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PRODUCTION AND SOME QUALITY ATTRIBUTES OF RICE-BAMBARA NUT FLOUR EXTRUDED FLAKES

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ABSTRACT

The proximate, functional and sensory properties of Rice-Bambara flakes were investigated. The flour was mixed at different proportions (100% Rice flour, 90:10, 80:20, 70:30, 60:40, 50:50 Rice-Bambara flour). The proximate composition, functional properties and sensory acceptability of the flakes were determined using standard laboratory procedures. The water absorption capacity ranged from 1.90 to 2.50. The swelling power and solubility index ranged from 3.51-4.37 and 13.35-20.50, respectively. The fat, protein, ash, crude fiber, moisture and carbohydrate contents ranged from 1.33-3.13%, 5.30-18.37%, 0.37-1.34%, 0.26-1.38%, 4.99-6.79%, and 69.35-85.18% respectively. Sensory panelists' scores for color, taste, aroma, texture and overall acceptability ranged from 4.46-7.23, 4.11-6.70, 5.00-7.09, 4.32-6.14, and 4.73-6.91 respectively. There were significant differences ($P<0.05$) between the sensory, functional and proximate properties of the flakes. The study showed that 90:10 Rice-Bambara flour extruded flakes had better functional properties and sensory acceptability.

Keywords: functional properties, extruded flakes, sensory acceptability, composite flour

INTRODUCTION

Rice is a staple food for a large part of the world's human population, especially in tropical Latin America, and East, South and Southeast Asia, making it the second-most consumed cereal grain. Also, it is a traditional food plant in Africa. The world's total rice utilization in 2006 was estimated to be 420 million tones, while in 2007 was recorded to be 435.7 million tones (FAO, 2008).

Rice flour has become an alternative ingredient in extrusion due to its unique attributes such as blend taste, attractive white color, hypoallergenic and ease of digestion (Kadam *et al*; 2008). The advantage of using rice or its products (such as snacks and breakfast cereals) lies in the fact that rice is non-allergic, gluten free and naturally low in sodium. It is an important source of vitamins and minerals and has about 7% high quality protein and only a trace of fat.

Bambara groundnut (*Vigna subterranea*) is an important but underutilized legume that is potentially very rich in proteins and minerals (Minka and Bruneteau, 2000). It is grown extensively in northern Nigeria, because it is well favored by the environmental conditions of the dry lands (Enwere and Hung, 1996; Mazahib, 2013). Bambara groundnut is

a particularly hardy crop, being extremely drought resistant, and can be grown under extreme climatic conditions; hence, it is a promising crop against global climatic changes. Bambara groundnut has been reported (Mune *et al.,* 2011) to contain carbohydrates (54.5–69.3%), proteins (17–24.6%), fat (5.3–7.8%), and calories (367–414 kcal per 100 g). It is a good source of calcium, iron and potassium. It is unusually high in methionine, an essential sulfur-containing amino acid. Bambara groundnut contains a lot of nutrients and has been identified as a potential protein source for human and livestock in Sudan-Sahelian parts of tropical Africa and some parts of Asia where animal protein is unaffordable (Linnemann, 1994; Bamshaiye et al. 2010).

Cooking-extrusion of starchy material has become a very widely used technique to obtain a wide range of products, such as snacks, breakfast, cereals, special flours (for instant soup mixes, porridge) (Gonzalez, *et al.,* 2000). The combination of Rice-Bambara nut flour in the production of snack food will not only enhance the nutritional quality of such snack especially improved protein quality and quantity but also serve as a veritable means of enhancing the commercial and/or industrial utilization of bambara nut. The objective of this study therefore was to develop a nutritious extruded snack from rice-bambara nut flour and determine the functional properties, proximate composition and sensory acceptability of the extruded flakes.

MATERIALS AND METHODS

Materials

The rice grain and bambara groundnut beans were purchased from Kuto market in Abeokuta, Ogun State, Nigeria.

Production of rice and bambara groundnut flour

The rice grain was milled into flour using laboratory hammer milling machine to pass through a 250 µm sieve. Bambara nut was soaked in clean water for about 24 h and dehulled manually by rubbing in between the palms. The dehulled nuts were dried in the oven at 60 °C for 5 h before being milled into flour using a laboratory hammer milling machine. The Rice and Bambara flour was mixed in different proportion as shown below:

	Rice Flour	**Bambara Flour**
Sample	1100%	0%
Sample	290%	10%
Sample 3	80%	20%
Sample 4	70%	30%
Sample 5	60%	40%
Sample **6**	50%	50%

Production of rice-bambara flakes

The extrusion process of the composite blends was conducted using a locally fabricated single-screw extruder. The extruder has a power of 0.25 hp, screw diameter of 18.5mm and screw length of 304mm. The extruder is composed of two sections: the transmission and the die zones. Rice and Bambara flour blends were mixed at different proportions (100% Rice, 90:10%; 80:20%, 70:30%, 60:40% and 50:50%) and the mixture were fed into the extruder. After extrusion, the products were dried to the desired moisture (9.5–10.5%) in a convection oven (65°C) for 2h, packed into polyethylene bags for storage and further analy-

sis (Anton and Luciano, 2007).

Analysis of the proximate composition and functional properties of the flakes

The moisture, fat, crude protein, ash and crude fibre contents of the flake samples were determined as described by AOAC (2000). Bulk density was determined by the method of Wang and Kinsella (1996), Water absorption capacity as described by Anderson *et al*. (1969), Swelling power, Swelling Capacity and solubility index according to the procedure described by *Leach et al. (1959),* Water Absorption Index by Ruales *et al*. (1993).

Sensory Evaluation

This was estimated using a fifty-member panelist. The panelists were asked to rate their degree of likeness of the prepared samples using 9-point hedonic scale with 1 indicating dislike extremely and 9 like extremely. The sensory properties assessed were color, texture, taste, aroma and overall acceptability.

Statistical Analysis

Data obtained were subjected to Analysis of Variance (ANOVA) using SPSS version 20. The differences between the mean values were evaluated at 5% confidence level using Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Proximate Composition of Rice-Bambara Groundnut Flour Flakes

The proximate composition of the extruded rice-bambara groundnut flakes is shown in Table 1. The fat content ranged from 1.33 to 3.13% with flakes from 50:50 flour combinations having the highest value, which showed that the presence of additional Bambara groundnut increased the fat content present in the flakes. The fat content of the flakes was significantly different ($p<0.05$). Fat is important in diets because it is a high-energy nutrient and does not add to the bulk of the diet. (Bogert *et al.,* 1994). The protein content ranged from 5.30 to 18.37% with flakes from 50:50 flour having the highest and 100% rice flour flakes having the lowest. There was significant difference ($P<0.05$) in the protein content of the flake samples. Moisture content ranged from 4.99 to 12.14% with 70:30 rice-bambara nut flour flakes having the highest value and 90:10 flakes having the least. Low moisture confers higher shelf life on product (Rolfe *et al.,* 2001). Extrudate moisture content is an important parameter that influences various properties such as water absorption, water solubility and pellet durability index (Rolfe *et al.,* 2001). Ash content ranged from 0.37 to 1.34% with 70:30 flakes having the highest value and 80:20 flake samples having the lowest. Crude fibre is an index of the amount of indigestible sugars present in a food sample. Fibre content of product ranged from 0.26 to 1.38%, with 50:50 rice-bambara nut composite flour flakes combination having the highest fibre content, while 80:20 had the lowest.

It has been reported that a diet low in fibre is undesirable as it could cause constipation and that such diets have been associated with diseases of colon like piles, appendicitis and cancer (Olanipekun *et al*., 2012). Carbohydrate content of the rice-bambara nut flakes ranged from 69.35 to 85.18% and 100% rice flour flakes recorded the highest carbohydrate content while 70:30 had the lowest. Cooking has been reported to cause granules to break down, soften the cellulose and make the starch more available (Agiang *et al.,* 2010). This finding agrees with the result obtained by Brough and Azam (1992); Christina, (2009) who reported that Bambara nut

seed makes a balance food as it contains sufficient carbohydrate, protein, fats with high proportions of lysine and methionine.

Table 1: Proximate Composition (%) of Rice-Bambara Nut extruded Flakes

RF-BF Flakes	Moisture	Ash	Fat	Fiber	Protein	Carbohydrate
100%RF:0%BF	6.79±2.70a	0.87±0.02b	1.33±0.01a	0.74±0.02c	5.30±0.49a	85.00±1.54c
90%RF:10%BF	4.99±0.96a	0.99±0.01c	2.64±0.01c	0.46±0.07b	5.75±0.49a	85.18±0.69c
80%RF:20%BF	6.49±1.16a	0.37±0.05a	2.84±0.19c d	0.26±0.01a	14.78±1.65b	75.28±2.96b
70%RF:30%BF	12.14±3.11b	1.34±0.01d	2.31±0.01b	0.50±0.00b	14.37±0.37b	69.35±2.75a
60%RF:40%BF	5.65±0.45a	0.99±0.01c	2.99±0.02d	1.04±0.02d	17.74±1.38c	71.62±1.79ab
50%RF:50%BF	6.46±1.17a	1.00±0.01c	3.13±0.25d	1.38±0.02e	18.37±0.81c	69.67±0.09a

± Standard deviation of 3 replicates
Means in the same column with different superscripts are significantly different at $p<0.05$
RF = Rice Flour
BF = Bambara groundnut Flour

Functional Properties Rice-Bambara Groundnut Flour Flakes

The functional properties of Rice-bambara groundnut flour flakes are presented in Table 2. The Water Absorption Capacity ranged from 1.90 to 2.50 with 90:10 flakes having the highest and 60:40 had the lowest. Water Absorption Capacity characterize how extruded products will interact with water and are often important in predicting how the extruded materials may behave if further processed (Scriburi *et al.,* 1999; Adebowale *et al.,* 2013). Also, the degree of conversion of starch from granule formed during processing can be determined using water absorption (Scriburi *et al.,* 1999). Water Absorption Capacity has also been reported to depend on the quantity of soluble materials, which can increase due to starch degradation (Guha *et al.,* 1997; Adebowale *et al*., 2013). Extrudates that exhibits high water absorption capacity values indicates that the starch had fully undergone conversion during extrusion cooking (Sriburi *et al.,* 1999; Anton and Luciano, 2007). The solubility index ranged from 10.95 to 18.48 with flakes from 60:40 flour combinations having the highest and flakes from 70:30 having the lowest. Swelling power and swelling capacity ranged from 3.51 to 4.37 and 13.75 to 20.50 ml, respectively with 90:10 composite flour flakes having the highest value of swelling power and swelling capacity and 70:30 having the lowest mean value for swelling power and 50:50 having the lowest swelling capacity. There was significant difference ($p<0.05$) in the water absorption capacity, swelling power, swelling capacity and solubility index of all the flakes from the different flour combinations.

Table 2: Functional Properties on Rice-Bambara Flakes

RF-BF Flakes	Water absorption capacity (%)	Swelling power	Solubility Index	Swelling capacity (%)
100%RF:0%BF	2.40±0.01d	4.37±0.02	12.66±0.06c	19.50±0.71c
90%RF:10%BF	2.50±0.00e	4.27±0.02e	11.57±0.04b	20.50±0.71c
80%RF:20%BF	2.14±0.01c	3.81±0.01b	14.78±0.11d	19.50±0.71c
70%RF:30%BF	2.11±0.01b	3.51±0.01a	10.95±0.08a	17.25±0.35b
60%RF:40%BF	1.90±0.01a	3.90±0.01c	18.48±0.04e	16.75±0.35b
50%RF:50%BF	1.92±0.01a	4.03±0.01d	14.86±0.21d	13.75±0.35a

± Standard deviation of 3 replicates
Means in the same column with different superscripts are significantly different at $p<0.05$
RF = Rice Flour
BF = Bambara groundnut Flour

Sensory Evaluation

Table 3 showed the mean sensory evaluation scores of the breakfast meal of extruded Rice-bambara flakes. There were significant differences ($p<0.05$) in all the sensory parameters. The values obtained for aroma ranged from 5.00 to 7.09 with 90:10 rice-bambara flake having the highest value and 60:40 having the least. The values for color ranged from 4.46 to 7.23 with 90:10 composite having the highest value and 60:40 having the lowest. The values for taste ranged from 4.11 to 6.70 with 100% rice flour flakes having the highest value and 60:40 having the lowest. The values for texture ranged from 4.32 to 6.14 with 100:0 and 90:10 rice-bambara nut flour flakes having the highest value and 60:40 rice-bambara nut flour flake had the lowest. The overall acceptability ranged from 4.73 to 6.91 with 90:10 rice-bambara nut flour flakes having the highest value and 50:50 rice-bambara nut flour flakes had the lowest. The overall sensory acceptability scores indicated that Rice-Bambara flakes with 90:10 formulations was most preferable while that of 60:40 was least preferred.

Table 3: Sensory Analysis on Rice-Bambara Flakess

RF-BF Flakes	Color	Taste	Aroma	Texture	Overall acceptability
100%RF:0%BF	7.00±1.20c	6.70±1.13d	6.55±1.57c	6.14±1.49c	6.32±1.29bc
90%RF:10%BF	7.23±1.27c	6.35±1.60d	7.09±1.31c	6.14±1.70c	6.91±1.27c
80%RF:20%BF	6.82±1.14c	5.86±1.06cd	6.32±0.95bc	5.59±1.30bc	6.05±1.09b
70%RF:30%BF	5.96±1.33b	5.35±1.39bc	5.68±1.32ab	5.00±1.45ab	5.77±1.23b
60%RF:40%BF	4.46±1.54a	4.11±1.41a	5.00±1.58a	4.32±1.62a	4.73±1.39a
50%RF:50%BF	5.00±1.41a	4.58±1.47ab	5.37±1.22a	4.55±1.23a	4.96±1.21a

± Standard deviation of 3 replicates
Means in the same column with different superscript are significantly different at $p<0.05$
RF = Rice Flour
BF = Bambara groundnut Flour

CONCLUSION

This study has shown the possibility of producing extruded flakes from Rice and Bambara flour using a single screw coking extruder and that the addition of Bambara groundnut to the production process improved the protein content of the flakes. However, the Rice-Bambara flakes from 90:10 composite flour was most preferred by the sensory panelists'.

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