Production and acceptability of *chinchin* snack made from wheat and tigernut (*Cyperus esculentus*) flour

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Abstract: Consumer interest in dietary fiber has continued to increase potential impact on health as more information about the nutritional benefits of this are being made available. Among the underutilized crops in Nigeria is tigernut which could find useful application in food industry because of its high level of dietary fibre and other inherent properties. Proximate composition and functional properties of wheat flour (WF) substituted with tigernut flour (TF) at varying proportions (100:0; 90:10; 80:20; 70:30) were carried out. Chinchin was produced based on prepared composite flour. Proximate composition and sensory properties of the product were carried out. The results of the protein were from 11.1 to 14.9%, while the crude fibre content ranged from 0.3 to 2.0% respectively. Increase in water absorption capacity and bulk density of the samples which ranged from 4.25 to 6.40 g/g and 0.51 to 0.62 g/ml respectively were also observed. Most of the parameters of proximate composition assessed increased with increase in tigernut flour for snacks making. Sensory evaluation showed that acceptable chinchin with qualities similar to 100% wheat chinchin can be produced with 10% tigernut flour replacement.

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PUBLIC INTEREST STATEMENT
Chinchin is a fried golden brown crunchy wheat flour-based snack, popular in Nigeria amongst several age brackets. It is available in various shapes and sizes. Its wide acceptance has promoted commercial production and marketing of the product by entrepreneurs. Processing and refining of wheat flour has long been reported to lower the quality of wheat based products from the health standpoint, hence the need to increase the fibre content of chinchin. Tigernuts flour was added to chinchin formulation, in this study to enhance it from the health standpoint, amongst the consuming population and determine acceptability of ingredient substitution. Significant benefits of foods rich in fibre, include but are not limited to reducing constipation by lowering stool weight and transit time, reducing risk of heart diseases and lowering blood cholesterol and reducing risk of colon cancer. Acceptance of wheat flour chinchin, supplemented with tigernuts, would promote tigernut utilization.
1. Introduction

Studies have shown that snacks can be used to increase the nutritional status of consumers by incorporating nutrients such as protein and fiber from plant sources which have health benefits (Zazueta-Morales, Martínez-Bustos, Jacobo-Valenzuela, Ordorica-Falomir, & Paredes-López, 2001). Wheat (*Triticum* spp.) is one of the major grains in the diet of a vast proportion of the world’s population. It has therefore a great impact on the nutritional quality of the meals consumed by a large number of people and consequently on their health. Although wheat’s ability to produce high yields under a wide range of conditions is one reason for its popularity compared to other cereals, the most important factor is the capability of wheat gluten proteins to form viscoelastic dough, which is required to bake leavened bread in particular. These gluten proteins are necessary for the production of the great variety of foods associated with wheat around the world. The total annual production of wheat for year 2016 as at June is put at 724 million metric tonnes (FAO/WHO, 2016).

Tigernut (*Cyperus esculentus*), an underutilized crop, was reported to be high in dietary fiber content, which could be effective in the treatment and prevention of many diseases including colon cancer, coronary heart diseases, obesity, diabetes, and gastrointestinal disorders. Tigernut flour has been demonstrated to be a rich source of quality oil and contains moderate amount of protein. It is also an excellent source of some useful minerals such as iron and calcium which are essential for body growth and development (Oladele & Aina, 2007). Its tubers are also said to be aphrodisiac, carminative, diuretic, stimulant and tonic properties (Adejuyitan, 2011).

Tigernut has also been reported to be used in the treatment of flatulence, indigestion, diarrhea, dysentery, and excessive thirst (Abaejoh, Djomdi, & Ndjouenkou, 2006). In addition, tigernut has been demonstrated to contain higher essential amino acids than those proposed in the protein standard by the FAO/WHO/UNU (1985) for satisfying adult needs (Bosch, Alegria, & Farre, 2005). Therefore, tigernut, with its inherent nutritional and therapeutic advantage, could serve as a good alternative to cassava in baking industry. This will also reduce cost and promote the utilization of indigenous crops in food formulation. Information on the use of tigernut in baked goods is scanty.

*Chinchin* is a fried snack popular in West Africa. It is a sweet, cookie-like product made from wheat flour and egg (Akubor, 2004). It is usually kneaded and cut into small sizes prior to frying. Wheat flour is the main raw material and therefore there is need to enrich it with adequate protein and fiber sources.

The objective of this research work is to evaluate the quality of an enriched chinchin snack produced from composite wheat-tigernut flour.

2. Materials and methods

2.1. Materials

The materials (fresh tigernut seeds, wheat flour, margarine, sugar, nutmeg, salt, milk, eggs, and baking powder) used were purchased from Iddo market in Oyingbo Lagos state, Nigeria.

2.2. Production of tigernut flour

Tigernut flour was prepared using the method described by Adeyemi (1988). The nuts were sorted in order to remove unwanted materials like pebbles, stones, and the foreign seeds before being washed with tap water. The cleaned nuts were dried, milled and sieved through 100 mm aperture size sieve and the resultant flour was packaged in cellophane until it was used.
2.3. Formulation of blend
Wheat and tigernut flour were mixed at different proportion; 90%:10%, 80%:20%, 70%:30% respectively. A Kenwood mixer (A901E, Kenwood Havant Hampshire, made in England) was used for mixing the samples to achieve uniform blends.

2.4. Chin Chin preparation
First the blended flour was put in a bowl followed by the addition of salt and ground nutmeg. After this, margarine was mixed together with it evenly. Eggs, sugar and other ingredients were added to make fairly stiff dough. The thick dough was rolled tightly on a board and cut into cubes followed by frying in deep hot vegetable oil until golden brown. The oil was then drained followed by cooling and packaging in high density polyethylene bags for storage until the chin chin was evaluated. This was repeated for all the blended flour samples.

2.4.1. Proximate composition
Protein, fat, crude fibre, moisture and ash were determined by the methods of Analysis of the Association of Official Analytical Chemists (2005) while carbohydrate was determined by difference.

2.4.2. Functional properties
Water absorption capacity and oil absorption capacity were determined using Wang and Kinsella (1976) method. Bulk density was determined using the Onwuka (2005) method. Swelling capacity was determined using the method of Ukpabi and Ndimele (1990) and pH was determined by using Analysis of the Association of Official Analytical Chemists (2000).

2.4.3. Sensory evaluation
The sensory attributes of the chin chin was determined by using simple hedonic tests as described by Larmond (1991). This was done using a 20-member panel comprising of students of the department of Food Technology, Yaba College of technology, Yaba, Lagos, Nigeria, who were familiar with the sensory attributes of chin-chin. Each panelist was asked to score each attribute on a 9-point hedonic scale where 1 and 9 represent dislike extremely and like extremely, respectively. The attributes that were evaluated includes colour, taste, texture, crispness and overall acceptability.

2.4.4. Statistical analysis
All collected data were subjected to analysis of Variance (ANOVA) using SPSS (Version 15, 2007). Duncan multiple range test was used to separate the differences in the mean scores.

3. Results and discussion

3.1. Proximate composition of wheat-tigernut composite flour
The proximate composition of the composite flour is presented in Table 1. It shows that the protein content of the composite flour increased from 12.9 to 14.9% with increase in tigernut flour substitution. There was also a notable enhancement of fiber content as well as ash content of the composite flour.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Moisture (%)</th>
<th>Protein (%)</th>
<th>Fat (%)</th>
<th>Ash (%)</th>
<th>Fibre (%)</th>
<th>Carbohydrate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>JCU</td>
<td>14.7 ± 0.1a</td>
<td>11.1 ± 0.3a</td>
<td>1.3 ± 0.3c</td>
<td>0.45 ± 0.01b</td>
<td>0.3 ± 0.1c</td>
<td>68.7 ± 0.3a</td>
</tr>
<tr>
<td>ASF</td>
<td>14.4 ± 0.1a</td>
<td>12.9 ± 0.3a</td>
<td>4.6 ± 0.2c</td>
<td>0.8 ± 0.02a</td>
<td>0.8 ± 0.1b</td>
<td>66.5 ± 0.2b</td>
</tr>
<tr>
<td>BOD</td>
<td>14.4 ± 0.0a</td>
<td>14.0 ± 0.4a</td>
<td>7.7 ± 0.3b</td>
<td>1.1 ± 0.02a</td>
<td>1.4 ± 0.4b</td>
<td>63.4 ± 0.1c</td>
</tr>
<tr>
<td>MLA</td>
<td>14.2 ± 0.0a</td>
<td>14.9 ± 0.5a</td>
<td>11.0 ± 0.3c</td>
<td>1.2 ± 0.01a</td>
<td>2.0 ± 0.4b</td>
<td>60.5 ± 0.1c</td>
</tr>
</tbody>
</table>

Notes: JCU = 100%WF, ASF = 90%:10%, BOD = 80%:20%, MLA = 70%:30% wheat:tigernut.
Values are represented as mean ± standard deviation of duplicate samples. Mean values with the same letter within the same column are not significantly different (p > 0.05).
flour. The fat content of the composite flour increased from 1.3 to 11.0% proportionately. This might be due to high fat content (24.00%) of the tigernut flour (Basman & Koksel, 2003). Defatting the tigernut before utilization may yield better result. The carbohydrate content of the composite flour decreased from 68.7 to 60.5% indicating low carbohydrate content of the tigernut flour particularly sugar.

3.2. Functional properties of the composite wheat-tigernut flour

Table 2 shows the functional properties of the composite wheat-tigernut flour. The functional properties are those parameters that determine the application and end use of food materials for various food products. Water absorption capacity (WAC) which defines the rate at which each sample absorbed water increased with increase in tigernut addition. Result shows an increase in WAC as tigernut flour ratio increases. Blend ratio 70:30 (6.40 g/g) has the highest value. This value reduces gradually as the ratio of tigernut decreases (5.48, 5.35, and 4.25 g/g for 90:10, 80:20 and 100:0 respectively). This could be because the addition of tigernut flour to wheat flour improves the reconstitution ability. High WAC is attributed to loose structure of starch polymers while low values indicate the compactness of the structure (Adebowale, Sanni, & Awonorin, 2005). Increase in WAC implies increase in digestibility of the product (Ayele & Nip, 1994).

The bulk density of the samples ranged from 0.51 to 0.62 g/ml with 100:0 and 70:30 having the lowest and highest values respectively. There were significant difference ($p < 0.05$) between these two samples when compared with others. A bulk density of 0.48–0.66 g/ml for raw and malted wheat flour by Magnesia and Wafflemix (2007), which is comparable to that obtained in this study. The bulk density is a reflection of the load the sample can carry if allowed to rest directly on one another. The bulk density of foods is affected by the particle size and the starch content. It is important in determining the packaging requirement, raw materials handling and application in wet processing in food industry (Adebowale, Sanni, & Onitilo, 2008; Ajanaku, Ajanaku, Edobor-Osoh, & Nwinyi, 2012).

There was decrease in the swelling capacity as the ratio of tigernut flour increases. The values recorded for the sample were 19.71, 17.55, 15.90 and 14.62 g/g for JCU, ASF, BOD and MLA respectively. Significant differences were observed ($p < 0.05$) amongst the samples. The higher the water absorption capacity, the lower the swelling capacity and the more readily digestible the product will be.

MLA had the lowest value, for Oil absorption. Magnitude of oil absorption capacity are in the following order JCU > ASF > BOD > MLA. This is as a result of high level of oil present in tigernut. The major component affecting oil absorption capacity is protein, which is composed of both hydrophilic and hydrophobic parts (Jitngarmkusol, Hongsuwankul, & Tananuwong, 2008). The results obtained from functional properties showed that flour with high protein content, for example wheat-tigernut flour could be used as functional ingredient in foods such as whipped topping, sausages, chiffon dessert, angle and sponge cake (Kaushal, Kumar, & Sharma, 2012). Oil absorption capacity is important
since oil acts as flavor retainer and increases mouth feel of foods (Aremu, Olaofe, Akintayo, & Adeyeye, 2008). There was an increase in pH value with increase in tigernut and the value ranged between 5.82 and 6.08. Chinma and Ocheme (2007) had earlier reported the pH of cassava flour was 6.55.

3.3. Proximate composition of chinchin

Table 3 shows the proximate composition of the chinchin from composite wheat-tigernut flour. The protein content of the chinchin samples increases as the ratio of tigernut flour increases in the mixture, the values ranged from 7.66 to 11.58%. Significant differences \((p < 0.05)\) were observed amongst the samples when compared. The ratio 90:10 showed no statistical significant difference \((p < 0.05)\) when been compared with 80:20. The decrease in the protein contents may be attributed to the low protein content of tigernut (Bamishaiye & Bamishaiye, 2011).

The moisture content of the samples ranged from 3.00 to 5.29%. The values were within the range reported to have no adverse effect on quality attribute of the product (Mepba, Achinewhu, & Aso, 2007). Sanni, Adebowale, and Tafa (2006) reported that the lower the moisture content of a product to be stored, the better the shelf stability of such product. The low moisture content could reduce the growth of microorganisms thereby increasing the shelf life of the product.

The ash content (%) of the sample increased with decrease in the ratio of wheat flour in the samples. The result shows that blend ratio MLA which contained the highest proportion of tigernut flour had the highest ash content (1.08%) and when compared with other samples showed statistically significant differences \((p < 0.05)\). The ash content is also a rough estimate of the mineral contents of the samples (Mepba et al., 2007).

The results shows there were significant increase in the fat content as the ratio of tigernut increases. This may be due to high amount of fat in tigernut as reported by Bamishaiye and Bamishaiye (2011). The tubers contain up to 30% of non-drying oil which is used for cooking and soap making (Nwaoguikpe, 2010). Defatting the nut before utilization may reduce the fat contents or reducing the quantity of oil to be used for frying. The carbohydrate content of the samples was found to decrease as the ratio of wheat flour decreases. There were significant differences in MLA which had the lowest value when compared with all other samples \((p < 0.05)\).

The addition of tigernut flour in the composition at the level of 10–30% resulted in a notable increase in the crude fibre contents (%) of the product.

3.4. Sensory evaluation

Table 4 shows the results of sensory evaluation of wheat-tigernut chin chin samples. There were significant differences in all the attributes measured. The results for colour, taste, crispiness and texture follows the same trends which show a decrease in values as the ratio of tigernut flour increases. The mean and standard deviation for colour were obtained as 8.56 ± 0.62, 7.22 ± 0.88,
6.78 ± 1.0 and 3.67 ± 2.03 for JCU, ASF, BOD and MLA respectively. The high value observed from 100% wheat flour may be as a result of changes in appearance and colour of chin chin due to addition of tigernut which had effect on both the appearance and colour, compare to whitish colour usually obtained for all-purpose wheat flour. The result of appearance for this study was more acceptable than that obtained for millet-wheat composite chin chin (Adegunwa, Ganiyu, Bakare, & Adebowale, 2014).

The textural mean values obtained ranged from 5.39 to 7.06. ASF had the highest value of likeness of 7.06 while MLA had the lowest value for likeness. Significant differences \((p < 0.05)\) were observed for crispness of chin chin sample. JCU had the highest value 7.61 for the attribute crispness, while MLA had the lowest crispness value of 3.67. This result compares favourably with result obtained from modified cocoyam-wheat composite chin-chin (Akusu, Kiin-Kabari, & Ebere, 2016).

(JCU) with 100% wheat flour was most preferred in terms of overall acceptability, followed by 90:10 (ASF), 80:20 (BOD) and 70:30 (MLA) with the following scores 7.78 ± 0.94, 7.39 ± 0.98, 6.72 ± 1.41 and 4.72 ± 1.81 respectively. The results obtained for 100% (JCU) and 90:10 (ASF) were comparable but 70:30 (BOD) showed high significant difference when compared with other samples \((p < 0.05)\). There were significant differences between MLA and BOD which has low values when compared with all other samples \((p < 0.05)\).

The result of the sensory evaluation revealed that chin chin made from 100% wheat flour and those produced from composite flour with 10 and 20% tigernut flour were rated closely in almost all the quality attributes evaluated indicating the feasibility of adding tigernut to our snack. This result suggests the potential application of tigernut flour either as full fat or defatted flour in food industry.

### 4. Conclusion

Results obtained indicated that wheat flour can be substituted with tigernut flour up to 30% level. A notable increase in fibre and ash contents with a decrease in carbohydrate content in composite chin chin was observed. The significant increase in the fibre content could be nutritionally advantageous in Nigeria, where 100% wheat chin chin is one of commonest fried snacks amongst all classes of people. Moreover, an increase in fat content is important in diets as wheat flour substitution with tigernut flour yielded chin chin product that was similarly rated with that produced from 100% wheat flour. The use of wheat flour blended with up to 20% tigernut should be encouraged, as it will be a good way of preventing, digestive disorder in children, diabetics and lactose intolerance in patients. It has great potentials to reduce the cost spent on wheat and enhance utilization of tigernut.

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### Competing Interests

The authors declare no competing interest.

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<table>
<thead>
<tr>
<th>Sample</th>
<th>Colour</th>
<th>Taste</th>
<th>Texture</th>
<th>Crispness</th>
<th>Overall acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>JCU</td>
<td>8.56 ± 0.62&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.72 ± 0.83&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.89 ± 1.13&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.61 ± 1.04&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.78 ± 0.94&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>ASF</td>
<td>7.22 ± 0.88&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.44 ± 1.15&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.06 ± 1.06&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.17 ± 0.86&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.39 ± 0.98&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>BOD</td>
<td>6.78 ± 1.00&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7.28 ± 1.07&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7.00 ± 1.03&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.94 ± 1.06&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.72 ± 1.41&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>MLA</td>
<td>3.67 ± 2.03&lt;sup&gt;c&lt;/sup&gt;</td>
<td>4.94 ± 2.10&lt;sup&gt;c&lt;/sup&gt;</td>
<td>5.39 ± 1.79&lt;sup&gt;c&lt;/sup&gt;</td>
<td>3.67 ± 1.85&lt;sup&gt;d&lt;/sup&gt;</td>
<td>4.72 ± 1.81&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Notes: JCU = 100%WF, ASF = 90%:10%, BOD = 80%:20%, MLA = 70%:30% wheat:tigernut.
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