PROXIMATE COMPOSITION AND ENERGY VALUE OF CRACKER BISCUIT FROM OKARA FORTIFIED PLANTAIN-SORGHUM FLOUR BLEND

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ABSTRACT

Biscuits were produced from composite flour of Plantain–sorghum fortified with Okara blends(100Plantain[P]:0Sorghium[S]; 75P:25S; 50P:50S; 25P:75S; 100S:0P;95P:0S:5Okara[O]; 72.5P:22.5S:5O ;47.5P:47.5S :5O; 22.5P:72.5S: 5O; 22.5P:75.5S:5O; 0P:95S:5O). The composite flour and the biscuit produced were analysed for proximate composition using standard methods. For the composite flour the moisture content ranged from 5.50 % to 7.70 %, ash 1.5 % to 2.40 %, fat 1.90 % to 2.89 %, protein 2.70 % to 6.00 %. Carbohydrate, 79.28 % to 83.80 % energy 366.2 to 20 kcal/100g-368.89 kcal/100g and the biscuits' proximate composition: moisture content 6.1 % to 8.2 %, fibre 2.7 % to 4.0 %, ash 2.8 % to 3.00 %, protein 2.9 % to 6.5 %, fat 3.20 % to 4.40 %, carbohydrate 75.1 % to 80.9 %, energy363.3 kcal/100g to 370.5 kcal/100g Sensory evaluation of the biscuits produced were evaluated, panelists were asked to evaluate each category of sample for colour, taste, flavour, texture, aroma, after taste, and overall acceptability on a 9-point Hedonic scale, blend of 72.5P:22.5S:5O, was the most acceptable sample among all the samples used for the production of biscuit.

1.0 INTRODUCTION

Crackers are usually defined as biscuits, which are all more or less unsweetened, salty, thin and crisp and refers to products with very low sugar and fat content. In Nigeria, biscuits constitute a popular cereal food consumed by the young and the old. Some of the reasons for such wide popularity are low cost compared to other processed foods, good nutritional quality and availability in different forms, varied taste and longer self-life. (Hussein et al., 2011). They are ready to eat convenient and inexpensive food products, containing digestive and dietary principles of vital importance (Kulkarini, 1997).

Soymilk residue (*okara)* is a by-product in the manufacture of soymilk and tofu, and can be grouped as non-traditional soy protein food. This by-product had little or no market value and was used mainly as animal feed despite its rich nutrient content.(Kulkarini, 1997). Its disposal constituted a very big problem to soymilk cottage industries because of its bulkiness and susceptibility to yeast. However, okara contains about 27 % protein (dry basis), 10 % oil, 42 % insoluble fiber and 12% soluble fiber [O'Toole, 1999]. The okara protein has good nutritional quality and a superior protein efficiency ratio. Extensive researches have been done by Puechkamut and colleagues on utilization of okara, for example, substituting if for wheat flour to produce cookies or bread, and extracting valuable protein from okara [Puechkamut and Thiewtua, 2006; Puechkamut, 2007; Puechkamut and Phewnim, 2011; Puechkamut and Panyathitipong 2012].

Plantain is a major staple food crop in the humid and sub-humid parts of Africa and a major source of energy for millions of people in these regions. It belongs to the family *Musaceae* and the genus *Musa. Musa paradisiaca*, also known as plantain (English), '*Ogede agbagba'* (Yoruba), *'Ayaba'* (Hausa) and '*Ogadejioke'* (Igbo), is a tropical plant that is native to India. In Nigeria, plantain production was estimated at about 2.11 million metric tons in 2004 of the most important crops of the tropical plants. The fruits grow in clusters, each separate plantain of the cluster being about 1 inch in diameter and somewhat longer than a banana fruit. Most plantain foods are eaten as boiled, fried or roasted. It was reported that when unripe plantain is processed into flour, it is used traditionally for the preparation of gruel, which is made by mixing the flour with appropriate quantity of boiling water to form a thick paste (Amala). Nutritionally, plantain fruit is endowed with carbohydrates, minerals, amino acids, fiber, and carotenoids. This composition makes it a good material for the formulation.

Sorghum is a major cereal in the semi-arid regions of the world where it is an important food and feed crop. Sorghum species (*Sorghum vulgare* and *Sorghum bicolor*) are members of the grass family. Sorghum is known by a variety of names: great millet and guinea corn in West Africa. In the semi-arid tropics of Africa and India the grain forms the staple diet for large populations, where nearly all the produce is used directly as human food (Sanni, et.al., 2004). The potential food and industrial applications of sorghum have been studied and reported by several authors (Doggett, 1998; Delcour, et.al., 2000). The flour was found to have higher levels of lipids, ash, crude fiber, and protein. Adeyemi and Idowu, (1990) and Dhingra and Jood, (2004), studied the effects of different flour substitutions on gruel making physical qualities which include colour, texture, taste and overall acceptance of composite flours produced from cereals and leguminous seed. It can also be malted and processed into malted foods, beverages, and beer.

Composite flour refers to the mixture of different concentrations of non-wheat flours from cereals, legumes, roots and tubers with wheat flour or can be a mixture of flours other than wheat flour Composite flours are recently manufactured not only to improve the desired functional properties of end product based on them but also to improve nutritional composition. (Adeyemi and Ogazi, 1985; Shittu ,et. al., 2007) Composite flours have been used extensively and successfully in the production of baked goods.

Over the years unripe plantain and wheat flour were recommended for regulating blood glucose due to their high fiber content and low glycaemic index. But the cost of importation associated with wheat, the need for production of functional composite flour using other readily available and inexpensive materials such as cereal and legumes (sorghum and soybean residue (*okara*) with good nutritional value of proteins, carbohydrates, fibers, fat and ash contents is necessary. Therefore the objective of this study is to determine the proximate composition and energy valve of cracker biscuit produced from okara fortified plantain-sorghum composite flour.

2.0 MATERIALS AND METHOD

Sample Procurement

The fresh plantains, Sorghum grains, and Soya-bean used for this study were bought from Sayedero market, Ilaro in Ogun State, Nigeria.

Preparation of Plantain Flour

The green plantain fingers (20kg) were thoroughly washed with water and sun dried for 30 minutes. The fruits were then hand peeled, sliced and stored in water to avoid browning before drying. The sliced pulp was subjected to drying for 6 hours at a temperature of 80 ^oC using hot air oven immediately. The resultant dried pulp slices were milled with hammer mill (Bentall Superb, Model 200L 09) and sieved through A 75 µm mesh sieve and stored in airtight plastic containers at room temperature (28±2 °C) for further use.

Preparation of Sorghum Flour

Sorghum grains (5 kg) were screened of foreign bodies, washed with clean water and subjected to drying in an open air for 4 hours. The cleaned dried grains were milled with hammer mill (Bentall Superb Model 200L 09) and sieved through a 75 µm mesh sieve and kept in airtight plastic containers at room temperature (28±2 °C) for further use.

Preparation of Soybean Residue (Okara) Flour

Using Fukushima (1991) method the soybean was cleaned and washed by floatation to remove all the foreign materials, spoilt grains and debris. The cleaned beans were blanched in hot water for 25 minutes at 100 ^oC and dehulled. The dehulled cotyledons were washed with hot (100 ^oC) water twice and wet milled using 5.0 litres of water to 1 kg of beans. The slurry obtained was mixed and filtered through a muslin cloth to remove the milk and recover the residue called *okara.* The fresh *okara* was dried using hot-air oven at a temperature of 70 ^oC, milled and sieved through a 75 µm mesh sieve and stored in airtight plastic containers in the refrigerator at 4 ^oC for further use.

Composite Flour Formulation

Table 1. Percentage Composition of plantain, sorghum and okara flour

SAMPLE	PLANTAIN (%)	SORGHURM (%)	OKARA (%)
A	100	-	-
B	75	25	-
C	50	50	-
D	25	75	-
E	-	100	-
F	95	-	5
G	72.5	22.5	5
H	47.5	47.5	5
I	22.5	72.5	5
J	-	95	5

Production of Cracker Biscuit from the Composite Flour

The cracker biscuit was prepared by measuring 50ml of water in a bowl, into which 3.48 g of yeast was added to form a suspension, 0.16 g of baking powder was added follow by 2.02 g of salt and 100 g of the flour was added with shortening and kneaded to form dough. The dough was later cut into desired shape and baked at 170 ^{o}C for 15 minutes.

Table 2. Ingredient Composition for Biscuit Production

Ingredient	Quantity
Composite flour	100g
Salt	2.02g
Fat	9.64g
Yeast	3.48g
Baking Powder	0.16g
Water	50ml

Chemical Analysis

The proximate composition of the composite flours analyzed using the procedure of Association of Official Analytical Chemist (AOAC, 1990), and the energy value calculated using Atwater factors (Ihekoronye and Ngoddy, 1985)

Sensory Evaluation

Sensory evaluation of the biscuit samples prepared from the plantain-sorghum fortified blends was performed using the 9 points Hedonic scale quality analysis (Iwe, 2002). Twenty (20) untrained panelists drawn from students and staff of the Federal Polytechnic, Ilaro, Ogun State, Nigeria, evaluated the biscuit samples for colour, aroma, taste, aftertaste and overall acceptability using the 9-point hedonic scale, where 1 corresponds to like extremely and 9 corresponds to dislike extremely.

Statistical Analysis

All analyses carried out in triplicate, with statistical significance established using one-way analysis of variance (ANOVA), and data reported as the mean ± standard deviation. Mean comparison and separation done using Duncan Multiple range (DMR) test at $p \leq 0.05$, described by the SPSS 16.0 statistical package.

3.0 RESULTS AND DISCUSSION

The moisture content of the composite flour as shown in Table 3 ranged from 5.50%-7.70% with sample E having the highest 7.70% while sample A and F having the lowest 5.50%. The moisture content of the composite flour is significantly different ($p < 0.05$) from each other. Generally, there was an increase in moisture content as the percentage of sorghum flour substitution increases. The lower the moisture content of the product to be stored the better the shelf stability of such product. Low moisture content ensures higher shelf stability. The fortification of the composite flour with okara has positive impact on the moisture content of the composite flour. The moisture content of biscuit produced from the composite flour ranged from 6.1 % to 8.1 % (Table 4) in which sample A has the lowest value and sample I has the highest value. The fortification of the composite flour to produce biscuit with okara has positive impact on the fibre content. It was observed in this study that the moisture content of biscuit produced from composite is higher than the moisture content of wheat biscuit produced by Ajibola, et. Al. (2015), recorded to be 3.65%, and this could be as a result of high moisture content in sorghum which was fortified with Okara.

The ash content of composite flour ranged from 1.5 % to 2.40 % in which the highest was recorded in sample F and the lowest is sample E. The ash content of the composite flour F is greater than that of the wheat flour recorded to be 2.0% (Nneka et.al., 2016). Ash content indicate a rough estimation of minerals content of product, sample F has the highest ash content of 2.40 % which show that sample F has the highest mineral content. The ash content of the composite flour is significantly different ($p < 0.05$) from each other. The ash content of biscuit produced by the composite flour ranged from 2.8 % to 3.0 % in which sample D, E, H, J has the lowest value, 2.8 % and samples A and F has the highest value 3.0 %. The fortification of the composite flour to produce biscuits with Okara has no impact on the ash content. The ash content of biscuit produced from composite flour in this study is higher, compared to wheat biscuit produced by Ajibola et, al., (2015) to be 2.31 %.

Table 3: The Proximate composition (%) and Energy (Kcal/100g) values of the Okara Fortified Plantain-Sorghum Composite Flour

Sample	Moisture	Ash	Fat	Protein	Fibre	Carbohydrates	Energy
A	5.50^{a}±.02	2.30^{e}±.06	1.90^{a}±.08	2.70^{a}±.06	3.80^{g}±.16	83.80^{i}±.02	363.00^{ab}±.09
B	6.00^{c}±.09	2.00^{d}±.08	2.10^{b}±.05	2.87^{a}±.28	3.30^{de}±.15	83.40^{h}±.05	365.30^{ab}±.07
C	6.40^{d}±.06	1.80^{c}±.05	2.20^{bc}±.06	3.90^{c}±.05	3.00^{c}±.11	82.70^{g}±.06	363.50^{ab}±.04
D	6.80^{e}±.08	1.60^{ab}±.02	2.20^{bc}±.14	4.40^{de}±.08	2.80^{b}±.02	82.20^{f}±.09	366.20^{a}±.20
E	7.70^{g}±.03	1.50^{a}±.15	2.30^{cd}±.12	5.60^{f}±.09	2.50^{a}±.07	80.40^{c}±.05	364.70^{ab}±.09
F	5.50^{a}±.05	2.40^{e}±.07	2.45^{de}±.09	3.20^{b}±.10	3.90^{g}±.03	82.62^{g}±.03	365.05^{ab}±.04
G	5.80^{b}±.10	2.00^{d}±.11	2.62^{ef}±.07	4.20^{cd}±.11	3.60^{f}±.04	81.61^{e}±.04	366.18^{ab}±.04
H	6.40^{d}±.12	1.80^{c}±.04	2.71^{fg}±.02	4.60^{e}±.13	3.40^{e}±.09	81.06^{d}±.012	367.15^{ab}±.07
I	6.80^{e}±.04	1.70^{bc}±.13	2.81^{gh}±.06	5.70^{fg}±.15	3.20^{d}±.05	80.20^{b}±.11	368.89^{b}±.06
J	7.40^{f}±.07	1.60^{ab}±.03	2.89^{h}±.08	6.00^{g}±.05	2.80^{b}±.08	79.28^{a}±.15	367.13^{ab}±.05

Table 4 The Proximate composition (%) and Energy (Kcal/100g) values of Biscuit prepared from Okara Fortified Plantain-Sorghum Composite Flour

Sample	Moisture	Ash	Fat	Protein	Fibre	Carbohydrates	Energy
A	6.10^{a}±.03	3.00^{e}±.06	3.20^{a}±.15	2.90^{a}±.07	3.90^{ef}±.06	80.79^{c}±.04	364.00^{b}±.02
B	6.40^{bc}±.04	2.90^{bc}±.06	3.40^{bc}±.11	3.40^{bc}±.11	3.50^{d}±.11	80.40^{c}±.09	365.80^{f}±.06
C	7.00^{d}±.09	2.90^{bc}±.07	3.60^{de}±.03	3.80^{c}±.03	3.30^{c}±.06	79.40^{c}±.04	365.23^{e}±.03

D	$7.50^{e}\pm.02$	$2.80^{ab}\pm.03$	$3.70^{ef}\pm.07$	$4.50^{d}\pm.09$	$3.00^{b}\pm.06$	$78.60^{bc}\pm.11$	$370.47^{i}\pm.12$
E	$8.20^{f}\pm.05$	$2.80^{ab}\pm.06$	$3.90^{g}\pm.08$	$5.70^{f}\pm.15$	$2.70^{a}\pm.02$	$76.60^{ab}\pm1.4$	$364.70^{ab}\pm.09$
F	$6.30^{b}\pm.10$	$3.00^{e}\pm.014$	$3.50^{cd}\pm.11$	$3.27^{b}\pm.03$	$4.00^{f}\pm.09$	$79.90^{c}\pm.07$	$364.40^{c}\pm.13$
G	$6.50^{c}\pm.14$	$2.90^{bc}\pm.03$	$3.80\pm.13$	$4.30^{d}\pm.04$	$3.80^{e}\pm.02$	$78.70^{bc}\pm.05$	$366.20^{h}\pm.06$
H	$7.07^{d}\pm.07$	$2.80^{ab}\pm.03$	$3.30^{ab}\pm.06$	$4.80^{e}\pm.04$	$3.40^{cd}\pm.05$	$78.60^{bc}\pm.15$	$363.27^{a}\pm.07$
I	$7.40^{e}\pm.15$	$2.70^{a}\pm.02$	$4.20^{h}\pm.14$	$5.60^{f}\pm.03$	$3.10^{b}\pm.13$	$74.67^{a}\pm.04$	$368.20^{i}\pm.12$
J	$8.20^{f}\pm.08$	$2.80^{ab}\pm.07$	$4.40^{i}\pm.04$	$6.50^{g}\pm.06$	$3.00^{b}\pm.05$	$75.10^{a}\pm.03$	$366.00^{g}\pm.04$

The fat content of the composite flour ranged from 1.90 % to 2.89 % in which sample A has the lowest 1.90 % and sample J has the highest 2.89 %. The fat content of the composite flour is significantly different ($p < 0.05$) from each other. Fasasi (2009) reported that low fat content in product would help increase the shell life of the sample by decreasing the chance of rancidity and also contribute to low energy value of product while high fat content produce would have high energy value and promote lipid oxidation. This study shows that sample A has the lowest fat content and will also have high shelf stability and low chance of rancidity. The fortification of the composite flour with okara has positive impact on them. The fat content of biscuit produced from the composite flour ranged from 3.20 % to 4.40 % in which sample A has the lowest and sample J has the highest. The fat content of biscuit from composite flour is significantly different ($p < 0.05$) from each other, and lower than that of biscuit produce from wheat by Ajibola et al. (2015) which was recorded to be 14.39 %. Hence the biscuits produced from the composite flour will have lower rate of rancidity to that of biscuit produced from wheat The fortification of the composite flour to produce biscuit with okara has positive impact on the fat content of the biscuit produced.

The protein content of the composite flour varied significantly ($p < 0.05$) from each other. The protein content of the composite flour ranged from 2.70 % to 6.00 % with sample J having the highest 6.00 % while sample A had the lowest 2.70 %. The fortification of the composite flour with Okara has positive impact on the flour. It was observed that there was increase in protein content as the level of sorghum percentage was increased which may be attributed to the high level of sorghum in this study which is also similar to that of Okoye et al. (2016) that reported 6.84 % . The protein content of the composite flour is lower than that of wheat which was recorded by Nneka, et al (2016) to be 10.12 % .The protein content of the biscuit produced from the composite flour ranged from 2.9 % to 6.5 % in which sample A has the lowest and sample J has the highest. The protein content of the composite is significantly different ($p < 0.05$) from each other. It was observed in this study that there was increase in protein content of biscuit than the protein content of composite flour which could be as a result of the ingredient use in the process. The protein content of biscuit produce in this study was observed to be lower than that of biscuit produce from wheat of Ajibola et al (2015) recorded to be 10.99.

The fibre content of the composite flour varied significantly ($p < 0.05$) from each other. The fibre content of the composite flour ranged from 2.50 % to 3.90 % in which the highest is sample F and the lowest is sample E. The highest value of sample F could be as a result of high fibre content in plantain and okara. A research work by Kiin-Kabari and Giami (2015) recorded that plantain is a good source of fibre which if mixed with Okara will surely improve the fibre content. The fibre content of sample F is greater than fibre content of Nneka, et al (2016) which is recorded to be 2.11 %.. The fibre content of biscuit produced from the composite flour ranged from 2.0 % to 4.0 % in which sample F has the highest value and sample E has the lowest value. The fibre content of the composite flour is significantly different ($p < 0.05$) from each other. It was observed in this study that the fibre content of biscuit produced by the composite flour is higher to the moisture content of wheat biscuit produced by Ajibola, et al (2015) to be 2.45 % biscuit produce from composite flour of sample F was recorded to have high crude fibre of 4.0 % which will have significant importance on the digestive system. The fortification of the composite flour to produce biscuit with Okara has positive impact on the fibre content

The carbohydrate content of the composite flour is significantly different ($p < 0.05$) from each other. The carbohydrate content of the composite flour ranged from 79.28 % to 83.80 % in which sample A has the highest value and sample J has the lowest value. The carbohydrate value of the composite flour in this study is higher than the value of wheat recorded by Nneka, et al (2016) to be 76.30 %. The carbohydrate content of biscuit produced from the composite flour ranged from 75.1 % to 80.9 % in which highest sample A with 80.9 % and lowest value 75.1 %. The fortification of the composite flour to produce biscuit with *Okara* has negative impact on the carbohydrate content. The carbohydrate content of the composite flour is significantly different ($p < 0.05$) from each other.

The energy value of the composite flour ranged from 366.2±.20 kcal/100g to 368.89±.20 kcal/100g in which sample A has the lowest value and sample I has the highest value. The energy value of the composite flour is significantly different ($p < 0.05$) from each other. The fortification of the composite flour with Okara has positive impact on the flour. The energy value of in this study is lower than that of Nneka, et al (2016) which was recorded to be 382.64 kcal/100g. The energy content of biscuit produced from the composite flour ranged from 363.3 kcal/100g to 370.5 kcal/100g in which sample D has the highest value, 370.5 kcal/100g and the lowest value sample H, 363.3 kcal/100g. The energy value of the biscuit produced from the composite flour is similar to that of Okoye et al. et al (2016)

Sensory Evaluation

Table 5: Mean score of sensory evaluation of biscuit from okara-fortified plantain-sorghum composite flour

	COLOUR	TEXTURE	AROMA	TASTE	AFTER TASTE	OVERALL ACCEPTABILITY
A	3.55 ± 0.31^{abc}	3.55 ± 0.28^{a}	1.40 ± 0.11	3.15 ± 0.46	3.45 ± 0.53	3.60 ± 0.21
B	4.00 ± 0.28^{bc}	3.55 ± 0.52^{a}	4.00 ± 0.49	3.80 ± 0.48	4.05 ± 0.39	4.50 ± 0.41
C	4.60 ± 0.23^{c}	6.35 ± 0.62^{cd}	4.95 ± 0.43	3.25 ± 0.24	3.60 ± 0.35	4.90 ± 0.34
D	4.05 ± 0.52^{bc}	6.95 ± 0.40^{d}	5.15 ± 0.52	4.05 ± 0.21	3.85 ± 0.35	5.10 ± 0.39
E	4.45 ± 0.27^{c}	5.45 ± 0.17^{bc}	2.90 ± 0.48	5.10 ± 0.34	4.90 ± 0.59	5.00 ± 0.34
F	3.20 ± 0.34^{ab}	5.10 ± 0.5^{bc}	3.50 ± 0.34	4.00 ± 0.42	3.90 ± 0.37	5.00 ± 0.36
G	3.95 ± 0.38^{bc}	4.90 ± 0.38^{b}	3.30 ± 0.33	4.05 ± 0.03	3.75 ± 0.50	5.20 ± 0.33
H	4.20 ± 0.32^{bc}	5.15 ± 0.48^{bc}	3.20 ± 0.32	3.20 ± 0.19	3.75 ± 0.46	4.70 ± 0.37
I	3.25 ± 0.32^{ab}	5.85 ± 0.43^{bcd}	3.60 ± 0.44	3.60 ± 0.40	4.15 ± 0.44	4.05 ± 0.29
J	2.75 ± 0.31^{a}	4.95 ± 0.51	3.55 ± 0.38	3.55 ± 0.44	3.50 ± 0.48	4.95 ± 0.31

The sensory scores of the biscuit produce from okara fortified plantain-sorghum composite flour revealed various significant difference in all the parameters Evaluated. All the samples were equally rated by panellist ,in terms of colour, sample C (50 % plantain +50 % sorghum without okara substitution) is the most acceptable with mean values of 4.60 and sample J (95 % sorghum + 5 % okara), and F(95 % plantain + 5 % okara) are partially acceptable with mean values of 2.75 and 3.20 respectively. however, samples substituted with quantity of sorghum flour were significantly different from sample A in terms of colour.The most acceptable sample in terms of texture is sample D (25 % plantain + 75 % sorghum) with mean value of 6.95 this could be due to the composition of sorghum flour in the substitution. Also sample D (25 % plantain + 75 % sorghum) is the most acceptable sample by the panelist in terms of aroma with mean value of 5.15. The taste of the biscuit is best with sample E (100 % Sorghum) according to the panellist and this has mean value of 5.10,also,sample (100 % Sorghum) has the most acceptable after taste with the mean value of 4.90. In terms of overall acceptability, sample G (72.5 % Plantain + 22.5 % sorghum + 5 % okara) was the mostly acceptable. Thus, composite flour produced of sample G could be used to produce organoleptically acceptable products and can be used for the production of cracker biscuit for everyone especially the diabetic patients.

4.0 CONCLUSION

The composite flour of plantain-sorghum fortified with *Okara* in this study was found to be highly nutritionally superior in terms of protein, crude fibre and fat compared to wheat flour. The fortification of the sorghum with 5 % Okara show notable increase in protein content. The fortification of plantain with 5 % okara in notable increase in fibre content compared to that of the control. The result obtained from this result shows that highly nutritious food/flour can be produced from plantain-sorghum composite fortified with Okara which also indicates that the composite flour could serve as the best alternative flour to substitute wheat flour. And also, production of products from this can be used to fight protein malnutrition in the developing countries.

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