

The Use of African Yam Beans and Shrimps in the Production of Maize-Based Cereal Blends

Adelekan Aminat O*, Arisa Ngozi U and Laguda OO

Department of Food Science and Technology, Bells University of Technology, Ogun State, Nigeria

Abstract

The use of African yam beans flour and shrimps flour in the production of different cereal blends were studied. African yam beans and shrimp flour were used to fortify maize flour in order to increase the nutritional value of the maize based cereal blends. Proximate, mineral, amino acid profile, anti nutritional and sensory analyses were carried out on the six different blends (BC1-75% Maize, 10% African yam bean, 5% Shrimps; BC2-65% Maize, 20% African yam bean, 5% Shrimps; BC4-70% Maize, 20% African yam bean, 5% Shrimps; BC4-70% Maize, 10% African yam bean, 10% Shrimps; BC5-60% Maize, 20% African yam beans, 10% Shrimps; BC6-50% Maize, 30% African yam bean, 10% Shrimps; DC5-60% Maize, 20% African yam beans, 10% Shrimps; BC6-50% Maize, 30% African yam bean, 10% Shrimps; DC6-50% Maize, 30% African yam beans, 10% Shrimps; BC6-50% Maize, 30% African yam bean, 10% Shrimps; DC6-60% Maize, 30% African yam beans, 10% Shrimps; BC6-50% Maize, 30% African yam bean, 10% Shrimps; BC6-60% Maize, 30% African yam beans, 10% Shrimps; BC6-50% Maize, 30% African yam bean, 10% Shrimps; DC6-60% Maize, 30% African yam beans, 10% Shrimps; BC6-50% Maize, 30% African yam bean, 10% Shrimps; BC6-60% Maize, 30% African yam beans, 10% Shrimps; BC6-50% Maize, 30% African yam bean, 10% Shrimps; BC6-60% Mai

Keywords: African yam bean flour; Shrimps; Maize flour; Fortification

Introduction

Nutritional experts have referred to breakfast as the most important meal of the day, citing studies that find that people who skip breakfast are disproportionately likely to have problems with concentration, metabolism, and weight [1]. The African food in general differs from the world food in many terms. Although the meals vary by region, the fruit plays significant part in an African breakfast and meals in general. Neighbouring cultures exert a great influence in Northern Africa while South African breakfasts have become defined by European and American settlers [2]. Breakfast is the first meal of the day, usually consumed in the morning. The word is a compound word of "break" and "fast", referring to the conclusion of fasting since the previous day's last meal. Breakfast meals vary widely in different cultures around the world, but often include a carbohydrate such as cereal or rice, fruit and/ or vegetable, protein, sometimes dairy, and beverage [2].

In Nigeria, cereals are consumed with little or no protein. This leads to protein-calorie malnutrition and pellagra [3]. Protein malnutrition of babies and children is one of the major challenges of the world today. This constraint is most prominent in the developing nations of the world [4].

Omololu [3] reported that protein malnutrition is one of the most important infant's health problems in the developing countries. Fourteen percent of death between the ages 0-4 can be associated with malnutrition. In Nigeria, the awareness led to an increase in importation of different infant and breakfast cereals in the early 70's. But with the recent economic recession the disposable income of most Nigerians have reduced, this has led to the production of breakfast cereals via locally available cereals as this will be cheaper than imported ones [3]. The average daily protein consumed by Nigerians is well below the recommended value. Ogi-porridge made from maize, is usually served with evaporated milk, or steamed in leaves to harden it. Ogi can be cooked to produce a thin gruel (porridge which is mixed with milk, and used as a weaning food for infants or as a major breakfast cereal meal for pre-school, school children as well as for adults [5].

Various workers have tried measures aimed at improving the nutritional value of ogi as well as minimising losses during processing; Akinrele and Edwards [6] reported the fortification of ogi with legumes, vitamins and minerals. Improvement in the technology of ogi has led to the development of soy-ogi, a combination of maize, with soybeans flour as well as instant ogi powder. Other workers Adelekan and Oyewole, Wang and Fields, Hamad and Fields [7-9] have found that nutritional quality of ogi can be improved by using malted cereal for ogi fermentation. The use of African yam bean and shrimp flour as a nutritional supplement in maize is therefore necessary to increase the nutritional value of this maize-based breakfast cereal blends. This study was embarked upon in order to study the effect of African yam bean and shrimp enrichment on the nutritional quality of maize-based cereal blends.

Materials and Methods

The Maize and Shrimps used for the study were purchased from Ota Market in Ogun State; the African yam bean was purchased from Main Market in Umuahia, Abia State. The samples were thoroughly cleaned by picking all broken kernels, stones together with other foreign particles, while sorting out the good ones.

Steeping of Maize

Maize grains were cleaned and steeped in water for 24 hours at room temperature and it was washed immediately to avoid fermentation. Steeped maize was washed thoroughly before it was wet milled and

*Corresponding author: Adelekan Aminat O, Department of Food Science and Technology, Bells University of Technology, Ota.P.M.B. 1015, Ogun State, Nigeria, Tel: +2348059506082; E-mail: bis_adek@yahoo.com

Received May 08, 2012; Accepted August 06, 2012; Published August 08, 2012

Citation: Adelekan Aminat O, Arisa Ngozi U, Laguda OO (2012) The Use of African Yam Beans and Shrimps in the Production of Maize-Based Cereal Blends. J Nutr Food Sci 2:155. doi:10.4172/2155-9600.1000155

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INGREDIENTS (%)	BC1	BC2	BC3	BC4	BC5	BC6
African yam bean	10	20	30	10	20	30
Maize	75	65	55	70	60	50
Shrimps	5	5	5	10	10	10
Sugar	5	5	5	5	5	5
Salt	1	1	1	1	1	1
Vegetable oil	4 ml					
Water	200 ml					

Table 1: Cereal blend formulation.



dried in the oven at a temperature of 70 $^{\circ}\mathrm{C};$ the dried maize was dry milled to form flour.

Pre Treatment of African Yam Bean

The African yam bean was first thoroughly cleaned by picking all the stones and other foreign materials present in them while sorting out the good ones. The cleaned African yam beans were steeped in water at room temperature $(28\pm2^{\circ}C)$ for a period of 24 hours to achieve easy peeling. The beans were dehulled by using stone and hand. After which the dehulled beans were washed with potable water to remove the outer coat and unwanted particles. The beans were then dried in the oven at a temperature of 70°C; the dried beans were dry milled into powdery form (Table 1).

Pre Treatment of Shrimps

The eyes, legs and head of all shrimps were removed. The remaining parts of the shrimps were grounded into powdery form, using a kitchen blender.

Preparation of the Cereal Blends

To make the cereal blends, the maize flour, African yam bean flour and the ground shrimp were combined in six different ratios with water, vegetable oil, sugar and salt to taste. The mixture of each ratio was cooked with 200 ml of water for 5 minutes until the cereal thickens and was allowed to cool down before filling it into an extruder (Icing sugar piston extruder). The nozzle allowed a circular shape to be formed; it was then baked in the oven at 100°C for 45 minutes. The cereals were allowed to cool and packed in polythene bags (Figures 1,2,3).

Chemical Analysis

The proximate analyses were determined using the method described by AOAC [10]. Amino acid profile, minerals, and anti nutritional factors were also determined using standard methods. Trypsin inhibitors were extracted by the methods reported by Kakade et al. [11].

Sensory Evaluation

The multiple comparison test method was used. Ten panellists were used for the evaluation and results were judged based on five-point hedonic scale rating with respect to taste, colour, mouth feel, aroma and flavour. Score "5" have excellent attributes and Score"1" had lowest attributes [12].

Statistical Analysis

The samples data were statistically analysed using SPSS (Statistical Package for the Social Sciences) version 17 for Windows PC. Data was presented as mean \pm SE. One way Analysis of Variance (ANOVA) was used for the data. Differences were considered significant if probability is less than 5% (P<0.05) for all the data.

Results and Discussion

Table 2 shows the proximate composition of the dehulled African yam bean flour, maize flour and the shrimp flour. The result showed that the dehulled African yam beans flour contained 7.70% moisture, 2.74% ash, 20.3% total protein, 1.52% fat and 87.62% carbohydrate. Earlier studies by Okigbo [13] revealed similar trend in proximate composition



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Figure 3: Flow chart for the production of Fortified cereal blend. Adapted from Akinrele and Edwards (1971).

Parameters (%)	African yam beans flour (%)	Maize flour (%)	Shrimps flour (%)
Moisture content	3.85 ± 0.2	4.39 ± 0.3	6.28 ± 0.4
Ash content	1.37 ± 0.5	0.55 ± 0.5	4.50 ± 0.3
Total Protein	10.15 ± 0.5	4.14 ± 0.3	32.25 ± 0.2
Fat content	0.70 ± 0.1	2.05 ± 0.3	0.65 ± 0.0
Carbohydrate	43.81 ± 0.5	39.41 ± 0.4	6.40 ± 0.4

Table 2: Proximate composition of raw materials.

Samples	Moisture content (%)	Ash content (%)	Total protein content (%)	Fat content (%)	Carbohydrate Content (%)
Maize flour	4.39 ± 0.3	0.55 ± 0.5	4.14 ± 0.3	2.05 ± 0.3	39.41 ± 0.4
BC1	3.14 ± 0.0	1.04 ± 0.0	5.91 ± 0.0	1.45 ± 0.0	38.44 ± 0.0
BC2	2.63 ± 0.0	1.00 ± 0.0	6.64 ± 0.0	1.59 ± 0.0	38.13 ± 0.0
BC3	2.15 ± 0.0	1.23 ± 0.0	7.29 ± 0.0	2.10 ± 0.0	37.68 ± 0.5
BC4	3.20 ± 0.0	1.34 ± 0.0	7.67 ± 0.0	2.99 ± 0.0	34.79 ± 0.0
BC5	5.15 ± 0.0	1.34 ± 0.0	7.71 ± 0.0	1.25 ± 0.0	34.59 ± 0.0
BC6	3.39 ± 0.0	1.18 ± 0.0	8.48 ± 0.0	1.72 ± 0.0	35.22 ± 0.0

*Results are ±S.E Legend:

BC1= 10% African Yam Bean flour: 75% Maize flour: 5% shrimp flour BC2= 20% African Yam bean flour: 65% Maize flour: 5% shrimp flour BC3= 30% African Yam Bean flour: 55% Maize flour: 5% shrimp flour BC4= 10% African Yam Bean flour: 70% Maize flour: 10% shrimp flour BC5= 20% African Yam Bean flour: 60% Maize flour: 10% shrimp flour BC6= 30% African Yam Bean flour: 50% Maize flour: 10% shrimp flour

 Table 3: Effect of enrichment on the proximate composition of the cereal blends.

of African yam bean flour, except for the carbohydrate content which was lower (68.70%). The proximate composition result of shrimp flour shows that it had 12.57% moisture, 9.18% ash, 64.50% total protein, 1.31% fat and 12.89% carbohydrate. Maize flour had 8.78% moisture, 4.10% fat, 1.10% ash, 8.28% total protein and 78.83% carbohydrate. This is in agreement with Akingbala et al. [14].

Table 3 shows the effect of fortification on the proximate composition of the cereal blends. The result shows that the moisture contents of the various cereal blends range between 4.30% for BC3 to 10.31% for BC5. Total protein of the blends shows that BC6 had

the highest protein content of 16.96% while BC1 had least protein content of 11.82%. When compared with the unfortified maize flour (8.28%), it can be seen that fortification with African yam bean flour and shrimp flour progressively increased the protein content of the cereal blends. As percentage substitution levels increased, the protein content of the cereal blends also increased. This finding is similar to the work earlier carried out by Adelekan and Oyewole [7] that found out that supplementation of "ogi" with soybeans greatly enhanced the nutritional values of "soy ogi" made from germinated sorghum. The proximate result also shows that there is a reduction in the fat content of the cereal blends with increase in substitution levels and BC4 had the highest fat content of 5.99%. The results of carbohydrate content follows similar trend.

The mineral content of the cereal blends are shown in table 4. There were visible differences in the mineral content of the cereal blends at 30% substitution level of African yam bean flour (BC3 and BC6). The percentage copper content of BC3 and BC6 were 0.50 and 0.40 respectively. These values were higher than that obtained for sample BC4 and BC5 (0.10%). BC1 and BC2 had the highest copper content (0.72% and 0.80% respectively). The percentage magnesium content increased with increase in substitution levels. Addition of shrimps and African yam bean flour increased the percentage magnesium content of maize flour from 0.15% to 9.82%, as reported by Obasi and Wogu [15] in this study. Blend BC1 had the lowest percentage magnesium of 9.00%. The iron content also increased with substitution levels. All the blends have no trace of lead in them.

Table 5 shows the effect of processing on the anti nutritional factors of the African yam bean flour used. BC2 was used as a reference sample to show if the anti nutritional factors present in the legume (African yam bean flour) will reduce during processing. The results show that the tannin, trypsin inhibitors and phytate present in the product (BC2) were lower when compared with the values of the raw African yam bean flour. However, the oligosaccharide content of the product increased (15.40%) as compared to the value present in the raw African yam bean flour (12.74%). This is because oligosaccharides are sugar and are not affected by processing except during fermentation.

Samples	Copper (%)	Magnesium (%)	Lead (%)	Iron (%)	Zinc (%)
BC1	0.72	9.00	0	6.88	3.27
BC2	0.80	9.10	0	8.64	4.27
BC3	0.50	9.20	0	8.26	2.80
BC4	0.10	9.54	0	6.90	1.72
BC5	0.10	9.71	0	8.37	4.29
BC6	0.40	9.82	0	9.41	6.21

*Results are mean of triplicate

BC1= 10% African Yam Bean flour: 75% Maize flour: 5% shrimp flour BC2= 20% African Yam bean flour: 65% Maize flour: 5% shrimp flour BC3= 30% African Yam Bean flour: 55% Maize flour: 5% shrimp flour BC4= 10% African Yam Bean flour: 70% Maize flour: 10% shrimp flour BC5= 20% African Yam Bean flour: 50% Maize flour: 10% shrimp flour BC6= 30% African Yam Bean flour: 50% Maize flour: 10% shrimp flour

Table 4: Effect of enrichment on the mineral content of the cereal blends.

Parameters	African Yam Bean Flour	BC2
Tannin g/100 g	0.02	0.01
Trypsin-inhibitor g/100 g	1.12	0.02
Phytate g/100 g	2.40	1.10

*Results are mean of Triplicate

Legend: BC2= 20% African Yam bean flour: 65% Maize flour: 5% shrimp flour **Table 5:** Effect of processing on the antinutritional factors of African yam bean flour. Citation: Adelekan Aminat O, Arisa Ngozi U, Laguda OO (2012) The Use of African Yam Beans and Shrimps in the Production of Maize-Based Cereal Blends. J Nutr Food Sci 2:155. doi:10.4172/2155-9600.1000155

Amino acids g/16N	BC1	BC2	BC3	BC4	BC5	BC6
LYSINE	3.40	3.50	3.61	4.60	4.41	4.76
THREONINE	3.83	3.74	4.01	4.90	4.81	4.97
VALINE	4.74	4.60	5.14	5.53	5.03	5.61
METHIONINE	2.86	2.75	2.94	3.48	3.15	3.57
ISOLEUCINE	4.84	4.68	5.01	4.88	4.74	5.16
LEUCINE	7.68	7.57	7.87	9.14	8.94	9.38
TYROSINE	5.26	5.06	5.31	6.27	6.16	6.48
PHENYLALANINE	5.48	5.39	5.60	6.70	6.51	6.81
CYSTEINE	1.99	1.93	2.10	2.53	2.48	2.67
TRYPTOPHAN	1.57	1.36	1.67	2.61	2.45	2.70
HISTIDINE	2.58	2.28	2.66	2.70	2.58	2.84

*Results are mean of Triplicate

BC1= 10% African Yam Bean flour: 75% Maize flour: 5% shrimp flour BC2= 20% African Yam bean flour: 65% Maize flour: 5% shrimp flour BC3= 30% African Yam Bean flour: 55% Maize flour: 5% shrimp flour BC4= 10% African Yam Bean flour: 70% Maize flour: 10% shrimp flour BC5= 20% African Yam Bean flour: 50% Maize flour: 10% shrimp flour BC6= 30% African Yam Bean flour: 50% Maize flour: 10% shrimp flour

Table 6: Effect of enrichment on the amino acid profile of the cereal blends.

Parameters	BC1	BC2	BC3	BC3	BC5	BC6
Taste	2.7 ± 0.2	3.4 ± 0.3	2.7 ± 0.2	3.6 ± 0.3	4.0 ± 0.3	3.8 ± 0.2
Colour	3.4 ± 0.4	4.3 ± 0.2	4.0 ± 0.3	3.6 ± 0.2	4.1 ± 0.3	4.0 ± 0.3
Mouth feel	2.6 ± 0.3	3.5 ± 0.4	2.9 ± 0.3	3.7 ± 0.3	4.0 ± 0.3	3.8 ± 0.2
Aroma	2.8 ± 0.3	3.6 ± 0.3	2.2 ± 0.4	1.6 ± 0.3	2.0 ± 0.3	1.7 ± 0.2
Flavour	2.2 ± 0.3	3.4 ± 0.3	2.3 ± 0.3	1.8 ± 0.3	2.5 ± 0.3	1.8 ± 0.3

*Results are ±S.E

BC1= 10% African Yam Bean flour: 75% Maize flour: 5% shrimp flour BC2= 20% African Yam bean flour: 65% Maize flour: 5% shrimp flour BC3= 30% African Yam Bean flour: 55% Maize flour: 5% shrimp flour BC4= 10% African Yam Bean flour: 70% Maize flour: 10% shrimp flour BC5= 20% African Yam Bean flour: 60% Maize flour: 10% shrimp flour BC6= 30% African Yam Bean flour: 50% Maize flour: 10% shrimp flour

 Table 7: Effect of enrichment on the sensory characteristics of the cereal blends.

Table 6 shows the Amino acid test result. The results showed that leucine was the highest in all the six different cereal blends, with the highest value of 9.38 g/16N present in BC4 and the lowest value being 7.57 g/16N present in BC2. Result also showed that the least amino acid profile was tryptophan with the highest value being 2.70 g/16N in BC6 and the lowest value was 1.36 g/16N in BC2.

Table 7 shows the effect of enrichment on sensory characteristics of the cereal blends. Sensory evaluation showed that there was no significant difference between the organoleptic properties (p<0.05), but BC2 had the highest consumer acceptability in terms of colour, aroma and flavour. BC1 had the least consumer acceptability.

Conclusion and Recommendation

This research work has shown that cereal blends which can serve as food cereals can be produced from African yam bean. The cereal competes favorably with conventional cereals produced from soybean in terms of nutritional value. The highest total protein content of one of the six cereal blends was 16.96% (BC6) and the lowest was 11.82% (BC1), the highest fat content was 5.99% (BC4) and the highest ash content was 2.69% (BC4), these values are close to the nutritional value of a standard soybean cereal. The result of the sensory evaluation carried out also showed that the cereal blends were also accepted, the aroma was unacceptable to some panelists because of the strong smell of the shrimp and African yam beans.

Food processors are recommended to embark on the production of cereals using some under exploit legumes such as African yam bean, mung bean, cowpea, pigeon pea, bambara groundnut, etc, as this will enable us to utilize these important food products as it is done in developed worlds. This will also reduce the cost of importing cereals into the country. Fruits can also be incorporated into our local cereal like "ogi" to improve the nutritional quality. The dehulling of the African yam bean was very difficult, as there is no mechanical peeling machine yet. Efforts should be made to develop a machine that can remove the seed coat. Lastly, the production of the cereal should be done in a more mechanized way so as to reduce product waste, and increase the hygiene level and production rate. Attractive packaging should also be used.

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