EVALUATION OF THE NUTRITIONAL AND FUNCTIONAL PROPERTIES OF TALIA MADE FROM WHEAT/SORGHUM FLOUR BLENDS

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ABSTRACT
Semolina (Triticum durum) was blended with sorghum (Sorghum bicolor) flour at different ratios of 100:0, 90:10, 80:20, 70:30, 60:40, and 50:50. The blends were used to produce Talia, a local noodle of the northern origin, usually a thin strips of dough locally made from semolina using manual cold extrusion and drying. The flour blends were subjected to functional properties analysis, while the Talia produced were analysed for proximate composition and cooking test. Result showed increase (7.33% - 12.33%) in water absorption capacity and decrease (52% - 45 %) in swelling capacity as sorghum level increases in the flour blends. Talia made from the flour composites showed significant (p < 0.05) increases in protein content (10.10% - 10.50%) and crude fibre (1.50% – 1.87%), while decreases were observed in moisture contents (9.86% - 8.00%). Significant (p<0.05) increases in cooking loss (1.37% - 8.2%), total organic matter (1.26 - 2. 84) and reduced expansion ratio (3.0 - 2.0) relative to control were also observed in the cooked Talia. Flour blend with 30% sorghum addition showed low water absorption (10.0%), high swelling capacity ( 50.3%), low cooking loss (6.19%) and total organic matter value ( < 2.1), therefore, could produce acceptable Talia.

INTRODUCTION
Talia is a Hausa name for local noodles. It consists of thin strips of dough locally made from durum wheat using manual cold extrusion and drying. Sorghum, a principal source of energy, protein, vitamins and minerals is less utilized among the cereals cultivated in Nigeria. The protein content is comparable to that of wheat and maize and it is tannin free (NRC, 1996). Sorghum contains 100% amylopectin and since it is gluten free makes it a good substitute for wheat flour (Miche et al., 1977). Composite flour technology holds a great future for developing countries (Dendy, 1992). Thus, the use of composite flour has been encouraged since it reduces the importation of wheat, lowers cost of production, encourages production and use of indigenous cereals (Omeire and Ohambelle, 2010). The use of locally available inexpensive cereal like sorghum that substitute a part of wheat flour without adversely affecting the acceptability of the product will be a welcome development. Partial substitution of wheat flour with sorghum flour will increase the overall nutrients (Adebowale et al., 2012), encourage the agricultural sector, increase the Talia pasta variety, and reduce dependence on semolina for production of pasta as well as lower production cost. This work therefore seeks to evaluate the nutritional and functional properties of the flour blends and to determine the optimal level of semolina substitution with sorghum in formulating good quality Talia using water absorption capacity, cooking loss, total organic matter and swelling capacity.

MATERIALS AND METHODS
The raw materials used in this study were white sorghum (Sorghum bicolor) and semolina (Triticum durum). Sorghum grains (white variety) were purchased from Ibi market in Ibi Local Government Area in Taraba State, Nigeria. Semolina was purchase from Oggige market Nsukka in EnuguState, Nigeria.

Preparation of sorghum flour
The sorghum grains (5kg) were sorted cleaned, dehulled, winnowed, and milled (attrition mill, De-Demark super Gx 160.55), sieved (600 μm) and heat sealed in polyethylene pouches and stored until used for analysis and product formulation.

Formulation of composite flours
Semolina and sorghum composite flours were formulated as shown in Table 1
Production of talia pasta

Talia samples were produce using the method described by Kent (1983) (Figure 1). Each flour blend was made into a stiff dough using 70-90ml of water per 100g flour blend. The volume of water used for each samples are as follows: W and W5 (70ml), W2 and W5 (80ml), W3 and W5 (90ml). After mixing, the dough was allowed to rest for 10 minutes and then kneaded until it is malleable, sheeted with a manual wooden roller and cut into strands using the pasta cutting machine (Imperia titania pasta cutting machine, China). The long strands were cut uniformly into the desired length (15cm) before drying. The Talia strands were put in clean aluminum trays and oven dried (Gallenkamp, England) at 80°C for one hour to a moisture content of 18%. The samples were allowed to rest in the oven for 4 hours after the initial drying. This was to allow moisture equilibration between the inner core and the outer surface of the product. Further drying was done at 60°C for six hours to bring the Talia to moisture content of 12%. The dried Talia samples were sealed in polyethylene bags and stored at ambient temperature until used for analysis.

Determination of proximate composition

Moisture, crude protein, total ash, total fat, crude fibre and carbohydrate contents were determined according to the methods of AOAC (2010)

Determination of functional properties of flour composites

Determination of Water Absorption Capacity

The method of Beuchart (1977) was used to determine the water absorption capacity. Exactly 1g of the sample was weighed into a test tube to which 10ml of distilled water was added. The content of the test tube was mixed thoroughly and allowed to stand for 10 min. The slurry was centrifuged (800-1 lower speed centrifugal machine) at 5,000 rpm for 30 min. The supernatant was decanted into a previously weighed Petri dish (W1), evaporated, and dried at 1300°C to constant weight (W3). The soluble solid was calculated by weight difference and expressed as a percentage of the sample weight used.

\[
\% \text{Solubles} = \frac{W_2 - W_1}{W_2} \times 100\%
\]

where:

- W1 - weight of empty petri dish
- W2 - weight of sample
- W3 - weight of petri dish plus dry supernatant

Swelling Capacity Determination

The method described by Leach et al. (1959) was used in the determination of swelling capacity. Exactly 10ml of distilled water was put into three graduated centrifuge tubes and 1g of sample was added. The tubes were thoroughly stirred and centrifuged (800-1 lower speed centrifugal machine) at 1000 rpm for 5 min. The volumes of the centrifuged samples in the tubes were read off immediately. The tubes were subjected to heating in a water bath set at 600°C for 1 hour with constant stirring. The heated suspension was centrifuged (800-1 lower speed centrifugal machine) at 1000 rpm for 15 min. The volumes of the sample in the tubes were read. The swelling capacity of the sample was calculated thus:

\[
\% \text{Swelling capacity} = \frac{\text{Vol. of suspension after heating and centrifuging}}{\text{Centrifuging before heating}} \times 100\%
\]

Water absorption index (WAI) Determination

The water absorption index of the flour samples was determined by the method of Mercier and Feilliet (1975). Two grams of flour sample was weighed into a porcelain dish and 10ml of water was added. The porcelain dish was heated in a water bath at 1000°C for 30 min. The resultant slurry was allowed to stand for 10 min and the supernatant was decanted. The gel was weighed. The water absorption index was calculated, thus:

\[
\text{WAI} = \frac{W_2}{W_1}
\]

where:

- W1 - Weight of dry sample
- W2 - Weight of gel

WAI - Gram gel obtained per gram of dry sample

Swelling index (SI) Determination

The swelling index (SI) of the flour is calculated as:

\[
\text{SI} = \frac{W - W_0}{W_0} \times 100\%
\]

where:

- W - Weight of gel
- W0 - Weight of sample
Swelling index of flour composites were determined using the method described by Mestres et al. (1988). Two grams of sample was weighed into a porcelain dish and 10ml of water was added. The porcelain dish was heated for 30 minutes in a water bath at 1000C. The cooked sample was drained and rapidly weighed (W1). The cooked product was dried to constant weight (W2). Swelling index was calculated thus:

\[
\text{% Swelling index (SI)} = \frac{W_1 - W_2}{W_2} \times 100
\]

where
- W1-Weight of cooked sample
- W2 -Weight of cooked dried sample

Water solubility index (WSI) Determination
The method described by Mercier and Feilliet (1975) was used for the determination of water solubility index. Two grams of the sample was weighed into a porcelain dish and 10ml of water was added. The porcelain dish was heated for 30 min in a water bath at 1000C. The gel formed was separated from the solution. The solution was centrifuged and supernatant was decanted. The supernatant was washed with distilled water and K2Cr2O7 was titrated with 0.5N Fe (NH4) 2 (SO4) 2. Diphenylamine (C6H5) 2 NH (0.5%) in Conc. H2SO4 indicator was added from a burette to wet the residue. After complete evaporation, further heating was avoided. Exactly 10ml of K2Cr2O7 was added from a burette to wet the residue completely. Then 20ml of 90% solution of H2SO4 was pipetted into the beaker, mixed for 1 min and allowed to stand for 30 min. The mixture was diluted with 200ml of distilled water and K2Cr2O7 was titrated with 0.5N Fe (NH4) 2 (SO4) 2. Diphenylamine (C6H5) 2 NH (0.5%) in Conc. H2SO4 indicator was used. The end point of the titration was indicated by a change of color from violet to green. Result was expressed as gram of starch obtained from 100g talia as follows.

\[
\% \text{Solid loss (SL1, %)} = \frac{W_3 \times 5}{W_4 \times 100} \times \text{DM}
\]

\[
\% \text{Soluble loss (SL2, %)} = \frac{W_6 \times 5}{W_4 \times 100} \times \text{DM}
\]

Total cooking loss (TCL, %) = SL1 + SL2
DM = dry matter ratio of crude sample

Expansion ratio determination
The radial expansion of the pasta talia was determined by measuring the diameter of the raw and cooked talia with a pair of venier calipers and expressed as the ratio of the cross section of the raw talia rod to that of the cooked talia rod (Mercier and Feilliet, 1975)

\[
\text{Expansion ratio} = \frac{\text{Cross-section of raw talia rod}}{\text{Cross-section for the cooked talia rod}}
\]

Total Organic Matter (T.O.M) Determination
Total organic matter of the talia was determined by the method described by D’Egidio et al. (1982). The method was based on washing the substances coating the surface of 100g of cooked talia with 500ml of water at room temperature for 12 min. During the 12 minutes washing, the product was stirred three times every 4 min. The talia was taken out and the washing water was analyzed for total organic matter. Exactly 5ml of the well stirred washing water suspension was pipetted into a 600ml beaker and was evaporated at 800C. After complete evaporation, further heating was avoided. Exactly 10ml of K2Cr2O7 was added from a burette to wet the residue completely. Then 20ml of 90% solution of H2SO4 was pipetted into the beaker, mixed for 1 min and allowed to stand for 30 min. The mixture was diluted with 200ml of distilled water and K2Cr2O7 was titrated with 0.5N Fe (NH4) 2 (SO4) 2. Diphenylamine (C6H5) 2 NH (0.5%) in Conc. H2SO4 indicator was used. The end point of the titration was indicated by a change of color from violet to green. Result was expressed as gram of starch obtained from 100g talia as follows.

\[
T. \ O. \ M. = (B - S) \times (\frac{20}{B}) x 3.75 x 100 x 0.9 x 1.0283
\]
where:

- B - ml of 0.5N Fe (NH₄)₂ (SO₄)₂ used as the blank
- S - ml of 0.5N Fe (NH₄)₂ (SO₄)₂ used for the sample
- 20 - Theoretical amount (ml) of Fe (NH₄)₂(SO₄)₂ equivalent to 10 ml of K₂Cr₂O₇
- 3.75 - mg of glucose equivalent to 1 ml of 0.5N Fe (NH₄)₂(SO₄)₂
- 100 - Dilution factor
- 0.9 - Factor for conversion of glucose into starch
- 1.0283 - Correction factor for incomplete digestion.

Values will be given as g starch/100g Talia T.O.M

Values < 1.4 - very good quality Talia
1.4-2.1 - good quality Talia
> 2.1 - Low quality Talia

Statistical analysis
Complete randomized design (CRD) was used to design the work. Data obtained from the proximate and functional properties analysis of the raw materials were analyzed using the students T-test, while data obtained from the proximate and functional properties of flour blends and cooking test of Talia were recorded in triplicate and subjected to statistical analysis of variance (ANOVA), mean separation was carried out using least significant different (LSD) at 5% level of significance.

RESULTS AND DISCUSSIONS
The results of the proximate composition of semolina and sorghum flours are shown in Table 2. Significant difference (p < 0.05) was not observed in the moisture, ash, fat, and crude fibre contents of semolina and sorghum flours. This showed that semolina and sorghum flours have comparable proximate composition as earlier noted by NRC, (1996). The moisture content of the flour samples fall within the 10% moisture level recommended for safe keeping of flour samples (SON, 2007) and also suitable for Talia keeping quality. The carbohydrate and protein contents of the flour samples were significantly different (p > 0.05) from each other, sorghum having lower carbohydrate content and slightly higher protein content than semolina. Although the protein content of these flours is too low for a high quality Talia and therefore need to be improved by adding protein from a legume source.

The results of functional properties of the flour blends are presented in Table 3. The flour samples of semolina and sorghum showed significant differences (p < 0.05) in all the functional properties determined in this study. Sorghum flour recorded higher values in water absorption capacity (18.0%), soluble solids (4.0%) and water solubility index (5.5%) than semolina. This could be attributed to the presence of amylopectin in sorghum which is readily water soluble (Miche et al., 1977). High water absorption capacity is not desirable in Talia as this could make it soft and brittle. Semolina showed higher swelling capacity (52.0%), water absorption index (8.0%) and swelling index (96.8%) than sorghum flour. This could be due to the presence of gluten in semolina which has the ability to swell and form gel. High swelling capacity is a significant index in Talia as it aids yield. The pH of the flours differ significantly (p < 0.05) and are within the range that can inhibit microbial growth (Faubion et al., 1982).

<table>
<thead>
<tr>
<th>Flour blends</th>
<th>Wheat (g)</th>
<th>Sorghum (g)</th>
<th>Total (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>100</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>WS1</td>
<td>90</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>WS2</td>
<td>80</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>WS3</td>
<td>70</td>
<td>30</td>
<td>100</td>
</tr>
<tr>
<td>WS4</td>
<td>60</td>
<td>40</td>
<td>100</td>
</tr>
<tr>
<td>WS5</td>
<td>50</td>
<td>50</td>
<td>100</td>
</tr>
</tbody>
</table>

S - Sorghum W - Semolina

Table 1: Formulation of semolina/sorghum flour blends

Fig.1: Flow diagram for Talia Production (Source: Kent (1983))
The results of proximate composition of Talia produced from semolina/sorghum flour composites are shown in Table 4.

Result showed no significant differences (p > 0.05) in moisture content of samples W and WS1 and also WS4 and WS5. Although decrease in moisture content was observed as the level of sorghum substitution increased. This could be attributed to the increased hydrophilic property of fibre in sorghum as it increases in the composite. This low moisture content predicts good keeping quality of the Talia (Nnam, 2002). Moisture content above 15% will cause mould to grow (Douglas and Mathew, 1982). Significance (p < 0.05) in fat content was observed between WS3, WS4, WS5 and W (the control). Fat content increased as sorghum levels increased, this is due to the higher fat content of sorghum (Table 2). Increases were observed in all the parameters as sorghum levels increases in the flour blends. But significant differences (p < 0.05) in ash content were seen in samples WS1 and WS2, WS3 and WS4. All the samples differ (p < 0.05) from the control in crude fibre but WS2, WS3 and WS4 are similar (p > 0.05) as were also seen in their water absorption capacity (Table 5) this showed that their water holding capacity will be the same (p > 0.05). Protein contents of samples WS3 and WS4 differ significantly (p < 0.05) as also reflected in their expansion ratio (Table 6). Generally, the fat, ash, crude fibre and protein contents of all the samples increased as the level of sorghum increased in the flour blends, except for moisture and carbohydrates contents that decreased. This showed that composites of semolina and sorghum could increase the ash, fat, protein and fibre contents and decrease the moisture and carbohydrates content of Talia (Table 4). This observation agrees with the findings of Adebowale et al. (2012) who reported increases in protein, fat, crude fibre and ash contents of biscuit produced from wheat/sorghum composite flours.

The result of functional properties of semolina/sorghum flour composites is presented in Table 5.

The water absorption capacity of the samples increased from 7.33% to 12.33% as the level of sorghum flour increased in the blends. This increase in water absorption capacity could be attributed to the predominance of amyllopectin in sorghum which was able to imbibe much water. Sample WS5 had higher water absorption capacity and is significantly different (p < 0.05) from the other samples because high water absorption capacity makes the product soft and brittle. Increases were observed in both soluble solids (2.5% - 3.5%) and water solubility index (2.5gg-1 - 5.0gg-1) of the flour blends as the level of sorghum substitution increased. This increase could be due to the increase in the amyllopectin as sorghum increases in the blends. Amylopectin is readily soluble in water which leads to the increase in solubility of the flour blends. Samples WS1, WS2 and WS3 showed significant differences (p < 0.05) among each other in soluble solids, while samples WS1 and WS2 were not significantly different (p > 0.05) in water solubility index. High soluble solids and water solubility index predicts high cooking losses of the product (Table 6). There are significant differences (p<0.05) in swelling capacity among samples WS3, WS4 and WS5, while all the samples differed significantly (p < 0.05) in swelling index. Decreases were observed in both swelling capacity (52.0% - 45.4%) and swelling index (96.8gg-1 - 72.0gg-1) of the flour blends as the level of sorghum increased. These decreases were attributed to the decrease of gluten in the blends. High

<table>
<thead>
<tr>
<th>Sample</th>
<th>Moisture (%)</th>
<th>Ash (%)</th>
<th>Fat (%)</th>
<th>Crude fibre (%)</th>
<th>Crude Protein (%)</th>
<th>Carbohydrates (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semolina</td>
<td>10.00±0.5</td>
<td>1.00±0.0</td>
<td>2.00±0.0</td>
<td>1.30±0.1</td>
<td>10.10±0.3</td>
<td>75.60±0.26</td>
</tr>
<tr>
<td>Sorghum</td>
<td>9.50±0.5</td>
<td>1.50±0.5</td>
<td>2.50±0.5</td>
<td>1.70±0.1</td>
<td>11.60±0.4</td>
<td>73.20±0.26</td>
</tr>
</tbody>
</table>

Values are means of triplicate determinations ± standard deviation. Means within the same row with different superscript are significantly different (p < 0.05).

<table>
<thead>
<tr>
<th>Functional Properties</th>
<th>Semolina</th>
<th>Sorghum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water absorption capacity (%)</td>
<td>7.33b±0.58</td>
<td>18.00±0.1</td>
</tr>
<tr>
<td>Soluble solids (%)</td>
<td>2.50b±0.1</td>
<td>4.00±0.01</td>
</tr>
<tr>
<td>Swelling capacity (%)</td>
<td>52.00±0.5</td>
<td>44.00±0.5</td>
</tr>
<tr>
<td>Water Absorption index gg-1</td>
<td>8.04±0.02</td>
<td>4.54±0.06</td>
</tr>
<tr>
<td>Water solubility index gg-1</td>
<td>2.50±0.05</td>
<td>5.50±0.05</td>
</tr>
<tr>
<td>pH</td>
<td>5.32±0.01</td>
<td>5.41±0.01</td>
</tr>
</tbody>
</table>

Values are means of triplicate determinations ± standard deviation. Means within the same row with different superscript are significantly different (p < 0.05).
swelling capacity and swelling index increase expansion of Talia and have been reported as part of the criteria for good quality pasta product (Achinewhu et al., 1998). Samples WS1 and WS2 were similar (p > 0.05) in water absorption index compared to other samples. Decreases in the water absorption index of the flour blends were observed as the level of sorghum increased. This could be due probably to the decrease in gluten content of the flour blends. The lower the gluten content, the lower the swelling of the flour blends. This means that higher substitution of semolina with sorghum will affect the swelling or expansion of the Talia. Therefore, samples with lower sorghum substitution were preferred for Talia production.

The result of the cooking test of Talia produced from semolina/sorghum composite flours is shown in Table 6. Significant differences (p < 0.05) were observed in expansion ratio among samples. Expansion ratio decreased (3 - 2) as the sorghum levels increased in the flour blend due probably to the decrease in gluten content as the level of semolina decreased, thereby resulting to poor product yield. There was no significant difference (p > 0.05) among samples in cooking time. Nevertheless the decrease (8 - 5 minutes) observed in cooking time as sorghum levels increases was due probably to amylopectin predominance in sorghum which is readily water soluble. Samples showed significant differences (p < 0.05) among each other in cooking losses. Sample WS5 showed higher cooking loss (8.20%) due probably to higher level of starch leaching, decrease in gluten and amylose as well as increase in amylopectin content of the flour blends and also the high soluble solids of sorghum (Table 2). However, according to Galvez and Ware (1994), solid loss of less than 9% is acceptable in pasta production; this means that all the samples showed cooking losses that are within acceptable range (1.37% to 8.2%). All the samples differed significantly (p < 0.05) in total organic matter (TOM) value. Sample WS4 and WS5 had TOM values higher than the standard value (2.1) (D’Egidio et al., 1982) and were adjudged to be of low quality Talia. This is because higher materials deposits were found on the Talia surface which resulted to a high TOM value. High materials deposit makes Talia sticky resulting to poor quality (D’Egidio et al., 1982).

### Table 4: Proximate composition (%) of Talia produced from semolina/sorghum composite flours

<table>
<thead>
<tr>
<th>Samples</th>
<th>W</th>
<th>WS1</th>
<th>WS2</th>
<th>WS3</th>
<th>WS4</th>
<th>WS5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>9.86±0.01</td>
<td>9.85±0.01</td>
<td>9.00±0.10</td>
<td>8.50±0.10</td>
<td>8.00±0.10</td>
<td>8.00±0.10</td>
</tr>
<tr>
<td>Fat</td>
<td>1.68±0.10</td>
<td>1.70±0.05</td>
<td>1.75±0.05</td>
<td>1.86±0.03</td>
<td>1.90±0.05</td>
<td>2.00±0.10</td>
</tr>
<tr>
<td>Ash</td>
<td>1.00±0.01</td>
<td>1.00±0.00</td>
<td>1.50±0.05</td>
<td>1.50±0.00</td>
<td>1.61±0.01</td>
<td>1.65±0.01</td>
</tr>
<tr>
<td>Fibre</td>
<td>1.50±0.10</td>
<td>1.65±0.01</td>
<td>1.76±0.01</td>
<td>1.78±0.01</td>
<td>1.80±0.01</td>
<td>1.87±0.01</td>
</tr>
<tr>
<td>Protein</td>
<td>10.00±0.10</td>
<td>10.17±0.02</td>
<td>10.25±0.02</td>
<td>10.30±0.01</td>
<td>10.42±0.01</td>
<td>10.50±0.01</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>75.86±0.01</td>
<td>75.63±0.01</td>
<td>75.75±0.01</td>
<td>76.08±0.01</td>
<td>76.27±0.01</td>
<td>75.98±0.01</td>
</tr>
</tbody>
</table>

Values are means of triplicate determinations ± standard deviation. Means within the same column with the same superscript are not significantly different (p>0.05). W - Semolina 100% WS1 - Semolina 90%/Sorghum 10% WS2 - Semolina 80%/Sorghum 20% WS3 - Semolina 70%/Sorghum 30% WS4 - Semolina 60%/Sorghum 40% WS5 - Semolina 50%/Sorghum 50%
CONCLUSION
Semolina and sorghum flour showed no significant difference (p > 0.05) in proximate composition except in protein and carbohydrate content. The entire flour composite had moisture content lower than 15% standard recommended for safe keeping of product showing that Talia will have good shelf life. The semolina /sorghum composite increased the fat, crude fibre, ash and protein contents of the product. Low water absorption capacity, cooking losses and high swelling capacity were observed in samples with sorghum substitution up to 30%. Thus, substitution of semolina with sorghum flour up to 30% could produce acceptable talia.

REFERENCES