PHYSICO-CHEMICAL AND SENSORY ANALYSIS OF BISCUITS MADE FROM MALTED SORGHUM –DEFATTED DIOCLEA REFLEXA SEED COMPOSITE FLOUR

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Abstract

Evaluation of the chemical composition, physical characteristics and sensory quality of biscuits made from malted sorghum-defatted Dioclea reflexa seed composite flour was carried out. This study revealed significant increase in protein, and ash contents of the biscuit samples as the substitution of malted sorghum with defatted Dioclea reflexa seed flour increased. While, significant reduction at (p≥0.05) probability level was observed in moisture, fat, and carbohydrate contents as defatted Dioclea reflexa substitution increased. The values of moisture, crude fat and carbohydrate contents ranged from 8.42±0.00 to 9.15±0.00%, 5.64±0.02 to 6.34±0.25% and 63.86±0.04 to 69.48±0.00% respectively, while protein, crude fibre, and ash contents ranged from 10.35±0.02 to 16.81±0.01%, 2.51±0.01 to 2.81±0.01%, 2.53±0.03 to 2.92±0.02%, respectively. Significant difference exists in colour, crunchiness, aroma and texture while this does not occur in taste and overall acceptability. Furthermore, physical analysis of the biscuit samples shows that inclusion of defatted Dioclea reflexa seed flour increases the diameter and weight of the biscuit while sample with 80% malted sorghum has the highest spread ratio. Results obtained indicate that nutrient composition and sensory quality of malted sorghum based biscuit improve when fortified with defatted Dioclea reflexa seed flour.

Keywords: Malted Sorghum; Defatted Dioclea reflexa; Composite flour

Introduction

Biscuit is one of the most consumed cereals food aside from bread. This is because they are readily available in local shops as ready-to-eat, convenient and inexpensive food products containing digestive and dietary principles of vital importance (Adebowale et al., 2012). In baking industry wheat is widely preferred cereal and most commonly used in biscuit production because of its unique rheological properties imparting positive effect on baking quality. The association of wheat consumption with health problems such as celiac disease makes it pertinent to utilize composite flour in biscuit production (Kiin-Kabari & Giami, 2015). More also, most of these foods made from wheat and other cereals are, however, poor sources of protein that is often of poor nutritional quality (Alobo, 2001). Composite flour is desirable in this regard because it improves the nutritional value of food products such as bakery products, especially when blended with legumes such as pigeon pea (Preedy et al., 2011). Therefore, Biscuits have been produced from mixture of different flours of cereals and legume or root crops. The use of composite flour based on wheat and other cereals in bakery products helps to satisfy specific functional characteristics and nutrients composition (Ubbor & Akobundu, 2009) and are now becoming popular because of the economic and nutritional advantages of composite flour (Neelam & Rajni, 2000). In Nigeria, staple crops that are grown other than wheat, such as cassava, sweet potatoes, cocoyam, sorghum and other cereals can be used for baked foods (Oluwamukomi et al., 2011).

Sorghum (Sorghum bicolor L. Moench) is a gluten-free cereal grown in many African countries primarily as food crop with less than 5% of the annual production commercially processed by the industry (Okoli et al., 2010). It is the grain of choice in brewing African traditional beers. Sorghum is readily available and acceptable in Nigeria. Sorghum is composed of anti-nutrients, such as tannin and phytic acid, which can inhibit the absorption of essential minerals and proteins in the body. Hence, traditional foods and baked products like bread, cakes and biscuits prepared from sorghum suffer low protein digestibility and nutrient bio-availability for absorption (Feyera, 2020). Therefore, many traditional processing techniques such as soaking, malting and fermentation reported to inhibit anti-nutrients in cereals, legumes, roots and tubers had been applied to sorghum (Khattab & Arnfield, 2009). Malting of sorghum caused an improvement in protein digestibility and other protein quality characteristics, such as percentage of protein, nitrogen solubility index and content of an essential amino acid, lysine increased with malting duration.
According to Maidala Dahuwa & Bakoshi (2016) malting of Kaura sorghum for 48 hours reduced (96.33%) of tannin, (80.29%) of phytate acid and (86.67%) oxalate and depressed most of the tannin factors. Malting was also reported to produced improvement in flavor profile and color. (Rooney & Waniska, 2000).

**Dioclea reflexa** (Leguminosae-Fabaceae) is a small genus containing 40 species, widely distributed in Africa and South America. *Dioclea reflexa*, a legume also known as “horse eye” is commonly distributed in the tropical region. It contains relative high moisture content. *Agbaarin* as it is commonly known in Western Nigeria, has the stem extract used as anti-inflammatory agents and also in the treatment of rheumatism and itching (Oladosu et al., 2010). The high fibre content is good for diabetic patients and also reduces cholesterol in the body (Ajayi & Adefioye, 2012). *Dioclea reflexa* is grossly underutilized in Nigeria.

Over-dependency on wheat, whose importation requires huge foreign exchange, needs to be reduced, therefore locally available grains such as sorghum can be adopted which improve the product quality and intake throughout the age group irrespective of the health challenges. Also, elimination of anti-nutritional factors present in sorghum grain through malting process will also improve the nutritional quality of the sorghum. Many recent research efforts are geared towards enhancing the nutritional content of ready-to-eat foods through supplementation with arrays of cereal grains and legumes. Sorghum flour blended with legumes and tubers has been used to produce cookies (Okpala & Okoli, 2011). Biscuits have also been produced from sorghum flour blended with wheat flour (Adebowale et al., 2012). The incorporation of *Dioclea reflexa* in the biscuit will help improve the nutritional quality of the snacks and reduces the protein deficiency causing diseases such as kwashiorkor and marasmus. Hence, this work is to evaluate the physico-chemical and sensory properties of biscuits produced from malted sorghum-

**Materials and Methods**

Sorghum grain, *Dioclea reflexa* seed, wheat flour, fat, sucrose, salt, milk and baking powder were purchased from a local market in Ilaro, Ogun state, Nigeria. All reagents used in the analysis were of analytical grade.

**Preparation of malted-sorghum flour**

Malted-sorghum flour was produced using the procedure described by (Bolarinwa et al., 2015). Two kilograms of sorghum grain was sorted in order to remove stones, dirt and other extraneous materials. The clean grains was thoroughly washed and steeped in water for 12 hours to attain a 42-46% moisture level. The hydrated grains was spread on a moist jute bag which had been previously sterilized by boiling for 30 minutes and the grains were allowed to germinate for four days. Non-germinated grains were discarded and the germinated seeds were dried at 60°C in a cabinet dryer to a moisture content of 10-12%. The withered rootless grains were gently brushed off, and the malted grains was dried milled, sieved and packed in a seal lock cellophane bag until it was ready for use.

**Preparation of *Dioclea reflexa* seed flour**

**Preparation of samples:** *Dioclea reflexa* seed was sorted to separate bad ones from the good and parboiled for 38-40°C to inhibit any microorganisms or foreign materials in the seeds. The seeds of *Dioclea reflexa* were split into two, the hard husks were removed and the seed pulverized using disc attrition mill. The flour obtained was then defatted using n-hexane. The flour was then packaged in a sterile polythene bag prior to further preparation and analysis.

**Preparation of Malted Sorghum- defatted *Dioclea Reflexa* Composite Flour**

Malted sorghum-defatted *Dioclea reflexa* seed flour blends were prepared as described by Bolarinwa et al., (2016). Six blends containing varying proportions of defatted *Dioclea reflexa* flour (0 to 50%) were prepared by uniformly blending malted sorghum flour and defatted *Dioclea reflexa* flour together at various ratio; 100:0, 90:10, 80:20, 70:30, 60:40 and 50:50 respectively. Wheat flour (100%) was used as control.

**Production of biscuit**

Biscuits was prepared using the creaming method described by (Okaka, 1997). The basic formulations were malted sorghum and defatted *Dioclea reflexa* seed composite flour (100%), fat (40%), sucrose (60%), milk (4%), salt (2%) and baking powder (1%). The sugar and fat were initially creamed in a mixer to produce a creamy mixture before the flour and other dry ingredients was added. Thereafter, the mixture was thoroughly mixed to form hard consistent dough. The dough obtained was thoroughly kneaded manually on a smooth, sterile, clean table for about 5 minutes.
The dough was thinly rolled on a wooden board with rolling pin to uniform thickness (2 mm) and cut out (using biscuit cutter) to desired shapes of similar sizes. The cut out biscuit dough pieces were placed in a greased baking tray and baked in an oven (190°C) for 30 minutes to produce malted sorghum-defatted *Dioclea reflexa* seed flour biscuits. The biscuits were cooled immediately after baking and packed in polyethylene bags, sealed and kept at room temperature until used for chemical analysis and sensory evaluation. Dough produced from wheat flour (100%) was similarly baked to produce biscuit, which was used as control.

**Chemical Analysis**

Proximate analysis was carried out on the biscuits produced from the composite flour and wheat flour. The malted sorghum-defatted *Dioclea reflexa* biscuits samples and wheat biscuit were analyzed for moisture, ash, crude fibre, protein and crude fat (AOAC, 2010). Carbohydrate was determined by difference.

**Sensory Evaluation**

The samples were presented as coded samples to 20 semi-trained panelists. The samples were randomly presented to the panelist. The panelists were given enough water to rinse their mouths in between each sample and were asked to indicate their observations using a 9-point hedonic scale for colour, taste, texture, aroma, crunchiness, and overall acceptability.

**Physical properties analysis: Diameter, spread ratio, thickness and weight**

Weight of the biscuit was measured using a digital weighing balance and mean values of five individual biscuit recorded. The cookies diameter (width) was determined by placing six cookies horizontally (edge to edge) in a row and the diameter was measured with a digital Vernier caliper with 0.01mm accuracy as described by Larmond, (1997). The mean value was recorded as the diameter of the biscuit. Thickness of biscuit was determined by stacking six biscuits, one on top of another and thickness was taken using digital Vernier caliper with 0.01mm accuracy. The mean value was recorded as the thickness of the biscuit. The spread ratio was calculated as the average diameter/thickness (Zoulias et al., 2000). Weight of biscuits was measured as average values of six individual biscuits with the help of an analytical weighing balance. Average value for weight was reported in grams.

**Statistical Analysis**

All data obtained from this study were subjected to analysis of variance (ANOVA), and means were separated using Duncan’s multiple range test. SPSS software version 15 was used for all statistical analysis.

**Results and Discussion**

**Table 1: Proximate composition of biscuits produced from malted sorghum and defatted *Dioclea reflexa* flour blends**

<table>
<thead>
<tr>
<th>Samples</th>
<th>Moisture (%)</th>
<th>Protein (%)</th>
<th>Fat (%)</th>
<th>Ash (%)</th>
<th>Crude fibre (%)</th>
<th>Carbohydrate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WF(100%)</td>
<td>8.90±0.02</td>
<td>10.35±0.02</td>
<td>5.64±0.02</td>
<td>2.53±0.03</td>
<td>2.67±0.02</td>
<td>70.86±0.02</td>
</tr>
<tr>
<td>MSF(100%)</td>
<td>8.81±0.00</td>
<td>10.45±0.01</td>
<td>6.26±0.02</td>
<td>2.85±0.02</td>
<td>2.67±0.02</td>
<td>69.94±0.05</td>
</tr>
<tr>
<td>90:10(MSF/DRF)</td>
<td>9.15±0.00</td>
<td>10.85±0.02</td>
<td>6.43±0.02</td>
<td>2.61±0.02</td>
<td>2.51±0.01</td>
<td>69.48±0.00</td>
</tr>
<tr>
<td>80:20(MSF/DRF)</td>
<td>9.04±0.00</td>
<td>12.92±0.01</td>
<td>6.23±0.02</td>
<td>2.73±0.02</td>
<td>2.62±0.02</td>
<td>67.09±0.06</td>
</tr>
<tr>
<td>70:30(MSF/DRF)</td>
<td>8.60±0.00</td>
<td>13.52±0.03</td>
<td>6.03±0.02</td>
<td>2.82±0.02</td>
<td>2.72±0.02</td>
<td>66.30±0.04</td>
</tr>
<tr>
<td>60:40(MSF/DRF)</td>
<td>8.57±0.00</td>
<td>14.33±0.02</td>
<td>5.92±0.03</td>
<td>2.86±0.03</td>
<td>2.74±0.02</td>
<td>65.60±0.12</td>
</tr>
<tr>
<td>50:50(MSF/DRF)</td>
<td>8.42±0.00</td>
<td>16.13±0.02</td>
<td>5.84±0.02</td>
<td>2.92±0.02</td>
<td>2.81±0.01</td>
<td>63.86±0.04</td>
</tr>
</tbody>
</table>

Key: WF= Wheat flour; MSF= Malted Sorghum Flour; DRF= Defatted *Dioclea reflexa* seed flour.

Note: All data are means of triplicate values ± standard deviation; means with the same superscripts are not significantly different.

**Proximate Composition**

Table 1 shows the result of the proximate composition of biscuit made from malted sorghum-defatted *Dioclea reflexa* seed flour. Significant increase at probability level (P>0.05) were observed in protein and ash contents of the biscuit as the increase in substitution of defatted *Dioclea reflexa* seed flour. Whereas significant reduction in moisture, fat and carbohydrate were observed as the level of defatted *Dioclea reflexa* incorporation increased.
Sample produced from 90/10% of malted sorghum and *Dioclea reflexa* flour blends. The high moisture content of the sample with 90% malted sorghum sample is an indication that the product cannot be kept for a long period of time before microbiological degradation set in (Bolarinwa et al., 2015). The protein content ranged from 10.35±0.02 to 16.13±0.02. The protein contents increased with increase in defatted *Dioclea reflexa* seed flours. The variation in this result can be attributed to their original raw material which contain significant amount of protein. This result is in tandem with the study by (Ogunlade et al., 2011) who reported that protein content of the seed of *Dioclea reflexa* and *Monodoramysistris* are comparable to those reported for guinea peanut (10.38%). The relatively high crude protein values reported for these seeds suggest that they may find use in food formulations. The fat content ranged from 5.64±0.02% to 6.34±0.02% there is significant increase in the fat content as the level of *Dioclea reflexa* seed flours increases. These values are higher than 1.95 ± 0.04% for jack bean (Arawande & Borokini, 2010). The crude fibre content ranged from 2.51±0.01% to 2.81±0.01%, the sample with 50% defatted *Dioclea reflexa* seed flour has the highest fibre content. The crude fibre of this biscuit was within the recommended range for diets of not more than 5g dietary fiber per 100g dry matter (FAO/WHO, 2014) and would enhance gastrointestinal tract and cardiovascular health. The ash content ranged from 2.53±0.03 to 2.92±0.02 with 100% wheat flour having the lowest ash content, whereas 50:50% combination has the highest ash content. This is as a result of a noticeable ash in the *Dioclea reflexa* seed flour, which shows the presence of some minerals in the flour samples. The result obtained from this study correlate with the study by Anchan (2010) who reported that; *Dioclea reflexa* flours recorded total ash content between 2.15 – 3.15%. Sample with high ash contents is expected to have high concentration of various mineral elements, which are expected to speed up metabolic processes, improve growth and development (Elinge et al., 2012). The carbohydrate content of the biscuit samples ranged from 62.58±0.05 to 69.48±0.00. The carbohydrate content decreases as the level of defatted *Dioclea reflexa* seed flour increases. This result is in line with the study by (Aremu et al., 2015).

### Table 2: Physical Characteristics of biscuit made from Malted-Sorghum and defatted *Dioclea reflexa* Seed flour blends

<table>
<thead>
<tr>
<th>BISCUIT SAMPLES</th>
<th>DIAMETER (cm)</th>
<th>THICKNESS (m)</th>
<th>WEIGHT (g)</th>
<th>SPREAD RATIO (cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WF(100%)</td>
<td>5.02±0.04</td>
<td>0.33±0.05</td>
<td>10.33±0.51</td>
<td>15.30±2.17</td>
</tr>
<tr>
<td>MSF(100%)</td>
<td>5.02±0.04</td>
<td>0.53±0.52</td>
<td>14.83±0.40</td>
<td>11.27±0.10</td>
</tr>
<tr>
<td>90:10(MSF/DRF)</td>
<td>5.52±0.04</td>
<td>0.42±0.04</td>
<td>10.50±0.54</td>
<td>13.82±0.09</td>
</tr>
<tr>
<td>80:20(MSF/DRF)</td>
<td>5.35±0.05</td>
<td>0.30±0.00</td>
<td>10.67±0.52</td>
<td>17.80±0.22</td>
</tr>
<tr>
<td>70:30(MSF/DRF)</td>
<td>5.62±0.04</td>
<td>0.45±0.05</td>
<td>10.50±0.84</td>
<td>12.65±1.59</td>
</tr>
<tr>
<td>60:40(MSF/DRF)</td>
<td>5.27±0.05</td>
<td>0.40±0.00</td>
<td>10.33±0.52</td>
<td>3.20±0.15</td>
</tr>
<tr>
<td>50:50(MS/DRF)</td>
<td>5.63±0.05</td>
<td>0.50±0.00</td>
<td>11.28±0.09</td>
<td>14.67±0.52</td>
</tr>
</tbody>
</table>

**Key:** WF= Wheat flour; MSF= Malted Sorghum Flour; DRF= Defatted *Dioclea reflexa* seed flour.  
**Note:** All data are means of triplicate values ± standard deviation; means with the same superscripts are not significantly different at p≤0.05; 90:10= Malted Sorghum flour: defatted *Dioclea reflexa* seed flour.

#### Physical Characteristics

Table 2 reveals the physical characteristics of the biscuit samples. Diameter of the biscuit samples ranged from 5.02±0.04 to 5.63±0.05. No significant difference is observed in the samples. Kaur et al., (2017) in their studies on biscuits fortified with barley flour, found that the enrichment of biscuits with 0, 5, 10, 15 and 20% of barley flour did not affect the diameter of the biscuits. Thickness of the biscuit samples ranged from 0.33±0.05 to 0.53±0.52m. Increase in defatted *Dioclea reflexa* seed flour inclusion increased the weight the biscuit. Also, spread ratio of the biscuit samples ranged from 11.27±0.10 to 17.80±0.22cm². Sample produced with 100% malted sorghum has the least spread ratio. Sample with 20% defatted *Dioclea reflexa* seed flour has the highest spread ratio. The spread ratio is considered as one of the most important quality parameters of biscuits, because it co-relates with texture, grain finess, bite and overall mouth feel of the biscuits (Jothi et al., 2014). Good quality cookies or biscuits should have a high spread ratio (Divyashree et al., 2016).
Table 3: Sensory properties of biscuit made from Malted-Sorghum and defatted *Dioclea reflexa* Seed flour blends

<table>
<thead>
<tr>
<th>Biscuit Samples</th>
<th>Colour</th>
<th>Crunchiness</th>
<th>Taste</th>
<th>Aroma</th>
<th>Texture</th>
<th>Overall Acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>WF(100%)</td>
<td>8.40±0.91</td>
<td>8.33±0.81</td>
<td>8.73±0.46</td>
<td>8.53±0.74</td>
<td>8.53±0.92</td>
<td>8.80±0.56</td>
</tr>
<tr>
<td>MSF(100%)</td>
<td>7.13±0.106</td>
<td>6.73±1.28</td>
<td>7.47±1.13</td>
<td>6.87±1.36</td>
<td>6.47±1.06</td>
<td>7.00±0.54</td>
</tr>
<tr>
<td>90:10(MSF/DRF)</td>
<td>6.80±1.08</td>
<td>6.53±1.30</td>
<td>7.47±1.51</td>
<td>6.33±1.40</td>
<td>6.80±1.08</td>
<td>6.93±0.88</td>
</tr>
<tr>
<td>80:20(MSF/DRF)</td>
<td>7.40±0.106</td>
<td>7.00±1.65</td>
<td>6.60±1.29</td>
<td>7.07±1.39</td>
<td>7.27±0.70</td>
<td>7.53±0.99</td>
</tr>
<tr>
<td>70:30(MSF/DRF)</td>
<td>6.60±1.18</td>
<td>6.60±0.99</td>
<td>6.47±1.41</td>
<td>6.53±1.13</td>
<td>6.00±0.93</td>
<td>6.53±0.73</td>
</tr>
<tr>
<td>60:40(MSF/DRF)</td>
<td>6.87±1.46</td>
<td>6.60±1.06</td>
<td>6.20±1.01</td>
<td>6.00±1.20</td>
<td>6.53±0.89</td>
<td>6.53±0.92</td>
</tr>
<tr>
<td>50:50(MSF/DRF)</td>
<td>7.40±0.99</td>
<td>7.73±1.34</td>
<td>5.93±1.10</td>
<td>7.00±1.07</td>
<td>6.93±1.16</td>
<td>7.60±1.06</td>
</tr>
</tbody>
</table>

Key: WF= Wheat flour; MSF= Malted Sorghum Flour; DRF= Defatted Dioclea reflexa seed flour.  
Note: All data are means of triplicate values ± standard deviation; means with the same superscripts are not significantly differences at p≤0.05; 90:10= Malted Sorghum flour: defatted Dioclea reflexa seed flour.

**Sensory Analysis**

Table 3 shows the result of sensory characteristics of malted-sorghum and defatted *Dioclea reflexa* seed flour. In terms of colour, it was observed that aside from the control sample significant difference (p≤0.05) only exists in sample having up to 50% of defatted *Dioclea reflexa* seed flour. This is in line with the finding of Bolarinwa et al., (2016) when malted Sorghum was complemented with soy flour. Addition of defatted *Dioclea reflexa* seed flour increase the color profile of the biscuit samples. Colour is a very important parameter in judging properly baked cookies that not only reflect the suitable raw materials used in the preparation but also provides information about the formulation and quality of the product (Ikpe ne et al., 2010). Significant differences at 5% confidence level (P≤0.05) were observed in the crunchiness of the biscuit samples. Sample produced with 100% wheat flour and 50% defatted *Dioclea reflexa* seed flour have the highest rating. While sample produced with 100% malted sorghum flour has the least rating of 6.73±1.28. It was evident that addition of *Dioclea reflexa* increases the crunchiness of the biscuits. This finding is in contrast with Idowu (2014) that reported decreased in the crispness as the level of inclusion of African yam bean into wheat flour increased. Significant differences at 5% confidence level (P≤0.05) were not observed in the taste of biscuit samples. Samples produced with 100% wheat flour and 50% defatted *Dioclea reflexa* seed flour were rated the best in terms of taste with the value of 8.53±0.92. It was evident that *Dioclea reflexa* seed flour shows significant differences at 5% confidence level (P≤0.05). Wheat flour has the highest rating with the value of 8.73±0.46 and 7.47±1.4 respectively. This is in agreement with the research of Adebayo & Okoli (2017) which reported that biscuits produced from sprouted Sorghum, sprouted lima bean and wheat flour were favorably compared with the (100%) wheat flour. Significant differences exist in the scores for aroma of the samples from each other, but the sample with 100% whole wheat has the highest rating to the sample. The sensory score of the biscuits with respect to aroma decreased as the level of defatted *Dioclea reflexa* seed flour addition increased when compared to 100% malted sorghum biscuit. This is similar to the finding of Bolarinwa et al., (2016) for biscuits produced from malted sorghum- soy flour blends. The texture results of the biscuits produced from substitution of defatted *Dioclea reflexa* seed flour shows significant differences at 5% confidence level (P≤0.05). Wheat flour has the highest rating with the value of 8.53±0.92. In terms of general acceptability, the biscuit produced from 50% malted sorghum and 50% defatted *Dioclea reflexa* flour blends was rated as the most acceptable by the panellists. The biscuit sample made from 50% malted sorghum and 50% defatted *Dioclea reflexa* seed flour showed no significant difference with 100% wheat biscuit for overall acceptability. This finding is in tandem with the work of Kaur et al., (2017).

**Conclusion**

This study has shown that the inclusion of defatted *Dioclea reflexa* seed flour to malted sorghum flour in the production of biscuit significantly improved the nutrient composition and organoleptic properties of biscuit. Significant increase was observed in the protein content, and ash contents of the biscuit as there was increase in the incorporation of defatted *Dioclea reflexa* seed flour. Therefore, this study further confirmed that when leguminous
crops such as Dioclea reflexa, soya bean are used partially to complement cereals in the production of biscuit not only would the nutritional composition improve but organoleptic acceptability could also be enhanced.

References


