

PROXIMATE COMPOSITION AND FUNCTIONAL PROPERTIES OF COMPOSITE SORGHUM-OKARA FLOUR AND SENSORY EVALUATION OF LOCAL SNACK PRODUCT (SOSA).

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ABSTRACT

Partial substitution of cereals with legumes has the potential to improve the nutritional content, functionality and other properties of the composite flour. This study aimed at ascertaining the effect of partially substituting sorghum flour with okara flour and also to access the acceptability of a snack product, sosa, produced from the flour blends. The blends were produced from sorghum and okara flour using the following proportions respectively; 100:0; 90:10; 80:20; 70:30; and 60:40 with 100% sorghum serving as control. Results of the proximate composition of the flour blends showed an increase in protein (8.18%-22.73%), fat (1.7%-5.53%), crude fiber (2.9%-11.55%) and ash (1.72%-2.83%), while the carbohydrate content decreased from (73.21% to 46.55%), with the moisture content varying between (10.81% and 12.41%). Bulk densities decreased with increase in okara substitution from 1g/ml to 0.72g/ml. The water absorption capacity and oil absorption capacity increased with increase in okara substitution from 278.67ml/100g to 328ml/100g and 177.33ml/100g to 249.33ml/100g respectively. The flour blends produced can all serve as thickeners and the local snack (sosa) produced from the flour blends was favourably accepted by the panelists.

Keywords: Local snacks: supplementation: sorghum-okara: composite flour.

INTRODUCTION

Soya bean pulp (*okara*) is the solid left over from the processing of soymilk (Porcel *et al.*, 2017b). As a result of it being a by-product, there has been a neglect of its nutritional value and potential uses (Aguado, 2010). Nevertheless, with the prevailing high levels of malnutrition in sub-Saharan Africa, it has a high potential of becoming an important food source. *Okara* can be dried and processed to flour which can be incorporated in making several food products. Sorghum (*Sorghum bicolor L. Moench*), is the fifth most significant grain after wheat, maize, rice and barley (Taylor, 2003). It is gluten free and can be digested by celiac patients. This makes it an appropriate substitute for gluten cereals such as wheat, thus creating opportunities for products made using sorghum flour to thrive commercially (Winger *et al.*, 2014). However, there is a need to complement cereal grains with legumes in order to improve their nutritional availability (Balogun *et al.*, 2012). Over the years, snacking has been linked to poor food intake because of their lack of basic nutrients and the prevailing high levels of calories, salt, fat and sugar they mostly contain (Kolawole *et al.*, 2013). Conversely, in such a busy world as ours today desperately in need of convenience food items that requires little effort and times to prepare, researches on nutritious and healthy snack products are gaining more prominence and attention than ever before (Hess *et al.*, 2016). Due to *okara* being rich in dietary fiber and nutrients, it has been utilized by researchers in making various food products such as; bread (Wickramarathna and Arampath, 2003) and (Porcel *et al.*, 2017a), *okara*/rice cake (Xie *et al.*, 2008), biscuits and muffins (Aguado, 2010), cookies (Porcel *et al.*, 2017b) and so on. It has also been utilized as part of formulations for developing gluten free flour (Aguado, 2010 and Porcel *et al.*, 2017b) which is suitable for celiac disease patients. The aim of this study was to verify the effect of partial replacement of sorghum flour with *okara* flour on selected properties and to assess the acceptability of a snack (*sosa*) produced from the composite flour blends.

MATERIALS AND METHODS

Source of Materials

All ingredients were procured from Bodija market in Ibadan, Oyo state, Nigeria. All reagents used in the analysis were of analytical grade. The experiment was carried out in the Food Processing and Food Chemistry Laboratory, Department of Food Science, University of Ibadan, Ibadan, Oyo State, Nigeria.

Production of Sorghum-okara Flour Samples

Cleaned Sorghum grains were dry milled using a milling machine, sieved with a sieve of 200 μ m mesh size then stored for use in seal lock cellophane bags at room temperature (28 \pm 2°C). Soya bean seeds soaked overnight were ground in a blender then sieved using a muslin bag. The resultant cake was dried in an air oven at 50°C for 8 hours, ground and sieved using a sieve of mesh size 200 μ m and stored for use in seal lock cellophane bags at room temperature (28 \pm 2°C). Composite flours of the sorghum flour and *okara* flour were then formulated using varying proportions of *Okara* flour at ratios; 100:0, 90:10, 80:20, 70:30 and 60:40 respectively. The 100% sorghum sample served as the control.

Production of Sosa.

The formulation was made up of sorghum-okara composite flour (39.1%), banana (37%), margarine (9.2%), egg (8.2%), sugar (6.1%), baking powder (0.26%), nutmeg (0.08%) and salt (0.06%). Firstly, the oven was preheated to 180°C while the butter and sugar were mixed together until light and fluffy. The eggs were beaten separately until foam was formed, then added to the mixture of the butter and sugar. The mixture was stirred continuously until a light and fluffy consistency was attained. The bananas were then mashed and mixed with the baking powder using a mixer which was allowed to sit for 2 minutes, then mixed into the butter mixture. In another separate bowl, the dry ingredients (flour, salt and nutmeg) were mixed together. This was added to the banana-butter mixture to form the dough. The dough was dropped in dollops onto a greased tray and baked for 12 minutes until a golden brown colour was developed. The snacks were cooled and packaged in an air tight container. The flow chart illustrating the process is shown in figure 1 below.

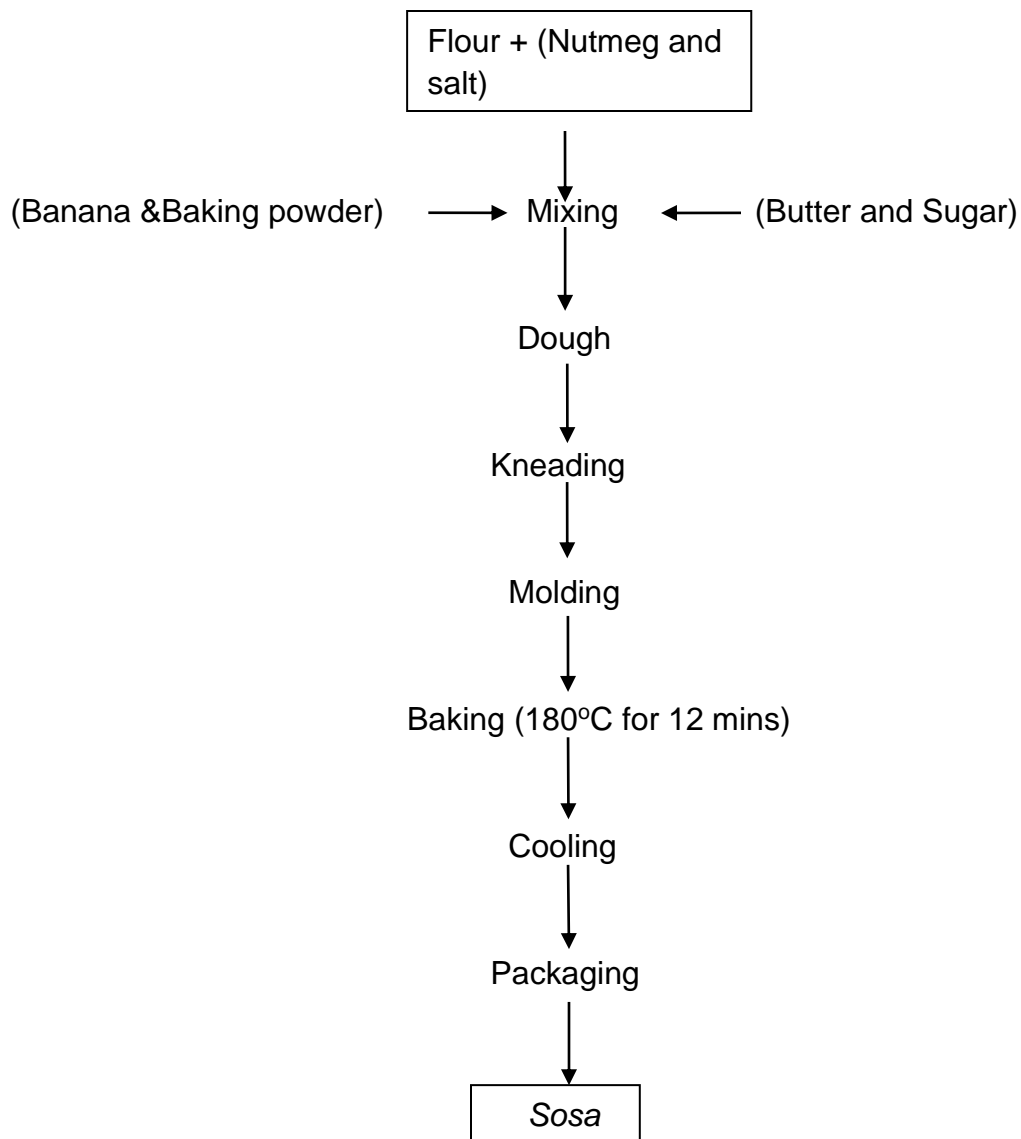


Figure 1: Production of Sosa.
(Adapted from simplyrecipes.com)

Analysis of the Proximate Composition of the Flour Blends

The Association of Official Analytical Chemist (A.O.A.C, 2005) standard procedure was used to determine the proximate composition of the Sorghum-Okara flour blends. The moisture content was determined by oven drying (AOAC – 925.10), fat by soxhlet extraction (AOAC – 2003.05), ash by combustion (AOAC – 923.03) and protein (AOAC – 960.52) content (Nx6.25) by micro Kjeldahl method.

Functional Properties of Sorghum-Okara Flour Samples

Determination of Bulk Density

The bulk density of each of the flour samples was determined according to the method of Onwuka (2005). A sample (1 g) was measured into a cylinder and tapped continually until there was no noticeable change in volume. The volumes before and after tapping the cylinder were taken note of and the difference in the bulk density was recorded in g/ml as;

$$\text{Bulk Density} = \frac{\text{Weight of sample (g)}}{\text{Volume of sample before tapping (ml)} - \text{Volume after tapping (ml)}}$$

Determination of Water and Oil Absorption Capacities.

Water absorption capacity was determined using the method described by Falade and Okafor (2015). Sample of (1 g) was weighed into a calibrated 25 ml conical centrifuge tube. The weight of centrifuge tube and content was taken and recorded. 10 ml of distilled water and 10 ml of groundnut oil were added into centrifuge tubes for both water absorption and oil absorption capacities respectively. The mixtures were made to stand at room temperature ($28 \pm 2^\circ\text{C}$) for 30 minutes. Centrifugation at 400rpm for 20 minutes on an Eppendorf Centrifuge (Model No. 5810R, Gaithersburg, USA) followed subsequently. The liquid was separated from the sediment after centrifugation and then the sample was reweighed. The water absorption capacity and oil absorption capacity were recorded in g/g as;

$$\text{WAC/OAC} = \frac{\text{Weight of tube after centrifugation (g)} - \text{initial weight of tube (g)}}{\text{Weight of sample (g)}}$$

Sensory Evaluation

Sensory evaluation of the snacks produced was conducted using 25 panelists selected at random from the Department of Food Technology, University of Ibadan. The samples were represented with codes and accessed using the nine-point hedonic scale for taste, colour, mouth feel, aroma and overall acceptability.

Statistical Analysis of Data

Data obtained from all analyses were subjected to Statistical Analysis of Variance (ANOVA) using SPSS version 20. Means were separated using Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Values of the proximate composition are shown in Table 1. The protein content of the samples was significantly higher than that of the control (100:0). An increase in protein content was observed with an increase in the level of *okara* substitution. The control sample recorded a value of 8.18% while the highest replacement level of 40% (60:40) had a value of 22.73%. This increase is expected since *Okara* has a high protein content as a result of it being processed from soybeans which is a known rich source of protein and the essential amino acid, lysine. (Babayehu *et al.*, 2017) This increase in protein content will serve to complement the amino acid profile of sorghum which is limiting in lysine (Vaclavik and Christian, 2008). There was a significant increase in the fat and fiber contents with increase in *okara* substitution. The increase in the fat content can also be linked to the source of *okara*; soybeans which is very rich in oil, containing about 20% (Osho and Taylor, 2005). The increase in fiber content proves that *okara* is rich in fiber, a major reason why it has been utilized by various researchers in making food products (Aguado, 2010 and Porcel *et al.*, 2017a). The results of the functional properties are presented in Table 2. The bulk density decreased significantly with increase in *okara* content from 1.00g/ml (100:0) to 0.72g/ml (60:40). Bulk density is a measure of heaviness of solid samples, which is important for determining packaging requirements, material handling and application in the food industry (Falade and Okafor, 2015). According to Akubor and Badifu (2004), flours with high bulk densities (>0.7g/ml) can be used as thickeners in food products. Hence, the flours in this study could be suitable as thickeners. Water absorption capacity refers to the amount of water retained by a food product after filtration and application of mild pressure of centrifugation (Falade and Okafor, 2015). This is an important factor in processing of soups, doughs, custards, sausages, where it is important to imbibe water without dissolution of protein, thus attaining perfect thickening and optimum viscosity (Otegbayo *et al.*, 2013). The values for water absorption increased significantly with increase in *okara* substitution from 278.67ml/100g (100:0) to 328ml/100g (60:40), though a deviation in trend occurred at 70:30 (283.67ml/100g). The noted increase in water absorption with increase in *okara* could be attributed to the fact that it

increases with increase in protein content (Agaudo, 2010 and Otegbayo et al., 2013). Oil absorption capacity refers to protein's ability to bind fat. It is an important factor since fats acts as flavor retainers and increases the mouth feel of foods (Otegbayo *et al.*, 2013). Generally, oil absorption capacity increases with increase in fat content due to increased lipid interactions. This was also observed in the results of the flours with the values increasing significantly with increase in okara substitution from 177.33 ml/100g (100:0) to 249.33 ml/100g (60:40). The results of the quality attributes are presented in Table 3. The results showed that the product made from 70:30 sorghum to *okara* blend was the least preferred for all parameters accessed (except aroma) and was significantly different from all others. In terms of taste, there was notable difference in the values for 100:0, 90:10 and 60:40. Generally, all the product samples were accepted by the panelists for all parameters accessed.

Table 1: Proximate analysis of the flour blends

Sorghum Okara (%)	Protein(%)	Fat (%)	Fiber (%)	Ash (%)	Moisture (%)	Carbohydrate (%)
100:0	8.18±1.06 ^e	1.7 ± 0.2 ^d	2.9±0.15 ^e	1.72±0.21 ^c	12.29±0.13 ^a	73.21±1.75 ^a
90:10	11.58±0.15 ^d	3.6 ±0.13 ^c	3.72±0.14 ^d	2.1±0.25 ^b	12.41±0.82 ^a	66.59±0.75 ^b
80:20	15.1±1.48 ^c	4.09±0.36 ^b	5.5±0.41 ^c	2.21±0.14 ^b	12.13±0.33 ^a	60.97 ± 2.7 ^c
70:30	17.6±0.69 ^b	5.15±0.16 ^a	8.1±0.32 ^b	2.34±0.21 ^b	12.12±0.22 ^a	54.69 ±1.6 ^d
60:40	22.73±1.2 ^a	5.53±0.33 ^a	11.55±0.34 ^a	2.83±0.27 ^a	10.81±0.23 ^b	46.55±2.33 ^e

Means with the same superscripts within the same column are not significantly different (P>0.05). Values are mean of triplicate determinations. a>b>c>.d>e.

Table 2: Functional properties of the flour blends

Sorghum: Okara (%)	Bulk density (g/ml)	Water Absorption Capacity (ml/100g)	Oil Absorption Capacity (ml/100g)
100:0	1.00±0.03 ^a	278.67±0.57 ^e	177.33±1.15 ^d
90:10	0.84±0.02 ^b	293.33±2.30 ^c	207.33±1.52 ^c
80:20	0.77±0.02 ^c	309.33±2.08 ^b	207.67±1.15 ^c
70:30	0.75±0.17 ^{cd}	283.67±2.08 ^d	238.00±2.00 ^b
60:40	0.72±0.02 ^d	328.00±4.00 ^a	249.33±4.51 ^a

Means with the same superscripts within the same column are not significantly different ($P>0.05$). Values are means of triplicate determinations. ^{a>b>c>d>e}.

Table 3: Sensory evaluation of the snack product

Samples Sorghum: Okara	Taste	Colour	Mouthfeel	Aroma	Overall Acceptability
100:0	7.64±1.22 ^a	6.80±1.11 ^a	7.20±1.58 ^a	6.80±1.29 ^a	7.40±1.11 ^a
90:10	7.20±1.50 ^a	6.56±1.53 ^{ab}	6.68±1.74 ^{ab}	6.96±1.30 ^a	7.20±1.08 ^a
80:20	7.00±1.32 ^{ab}	6.60±1.08 ^{ab}	6.92±1.41 ^a	6.64±1.28 ^a	6.68±0.90 ^{ab}
70:30	6.24±2.18 ^b	6.00±1.04 ^b	5.88±1.76 ^b	6.60±1.58 ^a	6.08±1.38 ^b
60:40	7.28±1.40 ^a	6.60±1.19 ^{ab}	6.68±1.40 ^{ab}	6.84±1.31 ^a	6.96±1.59 ^a

Means with the same superscripts within the same column are not significantly different ($P>0.05$). ^{a>b}.

CONCLUSION AND RECOMMENDATIONS

Composite flour can be derived from sorghum and *okara* which is suitable for individuals sensitive to gluten. In addition, the flours produced from this study can be used as thickeners due to the high bulk density values recorded. The snack product produced during the study was accepted by the panelists. However, it is recommended that further research work should be carried to determine the proximate analysis of the snack product and other properties of

the composite flour such as pasting properties, mineral composition, bio-availability and microbial analysis. Also, various ways of utilizing the flour product should be sought out and implemented.

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