



# Evaluation of Proximate Composition of Biscuits Produced from Wheat (*Triticum aestivum* L.) and Sorghum (*Sorghum Bicolor* [L.] Moench) Composite Flour

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## ARTICLE INFO

### Article history:

Received: 12 July 2018;

Received in revised form:  
20 August 2018;

Accepted: 30 August 2018;

### Keywords

Wheat,  
Malted-sorghum,  
Composite-flour,  
Underutilized-legume,  
Biscuit.

## ABSTRACT

Sorghum is an under-utilized crop in the semi-arid tropics of Asia and Africa due to its antinutrient properties but high in protein, vitamins, and minerals. Drying, soaking, and malting appears to reduce tannin which is an antinutrient in sorghum. The aim of this project was to evaluate malted sorghum-wheat flour biscuit. Sorghum grains were malted, dried and milled into flour and biscuit was produced from blends of wheat flour and the flour of malted sorghum (100:0, 95:5, 90:10, 80:20 and 70:30). The proximate composition and sensory properties of the biscuits were evaluated. The proximate composition of different flour mixes ranged from 6.75 to 7.12% moisture, 2.14 to 2.53% ash, 3.85 to 4.10 fat, 10.40 to 12.78% protein, 1.05 to 1.22% fiber and 73.18 to 74.88% carbohydrate. However, the protein (12.64-10.19%), fat ( 2.48-2.15%) and moisture (7.35-5.92% ) contents of the biscuit decreased as the level of substitution increases while increasing trends were observed for ash (2.17- 2.57%), fiber (1.06-1.55%) and carbohydrate ( 74.30-77.62%). Sensory evaluation showed that up to 30% substitution levels of malted sorghum could be used as a supplement with wheat flour for biscuit production, an indication that acceptable biscuit could be produced from low gluten flour. This has the potential to eradicate the problem of celiac disease associated with the intake of wheat gluten.

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## Introduction

Sorghum (*Sorghum bicolor* [L.] Moench) is one of the most under-utilized crops in the semi-arid tropics of Asia and Africa. It is the principal source of energy, protein, vitamins, and minerals for millions of the poorest in these regions [1]. Its products are deficient in essential amino acids such as lysine, threonine, tryptophan and the presence of anti-nutritional factors such as tannins and phytates limit their nutritional value. Therefore, attempts have been made to fortify these cereals with legumes or other cereals to make it nutritionally superior and acceptable products [2]. Malting essentially involves steeping, germination and limiting cereals, seedling growth by kilning [3]. During germination, enzymes are produced for the degradation of starch and protein in the cereal grain. Malting yields higher proportions of hydrolytic enzymes such as  $\alpha$  and  $\beta$  – amylases which may be either completely soluble or largely insoluble depending on the variety [4]. The malting potentials of sorghum grains can be utilized to produce soft dough biscuit.

Biscuit is one of the most commonly consumed snacks in Nigeria as in most other countries of the world. Owing to its long shelf life, it is considered useful for nutritional enrichment in feeding programmes. Extensive studies have been conducted on the fortification of wheat flour with high lysine materials to enhance the essential amino acid balance of baked goods [5]. Biscuits are extremely soft on the inside and similar to scones [6]. It is traditionally served as a side dish with a meal in the morning. They are often eaten with butter and a sweet condiment such as molasses, light sugarcane, sorghum syrup, honey or fruit jam with other

meals, and are usually eaten with butter instead of sweet condiments [7].

Excess consumption of gluten can cause celiac disease. Celiac disease is an inherited autoimmune disease. In celiac disease, the body's immune system responds abnormally to gluten, resulting in inflammation and damage to the lining of the small intestine, and reduced absorption of iron, calcium, vitamins A, D, E, K, and folate. The disease is now recognized as one of the most common chronic diseases. Therefore, to reduce this disease, low gluten flour is required in baking and in so doing the protein content of baked product will be reduced. So to prevent low protein intake of baked product this study utilized whole sorghum flour as means of enriching the content of biscuit [8].

## Materials

Sorghum grain, Golden Penny wheat flour (Nigeria Brand) and other ingredients used in the preparation of biscuits were obtained in Ogbomoso, Nigeria.

## Methods

### Production of malted-sorghum flour

Sorghum grains were malted using the method described by [9] as shown in Fig. 1. The grains were sorted to remove stones, dirt, and other extraneous materials. Exactly 2 kg of sorghum grain was weighed, cleaned thoroughly, washed and steeped in water for 12 h so as to attain 42-46% moisture level. Thereafter the hydrated grains were spread on a moist jute bag which had been previously sterilized by boiling for 30 mins and the grains allowed to germinate for 4 days. Un-germinated grains were discarded and the germinated seeds were dried at 60 °C in a cabinet dryer to moisture content 10-12%.

The withered rootless grains were gently brushed off, and the malted grains were dry milled, sieved and packaged in an airtight container until needed for analysis.

Different proportions of wheat flour and malted sorghum flour mixes for biscuit were prepared by varying the proportions of malted sorghum flour in each mix for a total of 100g. The proportion of wheat flour and malted sorghum flour mixes that was used for the production of the biscuits were attained at five levels of substitution (100:0, 95:5, 90:10, 80:20 and 70:30 w/w). Other ingredients that were added for the production of the biscuit are margarine, sugar, whole egg, and leavening agent (baking powder) [10].

#### Production of biscuit

Biscuit was produced according to the method of Akinwande *et al.* [10]. The flour used for biscuit production were from blends of malted sorghum and wheat using 0, 5, 10, 20 and 30% malted sorghum flour, respectively. 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 an electric mixer at medium speed for 2 min [11]. Baking powder and milk were added and mixed until the dough was thoroughly mixed. The dough was manually kneaded to ensure uniformity. The dough obtained from each mix was rolled out into a thin light sheet of about 0.4 cm on a sheeting board and was then stamped out into round shape cuts of about 4.5 cm in diameter. Cuts were then placed in thinly greased pans, before being baked for about 20 mins at an oven temperature of 150 °C. The baked biscuits were placed on a cooling rack for 30 mins to cool before packaging.

#### Analyses

##### Chemical analyses of biscuit

Proximate composition of the biscuit was carried out using AOAC [12]. Moisture content was determined by drying samples in an oven at 105 °C until a constant weight was reached. Protein was determined using Kjeldahl method. The nitrogen value was converted to protein by multiplying with a conversion factor. Crude fat was estimated using Soxhlet extraction method. The sample was incinerated in a muffle furnace at 550°C to determine the ash content. Carbohydrate was determined by difference and crude fiber was estimated according to AOAC [12] method.

##### Sensory Evaluation

The baked and cooled biscuit samples were presented to 25 panelists that were randomly selected. The biscuit samples were assessed for the following quality attributes: color, aroma, mouth feel, texture, taste, aftertaste, crispness and overall acceptability using a 7 point hedonic scale where 7 = like extremely and 1 = dislike extremely. The sensory data were subjected to analysis of variance (ANOVA) and Duncan Multiple Range for means separation.

##### Statistical analysis

The results were subjected to analysis of variance (ANOVA) and the means were separated with the use of

Duncan's multiple range test to detect significant difference ( $p < 0.05$ ) among the sample values using the statistical package for the social sciences (SPSS).

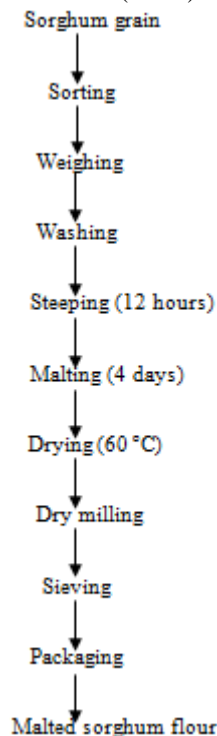


Figure 1. Flow chart of malted sorghum flour, Source: Hallen *et al.* [9]

#### Results and Discussion

The protein content of wheat-malted sorghum flour mixes revealed a decreasing trend of 12.78 -10.40% (Table 1). Protein content decreased as the % of substitution level increases. The highest value (12.78%) of protein was obtained with sample A and the lowest value (10.40%) was in sample E. Significant differences were obtained in all the samples at  $p < 0.05$ . The variation in the protein content may be due to the fact that raw wheat contains more protein than raw sorghum. Pasha *et al.* [13] reported a significant decrease in protein by supplementation of wheat with flour from malted sorghum. Similar studies also reported high protein content for wheat-soy plantain bread [14] and high protein of soybean biscuit [15]. Fat content in the flour ranged between 3.85 and 4.10%, with highest of fat (4.10%) obtained from sample A and the lowest value (3.85%) from sample E. Significant differences were observed for all samples except between samples A and B at ( $p < 0.05$ ). This result showed that fat content decreases as the quantity of malted sorghum flour increases. Alabi *et al.* [16] also reported that sorghum-soy composite flour contains 3.6% of fat. The fat content (3.85-4.10%) obtained in this study is in line with the fat content (4.5-7.1%) of wheat and soy flour blends [17] and that of rice and soy flour blends reported by Falola *et al.* [18].

Table 1. Proximate composition of flour produced from wheat/malted sorghum flour mixes.

Sample	Moisture (%)	Ash (%)	Fibre (%)	Fat (%)	Protein (%)	Carbohydrate (%)
A	6.75 <sup>b</sup>	2.14 <sup>c</sup>	1.05 <sup>c</sup>	4.10 <sup>a</sup>	12.78 <sup>a</sup>	73.18 <sup>d</sup>
B	6.81 <sup>b</sup>	2.16 <sup>c</sup>	1.09 <sup>bc</sup>	4.05 <sup>a</sup>	12.38 <sup>b</sup>	73.51 <sup>c</sup>
C	6.89 <sup>ab</sup>	2.25 <sup>b</sup>	1.15 <sup>b</sup>	3.94 <sup>b</sup>	11.97 <sup>c</sup>	73.80 <sup>c</sup>
D	6.95 <sup>ab</sup>	2.29 <sup>b</sup>	1.10 <sup>bc</sup>	3.90 <sup>bc</sup>	11.19 <sup>d</sup>	74.57 <sup>b</sup>
E	7.12 <sup>a</sup>	2.53 <sup>a</sup>	1.22 <sup>a</sup>	3.85 <sup>c</sup>	10.40 <sup>e</sup>	74.88 <sup>a</sup>

Mean with different superscript along the same column have significant difference from each other ( $p < 0.05$ ).

Sample A = 100:0 wheat flour; B = 95:5 wheat:malted sorghum flour; C = 90:10 wheat: malted sorghum flour; D = 80:20 wheat:malted sorghum flour and E = 70:30 wheat:malted sorghum flour

The ash content of the wheat-malted sorghum flour has an increasing trend as the level of substitution with malted sorghum increases. The value of ash ranged between 2.14 and 2.53%, with the highest value (2.53 %) in flour produced from sample E, and lowest value (2.14%) of ash was recorded in sample A. The ash content of food material could be used as an index of mineral constituents of the food because ash is the inorganic residue remaining after the water and organic matter have been removed by heating in the presence of an oxidizing agent [19]. Legumes have been reported to be a good source of ash. The ash content (2.14-2.53%) reported in this study is similar to the ash content of composite flour produced from maize-soy flour [20].

Values of crude fiber increase as more malted sorghum flour are added to wheat flour. These results suggest that malted sorghum flour has more crude fiber than wheat flour. However, the results were below 1.5% maximum allowable fiber content of bread flour as stated by Omole [23] and the 2.0% recommended by Nigerian raw materials research and development council [22]. Also, sample E recorded the highest value (7.12%) of moisture and the lowest value of moisture content (6.75%) was recorded in sample A. The value of moisture content increased with increases in the substitution level of malted sorghum. However higher moisture content was reported for wheat bread substituted with 40% soy flour (28.5-39.5%) by Ndife *et al.* [17]. Rita and Sophia [23] also reported higher moisture content (21.9-36.9%) for bread produced from wheat flour substituted with 20% soy flour.

Carbohydrate value ranged between 73.18 and 74.88%; the highest value was recorded in sample E and the lowest value (73.18%) was obtained in sample A. The carbohydrate content of wheat-malted sorghum flour varies significantly ( $p < 0.05$ ) when compared to 100% wheat flour (73.18%) and increased with increases in the proportion of the malted sorghum in the mixes. Oluwamukomi *et al.* [24] reported the value of 69.2-74.5% carbohydrate content for wheat-cassava and soy composite flour.

The protein content shows that sample A has the highest protein content (12.64%) and the lowest (10.19%) in sample E. Decreasing trend of protein with increases in the substitution level of malted sorghum flour may be due to the fact that raw wheat contains more protein than raw sorghum. This result is also in line with the work of Oluwamukomi *et al.* [24] which states that wheat flour contains more protein than cassava flour. Similar studies also reported high protein content for soy-maize *agidi* [25] and of soybean [26]. Malting/Sprouting of sorghum enhanced protein breakdown

while hindering the deleterious effects due to their strong interactions with proteins. The fat content in the biscuits ranged between 2.48 and 2.15%, with the highest content of fat (2.48 %) in biscuits produced from sample A and lowest (2.15%) obtained from sample E. Significant differences were obtained in all the samples ( $p < 0.05$ ). This is decreasing as the quantity of malted sorghum flour increases. Alabi *et al.* [16] also reported that sorghum-soy composite flour contains 3.6% of fat. However, biscuits with relatively low-fat content were produced from all samples of wheat- malted sorghum composite flour. The fat content (2.15-2.48%) is lower to that of the fat content (4.5-7.1%) of wheat and soy flour blends [27]. This agrees with the work of Idowu *et al.* [28] which stated that the nutritional qualities decrease as the level of starchy staples increases.

The biscuits produced from sample A have the highest overall acceptability with a score of 6.24 (Table 4.6) and lowest value of 5.56 for sample E. The result confirmed that the quality of colour, aroma, crispness, texture, and taste indeed influence the overall acceptability of the biscuits. No significant difference was observed in samples A, B, and C whereas slight differences were observed in samples D and E at  $p > 0.05$ . Wheat flour could therefore be replaced with up to 30% of malted sorghum flour in cookie production without affecting the sensory qualities. Chinma *et al.* [29] obtained a similar evaluation in the sensory evaluation of biscuit produced from unripe plantain and wheat flour mixes. The value of ash ranged between 2.17 and 2.57%, with the highest value (2.57 %) in biscuits produced from sample E and the lowest value recorded in biscuits made from sample A. Significant differences were obtained in all the samples at ( $p < 0.05$ ). The ash content of food material could be used as an index of mineral constituents of the food because ash is the inorganic residue remaining after the water and organic matter have been removed by heating in the presence of an oxidizing agent [19]. Crude fiber (1.06 to 1.55 %) increases as more malted sorghum flour is added to wheat flour in the biscuit production. The results suggest that malted sorghum flour has more crude fiber than wheat flour. The lower fiber content (1.01-1.55%) obtained in this study is in line with the result of rice and soybean flour blends [18]. However, higher fiber content (3.5-5.7%) of wheat and soy composite flour was reported by Ndife *et al.* [17]. Biscuits made from sample A recorded the highest value (7.35%) of moisture while the lowest moisture content (5.92%) was recorded in sample E. The lower moisture obtained in this study is a good indicator of their potential to have a longer shelf life.

**Table 2. Proximate composition of biscuit produced from wheat/malted sorghum flour mixes.**

Sample	Moisture (%)	Ash (%)	Fibre (%)	Fat (%)	Protein (%)	Carbohydrate (%)
A	7.35 <sup>a</sup>	2.17 <sup>d</sup>	1.06 <sup>d</sup>	2.48 <sup>a</sup>	12.64 <sup>a</sup>	74.30 <sup>c</sup>
B	6.45 <sup>ab</sup>	2.21 <sup>d</sup>	1.01 <sup>d</sup>	2.41 <sup>ab</sup>	12.25 <sup>ab</sup>	75.67 <sup>b</sup>
C	6.30 <sup>b</sup>	2.33 <sup>c</sup>	1.23 <sup>c</sup>	2.35 <sup>b</sup>	11.83 <sup>b</sup>	75.96 <sup>b</sup>
D	6.10 <sup>b</sup>	2.48 <sup>b</sup>	1.35 <sup>b</sup>	2.19 <sup>c</sup>	10.90 <sup>c</sup>	76.95 <sup>ab</sup>
E	5.92 <sup>c</sup>	2.57 <sup>a</sup>	1.55 <sup>a</sup>	2.15 <sup>c</sup>	10.19 <sup>d</sup>	77.62 <sup>a</sup>

Mean with different superscript along the same column have significant difference from each other ( $p < 0.05$ ).

Sample A = 100:0 wheat flour; B = 95:5 wheat:malted sorghum flour ; C = 90:10 wheat: malted sorghum flour; D = 80:20 wheat:malted sorghum flour and E = 70:30 wheat:malted sorghum flour

### Sensory Characteristics of Wheat/Malted sorghum Composite Biscuit

Table 3 shows the sensory attributes of biscuit produced using wheat/malted sorghum flour mixes. The attributes tested for in the biscuits produced include colour, aroma, mouth feel, crispness, texture, taste and overall acceptability. The result of the colour revealed that sample A had the highest value (6.24) and sample D had the lowest value

(5.68). No significant differences were observed between samples B and C, and samples D and E but significant difference was observed between samples A and D ( $p < 0.05$ ). The aroma shows that sample E had the highest value of 5.80 and sample D had the least value of 5.40. There was no significant difference ( $p > 0.05$ ) in all the biscuit samples. However, crispness reveals that sample E has the highest value of 6.08 and the lowest value of 5.72 obtained in

samples A and B. No significant difference ( $p>0.05$ ) in the samples for mouth feel, with the highest value of 6.40 obtained in sample A and lowest value of 5.52 in sample D. In texture, no significant difference was observed in samples A, C and D ( $p>0.05$ ). Sample E recorded the highest value of 6.0 while the lowest value of 5.4 was obtained with sample B. Sample C had the highest value of 5.8 in taste while the lowest value of 5.52 was obtained in sample E. The result shows that there was no significant difference ( $p>0.05$ ) in the taste of the biscuits.

**Table 3. Sensory composition of wheat/malted sorghum biscuit.**

Sample	Colour	Aroma	Mouth feel	Texture	Taste	Crispness	Overall Acceptability
A	6.24 <sup>a</sup>	5.64 <sup>a</sup>	6.40 <sup>a</sup>	5.88 <sup>ab</sup>	5.60 <sup>a</sup>	5.72 <sup>a</sup>	6.24 <sup>a</sup>
B	6.04 <sup>ab</sup>	5.64 <sup>a</sup>	5.88 <sup>ab</sup>	5.44 <sup>b</sup>	5.56 <sup>a</sup>	5.72 <sup>a</sup>	6.16 <sup>a</sup>
C	5.92 <sup>ab</sup>	5.52 <sup>a</sup>	6.00 <sup>ab</sup>	5.64 <sup>ab</sup>	5.88 <sup>a</sup>	5.88 <sup>a</sup>	6.08 <sup>a</sup>
D	5.68 <sup>b</sup>	5.40 <sup>a</sup>	5.52 <sup>b</sup>	5.80 <sup>ab</sup>	5.56 <sup>a</sup>	5.84 <sup>a</sup>	5.90 <sup>ab</sup>
E	5.72 <sup>b</sup>	5.80 <sup>a</sup>	6.04 <sup>ab</sup>	6.00 <sup>a</sup>	5.52 <sup>a</sup>	6.08 <sup>a</sup>	5.56 <sup>b</sup>

Mean with different superscript along the same column have significant difference from each other ( $p<0.05$ ).

Sample A = 100:0 wheat flour; B = 95:5 wheat:malted sorghum flour ; C = 90:10 wheat: malted sorghum flour; D = 80:20 wheat:malted sorghum flour and E = 70:30 wheat:malted sorghum flour

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## Conclusion

The study demonstrated that biscuit can be made with substitution of malted sorghum flour up to 30% without adversely affecting its sensory attributes. Consequently, this is an indication of viable alternative raw material in confectionery industries. Invariably, this could reduce the importation rate of wheat flour to enhance savings in foreign exchange in tropical continents where sorghum grows but largely underutilized.

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