists having a score of 6.20; and up to (10:90) with a mean value of 5.55.

Based on Aroma, there was no significant difference (P ≥ 0.05) up to 80:20 substitutions (wheat: Bambara). Also there was no significant difference (P ≥ 0.05) from 70:30 (6.36) (Wheat: Bambara) substitution up to 30:70 substitution (6.01). The products were likely slightly. Since aroma is a determining factor in consumers’ acceptance of biscuit it can be deduced that the biscuit is accepted up to 70% substitution with Bambara g/nut. The only handicap is the slight aroma of the beamy off flavour that was still noticed.

### Table I

<table>
<thead>
<tr>
<th>Parameters (%)</th>
<th>Samples Wheat flour</th>
<th>Bambara g/nut flour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture content</td>
<td>12.00</td>
<td>12.30</td>
</tr>
<tr>
<td>Protein content</td>
<td>13.24</td>
<td>20.13</td>
</tr>
<tr>
<td>Crude fibre content</td>
<td>0.70</td>
<td>6.18</td>
</tr>
<tr>
<td>Fat content</td>
<td>1.53</td>
<td>0.18</td>
</tr>
<tr>
<td>Ash content</td>
<td>0.70</td>
<td>3.68</td>
</tr>
<tr>
<td>Carbohydrate content</td>
<td>72.53</td>
<td>52.49</td>
</tr>
</tbody>
</table>

### Table II

<table>
<thead>
<tr>
<th>Samples</th>
<th>Crispness</th>
<th>Appearance</th>
<th>Aroma</th>
<th>Taste</th>
<th>Texture</th>
<th>Overall Acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 100:10</td>
<td>7.64a</td>
<td>8.2a</td>
<td>7.36a</td>
<td>7.68a</td>
<td>7.48a</td>
<td>7.96a</td>
</tr>
<tr>
<td>B 90:10</td>
<td>7.56a</td>
<td>7.84a</td>
<td>6.92a</td>
<td>7.60a</td>
<td>7.32a</td>
<td>7.76a</td>
</tr>
<tr>
<td>C 80:20</td>
<td>7.27a</td>
<td>7.51a</td>
<td>6.55a</td>
<td>7.41a</td>
<td>6.83a</td>
<td>7.43a</td>
</tr>
<tr>
<td>D 70:30</td>
<td>6.40b</td>
<td>6.80b</td>
<td>6.36b</td>
<td>6.44b</td>
<td>6.76b</td>
<td>6.44b</td>
</tr>
<tr>
<td>E 60:40</td>
<td>6.20b</td>
<td>6.60b</td>
<td>6.20b</td>
<td>6.24b</td>
<td>6.40b</td>
<td>6.16b</td>
</tr>
<tr>
<td>F 50:50</td>
<td>5.84b</td>
<td>6.28c</td>
<td>6.08b</td>
<td>5.84c</td>
<td>6.12d</td>
<td>5.60c</td>
</tr>
<tr>
<td>G 40:60</td>
<td>5.68c</td>
<td>6.20c</td>
<td>6.06b</td>
<td>5.68c</td>
<td>5.58c</td>
<td>5.04d</td>
</tr>
<tr>
<td>H 30:70</td>
<td>5.16c</td>
<td>6.12c</td>
<td>6.01b</td>
<td>5.20d</td>
<td>5.28c</td>
<td>4.92d</td>
</tr>
<tr>
<td>I 20:80</td>
<td>4.93d</td>
<td>5.96c</td>
<td>5.91c</td>
<td>5.10d</td>
<td>5.80e</td>
<td>4.80e</td>
</tr>
<tr>
<td>J 10:90</td>
<td>4.36e</td>
<td>5.55c</td>
<td>5.76c</td>
<td>4.32c</td>
<td>5.54c</td>
<td>4.60f</td>
</tr>
<tr>
<td>K 0:100</td>
<td>3.44f</td>
<td>4.44d</td>
<td>5.24c</td>
<td>3.24c</td>
<td>5.00d</td>
<td>3.60f</td>
</tr>
</tbody>
</table>

*Keynote - Mean values down the column with the same superscripts are not significantly different at P ≥ 0.05.*

Samples A = 100% wheat flour and 0% Bambara g/nut
The Taste result showed that the 100% wheat flour biscuit had the highest mean score of 7.68. This was closely followed by that of 10% and 20% substitutions with Bambara g/nut with mean scores of 7.60 and 7.41 respectively and there was no significant difference (P ≥ 0.05) between them. This result has proved that these three samples were equally accepted in terms of the taste of the biscuit samples. A significant difference (P ≤ 0.05) however occurred between these samples and those of all other samples. There was no significant difference between 70:30 and 60:40 (wheat: Bambara) substitutions although significant difference (P ≤ 0.05) occurred between this two and the rest of the samples.

From the result, it could be deduced that up to 60% substitution with Bambara g/nut could be accepted by the consumers with a mean score of 5.68.

The texture of the products were fairly accepted (slightly liked) at up to 50% substitution with Bambara g/nut. There was no significant difference (P ≥ 0.05) in texture up to 20% substitution (A, B, C) while a significant difference (P ≤ 0.05) occurred between them and all the other samples.

From the results of the overall acceptability of the samples, there was no significant difference (P ≥ 0.05) between samples A, B, C (up to 20% substitution with Bambara g/nut) with mean scores of 7.96, 7.76 and 7.43 respectively. Also up to 50% substitution with a mean score of 5.60 was slightly liked by panellists. This showed that the panellists accepted this product up to 50% level of substitution of wheat flour with Bambara g/nut flour. Since all the parameters used in this sensory evaluation had good sensory scores, it could be recommended that up to 60% Bambara g/nut flour be used in the substitution of wheat flour in the production of biscuits.

IV. CONCLUSION

Results from this work have shown that Bambara g/nut could be used for substituting wheat flour up to 40% level in the production of biscuits without adversely affecting the sensory attributes of the biscuits. Although, biscuits made from higher levels of flour substitution were significantly different in most of the attributes; they were still fairly accepted by consumers. The use of this flour will reduce the pressure on wheat flour and help to improve the utilization of Bambara g/nut, and prevent it from going into extinction.

V. RECOMMENDATION

Although a good product was best obtained at just 20% substitution, it is recommended that more studies be undertaken to eliminate completely the beany off flavour which affected the acceptability of the product. The Bambara g/nut flour could be bleached so as to remove the colour pigments that made the biscuit samples to appear burnt.

REFERENCES

