QUALITY CHARACTERISTICS OF COOKIES PRODUCED FROM WHEAT, ACHA AND PIGEON PEA FLOUR BLENDS

James Abiodun Adeyanju1*, Grace Oluwakemi Babarinde1, Akinfemiwa Ayobami Adekunle2
Ajekigbe Sola Olajire1, Adeola Abimbola Adegbeye1
1Department of Food Science and Engineering, Ladoke Akintola University of Technology, Ogbomoso, Nigeria
2National Biotechnology Development Agency, Bioresource Development Centre, Ogbomoso, Nigeria
*Email: jaadeyanju@lautech.edu.ng

Abstract
Cookies were produced from blends of wheat (Triticum aestivum), acha (Digitaria exilis) and pigeon pea (Cajanus cajan) flours at different proportions. The flours were analyzed for functional properties, pasting properties, anti-nutrient. Cookies produced from the flour blends sample were evaluated for proximate composition and sensory attributes. The oil absorption capacity, water absorption capacity, swelling capacity and solubility for the wheat-acha and pigeon pea flour blends ranged from 125 to 141%, 158 to 185%, 15.55 to 18.80%, and 40.25 to 41.88% respectively. The peak viscosity, breakdown value, final viscosity, setback value, peak time and pasting temperature of the flour blends ranged from 94.37 to 102, 19.43 to 19.65, 95.88 to 124, 26.93 to 33.75, 5.13 minutes to 5.25 minutes, 60.47 °C to 60.93 °C respectively. The tannin, trypsin inhibitor and phytate of the flour blends ranged from 8.17 to 8.58 mg/100g, 2.97 to 4.93 mg/100g and 0.35 to 0.43 mg/100g respectively. The protein, fat, ash, moisture, fiber and carbohydrate values for the cookies ranged from 14.23 to 15.03%, 15.14 to 15.43%, 0.38 to 0.89%, 2.56 to 2.74%, 5.10 to 5.33% and 61.38 to 61.81% respectively. Sensory evaluation of the cookies by the panelists showed that the products were well accepted in terms of colour, flavour, taste, crispiness, and mouthfeel as none of the products was rejected. However, the (20% wheat, 50% acha and 30% pigeon pea) sample was the most acceptable. Thus, the inclusion of pigeon pea in wheat-acha flour improved both the nutritional and sensory properties.

Keywords: Acha, pigeon pea, wheat, composite flour and cookies

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1. INTRODUCTION

Increasing trends in the level of protein deficiency have been occurring in the diets of people who eat carbohydrate based foods. Carbohydrate-based snacks such as cookies, doughnuts and potato chips have relatively low nutritional value (Lasekan and Akintola, 2002). The protein-calorie sources of vegetable origin have been proposed as a solution to this problem (Abioye et al., 2011), because legume proteins are high in lysine, an essential amino acid limited in most cereals (Alain et al., 2007). Cookies are commonly eaten by adult and children at an equal rate. Cookies is a product that has been dried to a relatively low moisture content (Okaka, 2009), and soften than biscuits. Cookies comprise of more composite flour than bread because it is ready to eat, wide consumption, longer shelf-life and good eating quality (McWatters et al., 2003).

Wheat (Triticum aestivum) the most important staple food crop for more than half of the entire population and supply energy and proteins to the world diet than all other cereal crops (Adams et al., 2002; Shewry, 2009). It contains more essential nutrients, easy to store and transport and can be further processed into another type of food. Wheat is a good source of protein, minerals, B-group vitamins and fiber (Shewry, 2007).

Acha (Digitaria exilis) is an annual cereal crop indigenous to West Africa where it is cultivated for its straw and edible grains. Acha is also known as “grain of life” in communities of West Africa, it matures early in the farming season, when other crops are yet to mature for harvest (Ibrahim; 2001). Acha grains are also considered as the best tasting and nutritious of all grains (Vietmeyer et al., 1996), it has 7% crude protein which is high in leucine which is about 9.8%, methionine is about 5.6% and valine is about 5.8% (Temple and Bassa,
1991). The grain contains methionine and cystine, and has low sugar on consumption (Ayo et al., 2003). Pigeon pea (Cajanus cajan) is a nutritionally important food crop of the leguminous family that exist in tropical and subtropical regions of the continent (Rampersad et al., 2003). Legumes are usually rich in proteins, essential amino acids and minerals, and are used to supplement other foods (Etonihu et al., 2009). Pigeon pea has a fairly high protein, relatively low fiber content and rather small seeds and is drought-resistant. Pigeon pea contains about 5.14% ash, 21.32% protein, 7.29% fiber, 54.25% carbohydrates, 3.8% fat, 10.1% moisture (Onimawo and Akpojovwo, 2006) and it is an important source of food calories and minerals. Pigeon pea flour contains a reasonable amount of protein, due to this reason it can be used as food supplement for cereal food products due to its high level of protein, iron and phosphorus (Harinder et al., 1999). Therefore, the aim of this research work was to determine the chemical, nutritional and sensory qualities of the cookies produced from blends of acha, pigeon pea and wheat flour.

2. MATERIALS AND METHODS

Materials
Seeds of pigeon pea were purchased at one market in Ife Odan, Osun state while acha grains were obtained from a local market in Jos, Plateau State. Other ingredients such as wheat flour, sugar, margarine, baking powder, eggs, milk and vegetable oil were purchased from Waso market in Ogbomoso, Oyo State, Nigeria.

Processing of Acha
Acha grains were processed into flour according to the method of Olapade et al. (2010). Acha grain was cleaned to remove some extraneous material by handpicking. Acha grains was washed with water and dried at a temperature of 50 °C for four hours. The grains were dry milled using a hammer mill and sieved to pass through 0.2 mm mesh to produce acha flour. The flour was packaged in a container to prevent the flour from absorbing the moisture.

Processing of Pigeon Pea
Pigeon pea seed was cleaned to remove the damaged insect and other extraneous material from the seed and was soaked in hot water for 1 hour. The seeds were manually dehulled by means of mortar and pestle to separate the seed coats from the cotyledon; the dehulled seeds were dried for 12 hours before milling. The sample was sieved using 0.5 mm sieve to obtain flour sample and was stored in a container to prevent the flour from absorbing the moisture according to the method of Enwere et al. (2003).

Composite Flour Formulation
Composite flour formulation was prepared from a blend of wheat, acha and pigeon pea in the ratio of 100:0:0, 35:55:10; 20:60:20; 35:45:20 and 20:50:30.

Preparation of Cookies
The cookies were produced from 100 g of composite flour, 1 g of salt, 1g baking powder, 31 g of egg, 40 g of margarine, 25 g of sugar, 7.8 g of milk and 5 ml vanilla flavour. Margarine and sugar were creamed to homogeneity using an electric mixer at a medium speed for 5 minutes. Egg and milk were added and then mixed for 30 minutes. Other ingredients such as vanilla flavour, composite flour, baking powder and salt were properly mixed before added to mixed cream before it was mixed together to form a dough. The dough was kneaded to a uniform slice thickness of 0.5 cm and a circular cut of 5cm diameter. It was allowed to bake at 150 °C for 30 minutes and then cooled (Okpala, 2012).

Analyses

Functional Properties Determination
Oil Absorption Capacity was determined according to the method of Giami et al. (2002). Swelling capacity and solubility were determined using the method of Ukpabi and Ndimele (1990). Water holding capacity was obtained according to the method of Giami et al. (2002).

Pasting characteristics Determination
A modified method of the Brabender Amylograph procedure known as the Rapid
Visco-Analyser (RVA) procedure as contained in the operation manual for the series 3 Rapid Visco-Analyser was adopted.

**Anti-nutrients Determination**
Tannin content was obtained by the method of Folin-Denis (AOAC, 1990); trypsin inhibitor activity was obtained by a spectrophotometric method described by Arntifield et al. (1985), while phytate was obtained by the method described by Pearson (1976).

**Proximate Composition Determination**
The moisture, crude protein, fats, fiber and ash contents of the composite cookies samples were determined using AOAC (2005). The total carbohydrate was obtained using Equation (1) Carbohydrate = 100% - (moisture + protein + fat + ash + crude fiber) % (1)

**Sensory Evaluation**
The sensory evaluation was determined using a fifteen-member panelist consisting of students from the Department of Food Science and Engineering, Ladoke Akintola University of Technology, Ogbomoso, Nigeria. Cookies samples were coded and served to panelists in a white plastic plate using a 9 point hedonic scale where 1 implies dislike extremely and 9 implies like extremely. Table water was used to rinse the mouth between evaluations. The panelists were instructed to evaluate the coded samples for crispiness, colour, taste, flavour, aroma and overall acceptability.

**Statistical Analysis**
Data obtained were subjected to statistical analysis using one-way analysis of variance (ANOVA). Mean separation was done by Duncan’s multiple range test using the Statistical Package for the Social Sciences (SPSS) 20.0 (SPSS Inc., Chicago, IL, USA).

3. RESULTS AND DISCUSSION

**Functional Properties of Wheat, Acha and Pigeon Pea Flours**
The results of the functional properties of wheat, acha and pigeon pea flour blends are presented in Table 1. The oil absorption capacity, water absorption capacity, swelling capacity and solubility index ranged from 125 to 141%, 158 – 185%, 15.55 g/g to 18.80 g/g and 40.25% to 41.88%, respectively. The OAC of the flour blends were generally high. Oil absorption capacity is the ability of flour to absorb oil which is important as oil act as flavour retainer and improves mouthfeel (Aremu et al., 2007). Water absorption capacity is the ability of a product to associate with water under limiting conditions. Flours with such high WAC as seen in this research work are very good in bakery products, because this will prevent staling by reducing moisture loss (Singh, 2001). High swelling capacity has been reported as part of the criteria for a good quality product (Nlba et al., 2001). The swelling capacity of the flour samples can be compared with results reported by Abulude et al. (2006). Swelling power provides evidence of the magnitude of interaction between starch chains. The solubility index of sample 35/55/10 has the highest solubility and sample 20/60/20 gave the lowest value for solubility and this is as a result of it low swelling power which results from high amylose content.

**Pasting Properties of Wheat, Acha and Pigeon Pea Flours**
The results of the pasting properties of the flour blends sample are shown in Table 2. Peak viscosity of the flour samples ranged from 94.37 to 102 RVU. Peak viscosity is an index of the capacity of starch-based food to swell freely before their physical breakdown (Sanni et al., 2006; Adebowale et al., 2008). The breakdown value ranged from 19.43 to 19.65 RVU. Adebowale et al. (2005) suggested that as breakdown in viscosity increased, the ability of the sample to withstand heating and shear stress during cooking decreased. The final viscosity is a measure of the stability of granules. The final viscosity ranged from 95.88 to 124 RVU. Shimels et al. (2006) reported that final viscosity is necessary to indicate the ability of starch to form various paste after cooling and that less stability of starch paste is commonly accompanied with the high value of breakdown. The setback viscosity ranged from 26.93 to 35.61 RVU.
Table 1: Functional properties of wheat-acha and pigeon pea flours

<table>
<thead>
<tr>
<th>Sample</th>
<th>OAC (%)</th>
<th>WAC (%)</th>
<th>SWC (g/g)</th>
<th>Solubility (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100/0/0</td>
<td>134±1.41bc</td>
<td>178±1.41a</td>
<td>17.05±0.21c</td>
<td>40.61±0.04c</td>
</tr>
<tr>
<td>35/55/10</td>
<td>125±1.41a</td>
<td>158±1.41a</td>
<td>18.80±0.14d</td>
<td>41.88±0.22a</td>
</tr>
<tr>
<td>20/60/20</td>
<td>141±1.41d</td>
<td>185±1.41c</td>
<td>15.55±0.35b</td>
<td>40.25±0.02a</td>
</tr>
<tr>
<td>35/45/20</td>
<td>130±1.41b</td>
<td>174±1.41b</td>
<td>16.45±0.21b</td>
<td>40.96±0.01d</td>
</tr>
<tr>
<td>20/50/30</td>
<td>138±2.12cd</td>
<td>183±2.83c</td>
<td>16.20±0.14b</td>
<td>40.37±0.01b</td>
</tr>
</tbody>
</table>

Means with different superscript in the same column are significantly different (p<0.05)

Legend
100/0/0: 100% wheat
35/55/10: 35% wheat + 55% acha + 10% pigeon pea
20/60/20: 20% wheat + 60% acha + 20% pigeon pea
35/45/20: 35% wheat + 45% acha + 20% pigeon pea
20/50/30: 20% wheat + 50% acha + 30% pigeon pea
OAC: Oil Absorption Capacity, WAC: Water Absorption Capacity, SWC: Swelling Capacity

Table 2: Pasting properties of wheat-acha and pigeon pea flours

<table>
<thead>
<tr>
<th>Sample</th>
<th>Peak viscosity (RVU)</th>
<th>Break down value (RVU)</th>
<th>Final viscosity (RVU)</th>
<th>Set back value (RVU)</th>
<th>Peak time (min)</th>
<th>Pasting temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100/0/0</td>
<td>98.70±0.00c</td>
<td>19.61±0.01bc</td>
<td>110±0.01c</td>
<td>28.32±0.00c</td>
<td>5.25±0.01c</td>
<td>60.79±0.01c</td>
</tr>
<tr>
<td>35/55/10</td>
<td>96.56±0.01b</td>
<td>19.58±0.01b</td>
<td>98.83±0.01b</td>
<td>29.28±0.00c</td>
<td>5.23±0.02c</td>
<td>60.89±0.01b</td>
</tr>
<tr>
<td>20/60/20</td>
<td>94.37±0.01c</td>
<td>19.43±0.01a</td>
<td>95.88±0.00a</td>
<td>26.93±0.01c</td>
<td>5.20±0.01b</td>
<td>60.93±0.01c</td>
</tr>
<tr>
<td>35/45/20</td>
<td>101±0.00d</td>
<td>19.63±0.01cd</td>
<td>118±0.01d</td>
<td>35.61±0.01c</td>
<td>5.18±0.00b</td>
<td>60.83±0.01c</td>
</tr>
<tr>
<td>20/50/30</td>
<td>102±0.01e</td>
<td>19.65±0.01d</td>
<td>124±0.01e</td>
<td>33.75±0.01c</td>
<td>5.13±0.01a</td>
<td>60.47±0.01a</td>
</tr>
</tbody>
</table>

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The higher the setback, the lesser the retrogradation of the flour paste during cooling and the lower the stalling rate of the product made from the flour (Adeyemi and Idowu, 1990). The peak time of the flour blends ranged from 5.13 to 5.25 min. Peak time is the time at which the peak viscosity occurred in minutes and this is a measure of the cooking time of the flour (Adebowale et al., 2005). The pasting temperature of the flour blends ranged from 60.47 to 60.93 °C. The pasting temperatures for the samples were quite lower than values obtained for wheat-flour cassava starch blend (Zaidul et al., 2007) and for dried moringa leaf-wheat flour blends (Dachana et al., 2010).

Anti-nutrient Content of Wheat, Acha and Pigeon Pea Flours

The anti-nutrient contents of the flour blends sample are presented in Table 3. Tannin contents ranged from 8.17 to 8.59 mg/100g. These levels of tannin were higher than 0.98% reported by Anuoye et al. (2012) for pigeon pea and unripe plantain blend. Trypsin inhibitors values ranged from 2.97 to 4.93 mg/100g. Trypsin inhibition was increased with increasing amounts of pigeon pea flour in the blends. The result obtained was in agreement with that of Iwe and Ngoddy (1998) and Iwe (2000) which state that protein and Trypsin inhibition activity increased with an increase in the amount of soybean flour. The phytate content of the products ranged from 0.30 to 0.43mg /100g. Bushway et al. (1984) suggested that the maximum tolerable dose of phytate in the body is from 250 - 500 mg/100g. Therefore, the flour produced from the blend of wheat, acha and pigeon pea is safe.

Proximate Composition of Wheat-Acha-Pigeon Pea Cookies

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The results proximate composition of the cookies prepared from 100% wheat flour and flour blends are presented in Table 4. The protein, fat, fiber, ash, moisture and carbohydrate contents ranged from 12.61 to 15.03%. The results show that sample E had the highest protein content of 15.03% while sample A had the lowest value of 14.23%. There was a significant difference (p<0.05) in protein content between the samples. The result is higher than 10.91% recorded for cashew nut-wheat cookies (Ojinnaka and Agubolum, 2013). The increase in protein of the cookies was as a result of the higher value of protein in pigeon pea (Tiwari et al., 2008).

The fat content of cookies ranged from 15.14 to 15.43%. The samples are significantly (p<0.05) different from each other. A similar non-significant increase has been noted in using defatted legumes such as pigeon and groundnut (Ayo et al., 2003).

The crude fiber values of cookies ranged from 0.38 to 0.89%. The fiber contents of all the cookies were within the Recommended Daily Allowance which should not exceed 5 g dietary fiber per 100 g dry matter (FAO/WHO 1994). The ash content of cookies ranged from 2.56% to 2.74%. There was a significant difference between the samples (p<0.05). Increase in ash content could make the product sources of minerals as observed by previous work reported by De Lemen et al. (2003). The moisture content of cookies ranged from 5.33 to 5.10%. This was in line with the report of Obasi et al. (2012) and Igbabul et al. (2015) who reported that a reduction in moisture content was observed in flour obtained from cereals and legumes. Due to this low moisture content in cookies (less than 10%) the self-life will be increased because the high moisture content is responsible for the microbial deterioration in the food product. The carbohydrate content of cookies ranged from 61.38 to 61.81%. The carbohydrate content of the sample is favourably compared with the Dabel et al. (2016) value implying that the cookies are the source of energy needed for body metabolism.

Table 3: Anti-nutrient content of wheat-acha and pigeon pea flours

<table>
<thead>
<tr>
<th>Sample</th>
<th>Tannin (mg/100g)</th>
<th>Trypsin (mg/100g)</th>
<th>Phytate (mg/100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100/0/0</td>
<td>8.27±0.01b</td>
<td>3.25±0.01c</td>
<td>0.30±0.00a</td>
</tr>
<tr>
<td>35/55/10</td>
<td>8.57±0.01c</td>
<td>3.13±0.00b</td>
<td>0.39±0.01c</td>
</tr>
<tr>
<td>20/60/20</td>
<td>8.59±0.01c</td>
<td>2.97±0.01a</td>
<td>0.43±0.01d</td>
</tr>
<tr>
<td>35/45/20</td>
<td>8.25±0.01b</td>
<td>4.75±0.01d</td>
<td>0.35±0.01b</td>
</tr>
<tr>
<td>20/50/30</td>
<td>8.17±0.01a</td>
<td>4.93±0.01c</td>
<td>0.37±0.01bc</td>
</tr>
</tbody>
</table>

Means with different superscript in the same column are significantly different (p<0.05)

Table 4: Proximate composition of cookies from wheat, acha and pigeon pea flour blends

<table>
<thead>
<tr>
<th>Sample</th>
<th>Protein (%)</th>
<th>Fat (%)</th>
<th>Fiber (%)</th>
<th>Ash (%)</th>
<th>Moisture (%)</th>
<th>Carbohydrate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100/0/0</td>
<td>12.61±0.09a</td>
<td>13.57±0.02a</td>
<td>0.44±0.02a</td>
<td>2.98±0.01a</td>
<td>5.33±0.02a</td>
<td>69.78±0.01a</td>
</tr>
<tr>
<td>35/55/10</td>
<td>14.33±0.06c</td>
<td>15.40±0.02a</td>
<td>0.85±0.02c</td>
<td>2.73±0.02b</td>
<td>5.27±0.02a</td>
<td>61.44±0.02c</td>
</tr>
<tr>
<td>20/60/20</td>
<td>14.47±0.06c</td>
<td>15.28±0.01b</td>
<td>0.57±0.02c</td>
<td>2.66±0.02b</td>
<td>5.18±0.02b</td>
<td>61.59±0.04c</td>
</tr>
<tr>
<td>35/45/20</td>
<td>14.84±0.05b</td>
<td>15.20±0.02b</td>
<td>0.44±0.02b</td>
<td>2.57±0.01c</td>
<td>5.13±0.02b</td>
<td>61.75±0.01b</td>
</tr>
<tr>
<td>20/50/30</td>
<td>15.03±0.05b</td>
<td>15.14±0.02c</td>
<td>0.38±0.02a</td>
<td>2.56±0.02c</td>
<td>5.10±0.01b</td>
<td>61.81±0.03b</td>
</tr>
</tbody>
</table>

Means with different superscript in the same column are significantly different (p<0.05)
Table 5: Sensory Evaluation of wheat-acha and pigeon pea cookies

<table>
<thead>
<tr>
<th>Sample</th>
<th>Colour</th>
<th>Aroma</th>
<th>Taste</th>
<th>Crispness</th>
<th>Overall acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>100/0/0</td>
<td>6.33±1.40</td>
<td>6.53±1.19</td>
<td>6.00±1.13</td>
<td>6.53±0.83</td>
<td>6.60±1.06</td>
</tr>
<tr>
<td>35/55/10</td>
<td>7.80±1.21</td>
<td>6.93±0.70</td>
<td>6.93±1.53</td>
<td>6.60±1.50</td>
<td>7.13±1.25</td>
</tr>
<tr>
<td>20/60/20</td>
<td>7.53±0.74</td>
<td>7.27±1.10</td>
<td>7.20±1.26</td>
<td>7.00±1.41</td>
<td>7.33±1.11</td>
</tr>
<tr>
<td>35/45/20</td>
<td>7.47±0.74</td>
<td>7.20±1.14</td>
<td>6.40±0.74</td>
<td>6.40±1.68</td>
<td>6.40±1.24</td>
</tr>
<tr>
<td>20/50/30</td>
<td>8.40±0.74</td>
<td>7.80±0.86</td>
<td>7.53±1.25</td>
<td>7.60±1.12</td>
<td>8.20±0.77</td>
</tr>
</tbody>
</table>

Means with different superscript in the same column are significantly different (p<0.05)

Sensory Evaluation
The sensory scores of the cookies made from wheat flour, acha flour and pigeon pea flour blend are shown in Table 5. The result shows that all the samples had very high sensory ratings in all the attributes considered such as colour, taste, aroma, crispness and overall acceptability. The colour of samples 20/60/20 and 35/45/20 was moderately liked with no significant difference in how much their colour was liked. Sample 20/50/30 was accepted by respondents when it comes to flavour, taste, crispness and mouth feel followed by sample 20/60/20 and 35/45/20, while sample 100/0/0 and sample 35/55/10 have the lowest preference. Test for overall acceptability of sample 100/0/0 and sample 35/45/20 was slightly liked. Samples 35/55/10 and sample 20/60/20 was moderately liked. Sample 20/50/30 was accepted most of all the samples with the mean of acceptability (8.20).

4. CONCLUSION
The finding has shown that acceptable cookies can be produced from flour blends of wheat, acha and pigeon pea. These cookies were found to be good nutritional products. This study shows that enrichment of wheat-acha with pigeon pea resulted in a notable increase in protein content, which could be of great nutritional benefits to Nigeria, where many can hardly afford to buy high protein foods due to high cost.

5. REFERENCES


