The high price of wheat flour coupled with an unfavourable climatic condition for profitable wheat production in Nigeria has led to the search for alternative flours for the production of bakery and deep fat fried foods, such as bread, chinchin, buns, doughnuts, etc. In this project, malted sorghum flour was used with cassava and rice flour as binders for the production of buns (a deep fat fried product). Buns were formulated from 100% flour; 25% fat; 30% sugar; 2% salt; 10% egg and 20% water. The effects of percentage binder used, temperature and time of frying on oil penetration were investigated. Proximate analysis of the product showed that moisture content ranged from 10.5% to 11.6%; ash content from 1.15% to 1.25%; protein content 4.64% to 4.77%; fibre content 0.35% to 0.4% and the volume was the same, about 208.86 cm$^3$ irrespective of the binder used. The extent of oil penetration decreased with increasing binder: flour ratio as well as with increased temperature of frying, but increased with time of frying until after 420 seconds when it becomes constant. The sensory evaluation of 15-member panel rated the buns above 7 points in a 9-point hedonic scale.
INTRODUCTION

Deep fat (or immersion) frying (DFF) is a cooking and drying process using a hot oil medium and is widely used in food preparation. It may be defined as a cooking process in which food is immersed in edible oil at a temperature above the boiling point of water contained in that food; the oil temperature may range from 130°C to 200°C, but is generally between 170°C to 190°C (Tangduangdee et al., 2003). During frying, heat and moisture transfer is coupled as in the drying process. The decreased moisture content of the fried food with elevated temperature causes many physical, nutritional and chemical changes such as browning, gelatinization, denauration etc, to occur. These changes depend on the frying conditions i.e. frying oil temperature, frying time, types of oil and food (Cheevasathianchaiporn and Tangduangdee, 2009).

In the past, wheat flour has been solely used for the production of deep fat fried and baked products such as, bread, cakes, buns, doughnuts, chinchin and biscuit. This is as a result of the nature and functional properties of the wheat flour proteins. But, local climatic conditions in tropical countries such as Nigeria are not suitable for profitable wheat production. Hence Nigeria’s wheat production in 2012/13 is forecast to remain small at only 100,000 tons, the same as in 2011/2012 (USDA, 2012). Consequently, Nigeria has been completely dependent on imported wheat for the manufacture of baked goods and deep fat frying products.

Since 1960, much research aimed at incorporating non wheat materials of local origin on bread and other flour product was undertaken, thus limiting wheat import (Gomez et al., 1992). Such non-wheat flours are obtained from other cereals, tubers, and root crops; for example maize, sorghum, cassava potato and plantain (Olatunji et al., 1983; Ayayi, 1986). The use of blends of wheat and non-wheat flour, known as composite flours, have been used for producing bread, biscuits and other snacks (Badi et al., 1976; Rooney et al., 1970; Hulse et al., 1980).

To further this course, the federal government of Nigeria has introduced policies to discourage wheat flour importation while encouraging the substitution of wheat flour in bread baking with high quality cassava flour. One of such policy includes the introduction of a 65% levy on wheat flour import to increase the effective duty from 35% to 100%. The federal government has also introduced guidelines which encourages the substitution of wheat flour in bread-baking with high quality cassava flour. Under the proposed guidelines, bakeries will have 18 months in which to make the transition and will enjoy a corporate tax incentive of 12% rebate if they attain 40% blending (Bglgrouping.com, 2012).

Another fiscal incentive attached to this initiative includes duty free import of related equipment and machinery. Consequently, the president launched 40% high quality cassava flour bread by IITA on 30th November and challenged the private sector to commercialize it (Federal ministry of Agriculture and Rural Development, 2011). He also launched UTC and Butterfield commercialized cassava bread on the 28th of April 2012 (Federal ministry of Agriculture and Rural Development, 2011). It is instructive to note that bread similar to wheat bread cannot be obtained from non-wheat flour (Bello, 1986). Bread from 100% corn flour has been baked by the Federal Institute of Industrial Research, Oshodi (FUTO), and results showed that the products obtained could hardly be called bread (Akinbawo, 1986; Ajayi, 1986).

These difficulties in the use of non-wheat flour for the production of baked goods due to the deficiency of gluten-a viscoelastic protein- necessitate the search for products which do not require the leavening action of gluten. Such products are mostly deep fat fried products like buns, chinchin, etc.

Sorghum (Sorghum bicolor) locally called guinea corn in Nigeria is a gluten-free grain that has the potential to be used as an alternative to wheat flour (Liu et al., 2011). About 50% of the total area devoted to the cereal crops in Nigeria is occupied by sorghum, making it the most extensively growing cereal grain in the country (Aba et al., 2004). Evidently, it is produced in very large quantities in the Northern part of Nigeria where it is processed into many food products and snacks for both human and animal consumption. Unlike the USA and India, where sorghum is mostly used as animal feed, in Nigeria, it is a staple food crop cultivated on a substantial level by farmers in these areas for human consumption (Fadlallah, 2010). In many African countries, it is milled into flour before fermentation and cooking.

It can be ground or cracked, prepared into dough and baked as flat, unleavened bread or cooked like rice or even mixed with other cereals like rice, dried cereal legumes, crude sugar or spices for various preparations such as deep- frying in vegetable or butter oil. It can also be used in various forms such as brewing flour composites, animal feed etc.

However, sorghum has very low or no binding properties. For this reason, in this work, cassava and raw rice flour are used as composites to improve the binding properties of the product. Cassava (a root crop) is produced in large quantity especially in Nigeria. In 2006, her annual production was about 38 million metric tons (MT) per annum; a figure expected to double by 2020 (UNIDO, 2006). The starch of cassava flour is capable of forming strong gel and hence cassava flour could be used as a composite flour of good binding property. Cassava is the chief source of dietary food energy for the majority of the people living in the lowland tropics and much of the sub-humid tropics of west and central Africa (Echebiri and Edaba, 2008). Estimates of industrial cassava use suggest that approximately 16% of cassava root production was utilized as an industrial raw material in 2001 in Nigeria, 10% was used as chips in animal feed, 5% was processed into syrup concentrate for soft drinks and less...
than 1% was processed into high quality cassava flour used in biscuits and confectionery, dextrin, pre-gelled starch for adhesives, starch and hydrolysates for pharmaceuticals and seasonings (Kormawa and Akoroda, 2003).

Rice is a staple food for more than half of the world’s population (Wanyo et al., 2009). Rice flour is obtained by milling broken rice grains (rice grits). Use of rice flour for baby food; breakfast foods and meat products; for separating powders for refrigerated, preformed, unbaked biscuits, dusting powders, breading mixes; and for formulations for pancakes and waffle is a long time existing exercise (Luh and Liu, 1980). Rice flour could form a rigid gel on cooling but rice flour lacks gluten. Nevertheless rice starch could form good binding product. When rice is used as the composite, a wider range of people could use the product as against cassava flour composite because of the fear that most people have about cassava Cyanide toxicity and even when the process involved are enough to reduce the Cyanide to safe levels, it is difficult to convince the consumer. The objectives of this project is to produce a deep fat fried product from modified cereal (Sorghum) with cassava and rice flour as binders (non-wheat raw materials) and to determine acceptability.

MATERIALS AND METHODS

The sorghum grain used was bought from Umuahia Local Market and was not graded. The rice grain (Paddy) used was a locally grown short-grain type from Anambra-Imo Rivers Basin Development Authority Farm, Omor. The rice grains at the point of collection are in paddy form, ungraded and untreated. The cassava tubes were specially ordered for and collected from Agricultural Development project, Owerri.

The oil (Refined Palm Oleic) was bought from Owerri New Market. The oil is a product of Ferdinand oil refining industry. The other ingredients – salt, sugar, shortening – were bought from Ekeonunwa market, Owerri. The eggs were bought from SAAT farm, FUTO. It is believed that they were sorted out before they were sold and so are safe for consumption.

The sorghum was then sorted to remove the bad, broken and weevil infested grains, stones, straws, sticks, chaffs, insects, grasses, rodent droppings, and other extraneous materials. The remaining chaff, dust, insects, dead and alive and other light weighted materials were removed by winnowing. The grains were washed twice in enough water to remove adhering dirt and dust particles as well as other contaminants. After washing, the clean grains were soaked in water in a plastic bucket. The steeped grains were aerated after 6 hours intervals and the steeping was done for 2 days.

The soaked sorghum grains were sprayed in polythene bags with the mouth closed with a heavy metal. At 4 hours interval, the polythene bags were opened and the content aerated. Sprouting of the grains started after 16 hours and sprouting was stopped after 60 hours. The lengths of the rootless were averagely measure to be 3.5cm.

The sprouted grains were then transferred into trays where they were evenly spread. These were placed in a Gallenkamp moisture extraction oven at the temperature of 54°C. After 5 hours, the temperature of the oven was raised to 110°C and drying was done for 4 hours. Then the grains were removed, cooled and the shoots and rootlets detached by hand after which it was winnowed to remove them from the grains. What is obtained is known as the malt. The malt was then stored in a cool, dry cupboard until it was needed. The malting process took 6 days.

The rice paddy was cleaned by sorting to remove the stones, sticks and other extraneous materials; then winnowed to remove dusts, light particles etc. The cleaned paddy rice was then wetted with little water to help to loosen the husk and make its removal easier. Wetting also toughens the grains making it less vulnerable to break.

A local dehulling machine was then used to remove the husks. The machine also separates the husks from the cleaned grains. The remaining husks or those that passed with the grains are small enough to be removed by winnowing before milling.

Cassava (Manihot esculenta) tubers were washed properly to remove sand, adhering dirt and dust as well as contaminating microorganisms. The clean peeled tubers were cut into large sizes longitudinally and soaked in lukewarm water with a temperature of 50°C for 24 hours. The soaking water was drained and the tubers further cut into thin slices to facilitate fast drying. The thin slices were sprayed in a tray and were sundried. Drying was done for 3 days at the end of which the moisture content of the product was highly reduced. Products obtained at this stage were very light and fragile, and the colour was white. The dried slices were packed in plastic bucket with cover and stored in cool dry cupboard.

The grinding machine was used for all the milling purposes. The machine was cleaned before and after milling of each sample (malted sorghum, rice grains and cassava slices). Milling was done gradually and repeatedly until a reasonable fine particle size was obtained. The products obtained from this milling were more meal than flour. The flour was only obtained after sieving. The raw materials milled were 3 samples and these were allowed to cool before sieving.

The milled materials were sieved one after the other. The sieving was done using sieve 425,300 and pan arranged in a descending order on the Belastung Baujuhranolab sieve shaker set at 20 minutes stopping time. The troughs of 425 which do not pass through 300um were rejected because of large particle size distribution, and only the troughs of 300um were used.
Thus, the particle size of the flour used in this work is below 300μm.

The malted sorghum flour was then blended with the cassava and rice flours in the proportion of 95:5%; 90:10%; 85:15%; 80:20%; 75:25%; 70:30% and a trial run were performed to obtain the blend that would give the best result. For the cassava flour without egg, 85:15% yielded the best result whereas for hut with egg, 80:20% yielded the best result. For the rice flour, 80:20% yielded the best result without egg and 75:25% yielded the best result with eggs.

Hence, the flour was blended in the proportion of 80% sorghum with 20% cassava flour and 75% sorghum with 25% rice because egg was used. At lower percentage of binder, the product either soaked too much oil or shattered in the oil. At higher percentage of binder, the product becomes too hard and unacceptable. Egg as well as shortening acted as tenderizers in the work.

### Buns Production

<table>
<thead>
<tr>
<th>INGREDIENTS</th>
<th>RECIPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flour</td>
<td>100%</td>
</tr>
<tr>
<td>Fat</td>
<td>25%</td>
</tr>
<tr>
<td>Sugar</td>
<td>30%</td>
</tr>
<tr>
<td>Salt</td>
<td>2%</td>
</tr>
<tr>
<td>Egg</td>
<td>10%</td>
</tr>
<tr>
<td>Water Added</td>
<td>20%</td>
</tr>
</tbody>
</table>

The recipe for the buns as shown in table 1 above was developed after several trials and error as the recipes obtained from the literature failed. The blended flours were coded A, B and C. 250grams of each blend of flour and wheat flour was weighed out using the Libor electric weighing balance into a dough mixer. The dry ingredients were weighed out and added. The sugar and salt were reground to obtain a finer particle size before adding them to sample. After mixing the dry ingredients and the flour, fat was added and after proper mixing of the measured quantity of egg was added. Water was added little by little until the required amount of water to form stiff dough has been added. When all the ingredients were properly mixed, the dough was kneaded and rolled.

The oil (bleached, refined palm oleic) was heated in the metal cooking pot to a temperature of 145°C. The temperature was taken by using a thermometer clamped on a retort stand and into the oil. The temperature was maintained at this point (145°C) by allowing the gas cooker flame stay at lowest level of flame throughout the period of frying.

The rolled dough was put into the oil which was enough to immerse it completely and the frying was completed in 10 minutes. The product was removed and left in a basket to drain off the oil. After that, it was cooled, packaged in polyethene bags and stored in the refrigerator.

### Chemical and Physical Analysis

The methods used in this proximate analysis were the standard methods obtained from principles laid down by the Association of official analytical chemists (AOAC, 1970).

#### Moisture Content Determination

The moisture contents of the samples were determined by oven moisture extraction according to AOAC method 14.003 (AOAC, 1970).

#### Ash Content Determination

The ash content was analyzed according to AOAC (1970) official method 14.006.

#### Crude Protein Analysis

The method used in this analysis was the micro kjeldahl method as prescribed in AOAC method 47.001(AOAC, 1970) with some modifications to suit the available chemicals.

#### Fibre Determination

The fibre content was determined by the method outlined in AOAC (1970).

#### Oil Penetration Determination

Vernier Caliper was used for this analysis. The buns were cut into 2 with a sharp knife. The Vernier Calipers was used to measure the extent of oil penetration into the balls of the buns. This was converted to percentage using diameter of the buns ball.
**Volume Determination**

The buns ball volume was determined by the seed displacement method (Pomenranz and Shellenberger, 1981). Soybean Seeds were used in place of rapeseeds because of the non availability of the rape seeds.

**Sensory Evaluation Panel**

Samples for the panel evaluation were fried from samples of blended flour which had been packaged in polyethene sacks and stored in the deep freezer for four (4) weeks. 250g of flour with appropriate ingredients measured were used. The buns samples were labelled appropriately as A, B, C, and presented to the 15 member sensory evaluation panel drawn from students and staffs of Federal University of Technology, Owerri. The members were requested to observe and taste each sample and then score them on parameters such as: appearance texture, colour, flavour, taste, friability and general acceptance using a 9-point Hedonic scale that ranged from; extremely liked (9 points) to unacceptable (1 point).

The panel scores were tabled and the mean score for each sample and parameter were calculated. From the result, consumer preferences for the buns as well as acceptability of the product (buns) were determined.

**RESULTS AND DISCUSSIONS**

**Moisture content**

The moisture content (as shown in Table II) of the buns with cassava flour as binders was 11.6% while the buns with rice flour as binder had moisture content of about 10.5%. This shows that the cassava flour have more ability to retain moisture in the final product than rice flour. This could be as a result of granular size difference between cassava starch and rice starch.

**Ash content**

The ash content of the buns with cassava flour as binder was 1.25% and that of buns with rice flour as binder was 1.15% (Table II). The ash content is lower than 1.55% which was obtained by Ifi (1989) with malted sorghum biscuit using cassava flour as binder. The ash content of buns with cassava flour as binder was higher by 0.1 than that of buns with rice flour as binder. The difference is low and might be due to the compositional difference between cassava and rice flour.

**Crude protein**

The protein content of the buns with cassava flour as binder was 4.64% and that of buns with rice flour as binder was 4.64%, and while that of buns with rice flour as binder was 4.77% (Table II).

The protein content of sorghum was reported by Kent (1975), Ihekoronye and Ngoddy (1985) to be between 10 – 15%. This means that the protein content obtained for the buns is very low. This could be attributed to loss during processing. Processes that could lead to loss in protein include milling and frying. During milling, protein loss occurs as a result of sifting out some portions of the grain. During frying the high temperature encountered will lead to destruction of protein and hence result in the low protein content of the final product.

**Fibre content**

The fibre content obtained from this work, as shown in table 1 was 0.35% for buns with cassava flour as binder and 0.4% for buns with rice flour as binder. The lower values obtained in the product is due to the fact that the major fractions of the fibre content are eliminated during processing of the flours.

**Volume**

The values for the volume of the products are as shown in Table II. The volumes of the products were the same (about 208.86 cm). This is expected as the weight of the raw materials were the same (about 45g). The volume is a measure of how much the food material can expand during frying. Since no raising agent was used, very high volumes are not expected. Actually if the volume is very low, the product will be dense with little air spaces. This is expected for good eating quality buns.

**Oil penetration**

The result obtained on the dependence of oil penetration;

(i) Amount of hinder used in percentage binder,
(ii) Frying temperature i.e. temperature of oil or frying medium, and
(iii) Frying time

shows that oil penetration decreases as the percentage binder increases, and at the same temperature, time and amount of binder; the percentage oil penetration is higher in the buns with rice flour as binder than in the buns with cassava flour as binder. This may be as a result of the fact that rice flour has lower binding capability than cassava flour which reveals the binding strength of the starches for each flour sample.
Table II: Moisture Content, Ash, Crude Protein Fibre Content and Volume of the Buns.

<table>
<thead>
<tr>
<th>Buns</th>
<th>Moisture Content(%)</th>
<th>Ash(%)</th>
<th>Protein(%)</th>
<th>Fibre(%)</th>
<th>Volume(cm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cassava Flour Binder</td>
<td>11.6</td>
<td>1.25</td>
<td>4.64</td>
<td>0.35</td>
<td>208.86</td>
</tr>
<tr>
<td>Rice Flour Binder</td>
<td>10.5</td>
<td>1.15</td>
<td>4.77</td>
<td>0.40</td>
<td>208.86</td>
</tr>
</tbody>
</table>

Sensory evaluation

The mean scores of a 15 – member panelists on all the parameters considered for each tested sample product showed that the control was preferred in most of the parameters. But the difference is not significant when tested on ANOVA table. This means that product can compare to some extent if further modifications would be done on the texture. Sorghum flour is gritty and coarse. Hence the products had a coarse mouth feel.

Consumers have been used to the taste of buns from wheat flour. That explains the higher rating in taste and flavour of the control compared to each product. There is no surprise about the higher rating of overall acceptance of the control than the products since consumers are used to buns from wheat flour.

The buns with cassava flour binder were also preferred to the one with rice flour as binder. This might be as a result of ability of cassava flour to dilute to some extent the coarse mouth feel of the sorghum product. Cassava flour has a flat taste; hence the taste of the malted sorghum is outstanding in the product. The higher score in friability of sorghum buns with rice flour as binder shows that rice starch has a lower binding power than cassava starch.

On the whole, the result showed a mean score of above 7 points and an overall acceptance of above 7 points on a hedonic scale for the sample, thus revealing that the products were very acceptable as shown in table (iii) and (iv) below.

TABLE III: Panelist Mean Scores for the Products Composition of Buns Samples

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SORGHUM: CASSAVA</th>
<th>SORGHUM: RICE</th>
<th>WHEAT (CONTROL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>COLOUR</td>
<td>80 : 20</td>
<td>75 : 25</td>
<td>100%</td>
</tr>
<tr>
<td>FLAVOUR</td>
<td>7.53</td>
<td>7.33</td>
<td>7.33</td>
</tr>
<tr>
<td>TEXTURE</td>
<td>7.07</td>
<td>6.93</td>
<td>7.07</td>
</tr>
<tr>
<td>FRIABILITY</td>
<td>7.13</td>
<td>7.27</td>
<td>7.07</td>
</tr>
<tr>
<td>TASTE</td>
<td>7.07</td>
<td>7.27</td>
<td>7.73</td>
</tr>
<tr>
<td>APPEARANCE</td>
<td>7.53</td>
<td>7.13</td>
<td>7.13</td>
</tr>
<tr>
<td>OVER-ALL ACCEPTANCE</td>
<td>7.20</td>
<td>7.27</td>
<td>7.67</td>
</tr>
<tr>
<td>TOTAL MEAN SCORE</td>
<td>50.53</td>
<td>50.33</td>
<td>51.60</td>
</tr>
<tr>
<td>AVERAGE MEAN SCORE</td>
<td>7.22</td>
<td>7.19</td>
<td>7.37</td>
</tr>
</tbody>
</table>
Table IV: Panelist Score on Over-All Acceptances

<table>
<thead>
<tr>
<th>Panelists</th>
<th>Sample</th>
<th>Score</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>7</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>1</td>
<td>7</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>B</td>
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<td>7</td>
</tr>
<tr>
<td>2</td>
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<td>7</td>
<td>8</td>
</tr>
<tr>
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<td>12</td>
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<td>14</td>
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</tr>
<tr>
<td>15</td>
<td>7</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>108</td>
<td>109</td>
<td>115</td>
</tr>
<tr>
<td>Mean</td>
<td>7.2</td>
<td>7.27</td>
<td>7.67</td>
</tr>
</tbody>
</table>

CONCLUSION

This work has revealed that Buns (a deep fat fried product) could be produced from malted sorghum flour with cassava and rice flour as binders. The products were acceptable as revealed by the sensory evaluation result. The result showed a mean score of about 7 points for the samples and an overall acceptance of above 7 points on a hedonic scale, thus revealing that the product was very acceptable. The result can be improved using flours of finer particle size. The products have good flavour reflecting the flavour of the malted sorghum. The amount of sugar used to develop the taste and colour is reduced because of the natural sugar developed in the malted sorghum and the colour of the malted sorghum. This also reduces the cost of production which is highly desirable.

The work has also shown that cassava starch has better binding power than rice starch as revealed by the performance of their flours as binders. When rice flour is used, a higher percentage should be used for better results.

When the work is developed further, especially for commercial production a cheaper substitute to wheat for the production of deep fat fried products will be developed.

This will further increase the utilization of sorghum which is produced in large quantity in Nigeria.

REFERENCES


NOTE:The following authors below were cited in the content but not listed as references
