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Nutrient composition and sensory properties of *kokoro* (a Nigerian snack) made from maize and African yam bean flour blends

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Abstract

Kokoro is a popular traditional maize snack widely consumed by adults and children in Southern states of Nigeria, but characterized by low protein content. African yam bean is an underutilized crop with high nutritional value, but literature is sparse on its utilization to enrich maize snacks. Maize flour (MF) was supplemented with African Yam Bean Flour (AYBF) and used to produce *kokoro* at various ratios MF/AYBF (100:0, 80:20, 70:30, and 60:40). The 100% MF *kokoro* served as control. Proximate composition, minerals composition and sensory evaluation of the samples were determined. Proximate analysis results showed significant increase ($p<0.05$) in protein (10.88-13.11%), ash (1.87-2.42%) moisture (1.72-2.13%) and sugar contents (4.99-5.72%), and decrease in fat (34.25-29.58%) and starch content (83.64-62.79%) as the % AYBF increased. Potassium (0.56-1.41%) was the predominant mineral, followed by calcium (0.49-0.74%) and magnesium (0.12-0.21%).Sensory evaluation results showed a high level of acceptance of the product, the 30% and 40% AYBF compared favorably with control (100% MF). African yam bean is useful for enrichment of maize-based snacks because of its nutrient density. This will create a novel use for African yam bean as well as improve the nutritional quality of the snacks.

Introduction

Maize (*Zea mays* L.) is the third most important cereal in the world after rice and wheat and ranks fourth after millet, sorghum and rice in Nigeria (FAO, 2009). It is a good source of carbohydrate, vitamins and minerals and it can be processed into a wide range of food items and snacks. Some of the maize-based snacks in Nigeria include: aadun (maize pudding), kokoro (maize cake) and donkwa (maize-peanut ball). Legumes are relatively minor crops despite their role as a source of protein and oil in the diet of people of the developing world. Legumes rank next to cereals as source of human food and provide much of the needed protein to the vegetarian population.

African yam bean *(Sphenostylis stenocarpa)* is a lesser known legume of the tropical and sub-tropical areas of the world which has attracted research interest in recent times (Azeke *et al*., 2005). It is classified as neglected underutilized species (NUS) legume (Amoatey *et al*., 2000). The plant is well adapted to withstand adverse conditions. It grows well in acid and highly leached sandy soils of the humid lowland tropics where other major food legumes do not flourish. It suffers less of pest damage than the other legumes both in cultivation and storage and it has the potential to meet year round protein requirements if grown on a large scale (Adewale *et al*., 2010). The crop has twining vigorous vines, which could be green or pigmented red. The vines twine clockwise around the stakes or climb other supports to a height of about 3 metres or more. The leaves are compound trifoliate and its pods are usually linear, housing about 20 seeds, which vary in size, shape, colour, colour pattern. It is grown throughout Tropical Africa, most commonly in Central and Western Africa. It is reported to be cultivated in Ivory Coast, Ghana, Gabon, Congo, Ethiopia and parts of East Africa (Wokoma and Aziagba, 2001). Nigeria is very significant for AYB production where extensive cultivation has been reported in the Eastern (Abbey and Berezi, 1988) Western, and Southern parts (Saka *et al*., 2004).`Nutritional composition of the AYB seeds is of great importance. The amino acid values in AYB seeds are higher than those in pigeon pea, cowpea, and bambara groundnut (Uguru and Madukaife, 2001). The crude protein content (29%) in AYB seeds is lower than that in soybean (35%), but the amino acid spectrum indicated that the level of most of the essential amino acids especially lysine, methionine, histidine, and iso-leucine in AYB is higher than those in other legumes including soybean (Ihekoronye and Ngoddy, 1985). Generally, the amino acid profile of AYB compares favourably with whole hens' eggs

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and most of them meet the daily requirement of the Food and Agriculture Organization and World Health Organization (Ekpo, 2006). AYB is rich in minerals such as K, P, Mg, Ca, Fe, and Zn but low in Na and Cu (Edem *et al*., 1990). AYB has been utilized in the production of fermented sauce (Arisa and Ogbuele, 2007). Its protein concentrate has been reported to be used in fortification of starchy foods like maize, cassava and Akamu flours (Eneche, 2005). It has also been reported to be of some health benefits: its low sodium content makes it good for hypertensive patient and the fact that it digests slowly leads to gentle rise in the blood sugar making it good for diabetic patients. Despite this, African yam bean is underutilized and rarely consumed in urban areas which are attributed to its elaborate preparation method.

Kokoro is one of the traditional Nigerian maize-based snacks, which like other cereal-based foods is rich in carbohydrate and low in protein and deficient in some essential amino acids particularly lysine. African yam bean is rich in lysine, methionine and some other amino acids that are lacking in maize; therefore utilizing it in enriching the maize-based snack is complementary in improving their nutritional quality. Since these snacks are consumed among all levels of the populace including school-aged children as refreshment in Southern Nigeria, incorporation of AYBF will make the snacks useful protein and energy sources for its consumers. This study thus seeks to evaluate the nutrient composition as well as the acceptability of snack produced from maize and African yam bean blends thereby promoting utilization of African yam bean and increasing the nutritional content of *kokoro*.

Materials and Methods

Sample materials

The maize variety, (BR-9928-DMR-SY) was obtained from International Institute of Tropical Agriculture (IITA), Ibadan, Oyo state, Nigeria. While the African yam bean seeds *(Sphenostylis sternocarpa)* were purchased from a local market (Umuaiha) in Abia state, Nigeria and identified as Tss 30 at the IITA genetic resource centre. The seeds were thoroughly cleaned by removing extraneous materials and stored in airtight polyethylene bag at a temperature of 4^{o}C until needed.

Maize and African yam bean flour blends

The African yam bean seeds were sorted, weighed, washed, dehulled manually by soaking in water at ratio (1:5w/v) for about 4 h at room temperature (29±2^{o}C) and dried (60±2^{o}C) in an oven. The seeds were milled using hammer mill (model ED-5 Thomas Wiley, England) and sieved with 500 µm mesh sieve to obtain the yam bean flour. The maize samples were also sorted and milled using 750 µm mesh size. Parts of the maize flour (MF) were substituted with 20, 30 and 40% African yam bean flour (AYBF) by weights. Each blend was separately mixed in a Philip blender (HR2611 model) for three minutes at high speed. The various blends were packed separately in airtight plastic containers till needed.

Preparation of kokoro

Kokoro samples were prepared according to the method described by (Uzo-Peters *et al.*, 2008) with a slight modification in the recipe used as onion and salt were used in place of sugar and salt. Half of each flour blend (100 g) was mixed and stirred in boiled water (400 ml) to make a paste and the remaining half (100 g) was first mixed with salt (3 g) and onion (10 g) and added to the paste with continuous stirring for about 3 min to form homogenous dough. The dough was allowed to cool to a temperature of 40^{o}C and kneaded on a chopping board. The kneaded dough was extruded into uniform sizes using locally fabricated extruder and deep fried in hot vegetable oil (specific gravity 0.918) at temperature 170^{o}C for about 10 min; the fried snack was drained and left to cool. This was later packed in polyethylene bags (100 µm gauge) and stored at ambient conditions (24.2±3^{o}C, 61±3% relative humidity).

Proximate analysis

Proximate analysis of the AYB-maize kokoro samples were carried out in triplicates. Moisture, ash and fat contents were determined using method of Association of Analytical Chemists (AOAC, 2005).

Determination of crude protein

Crude Protein content was determined by Kjeldahl method using KjeltecTM model 2300 protein analyzer,(AACC, 2005). Exactly 0.2 g of sample was digested at 420^{o}C for 1 h to liberate the organically-bound nitrogen in the form of Ammonium Sulphate. The ammonia in the digest (Ammonium Sulphate) was then distilled off into a Boric acid receiver solution, and then titrated with standard Hydrochloric acid. A conversion factor of 6.25 was used to convert from total nitrogen to percentage crude protein (displayed on the screen of the protein analyzer).

Determination of starch and sugar contents

Starch and sugar contents were carried out according to the method described by Dubois *et al.*

(1956). Exactly 0.020 g of finely ground sample was weighed into centrifuge tubes and wet with 1 ml of 95% ethanol. To this, 2 ml of distilled water was added, followed by 10 ml hot ethanol. The mixture was vortexed and centrifuged at 2000 rpm for 10 min. The supernatant was collected and used for free sugar analysis, while the residue was used for starch analysis.

To the residue, 7.5 ml of concentrated Perchloric acid was added and allowed to hydrolyze for 1 h. It was then diluted to 25 ml with distilled water and filtered through whatman No. 2 filter papers. From the filtrate 0.05 ml was taken, made up to 1 ml with distilled water, vortexed and the color was developed by adding 0.5 ml phenol followed by 2.5 ml of conc. H_2SO_4. This was vortexed, allowed to cool to room temperature and the absorbance was read on a spectrophotometer at 490 nm. To the supernatant made up to 20 ml with distilled water, an aliquot of 0.2 ml was taken; 0.5 ml (5%) phenol and 2.5 ml conc. H_2SO_4 were added. This was allowed to cool and the absorbance read at 490 nm.

The glucose standard solution was prepared by weighing 0.01 g of D-glucose into a 100 ml volumetric flask. This was dissolved and made up to 100 ml mark with distilled water. 0.1, 0.2, 0.3, 0.4 and 0.5 ml of the stock (100 µg/ml glucose) solution was dispensed into test tubes and each was made up to 1 ml with distilled water. This corresponds to 10, 20, 30, 40 and 50 mg glucose per ml. This was then followed by the addition of 0.5 ml of 5% phenols and 2.5 ml of H_2SO_4 , vortexed, cooled and the absorbance read at 490 nm.

Then a graph (standard glucose curve) of Absorbance against Concentration was plotted to determine the slope and intercept.

$$\%Sugar = Abs - Intercept x \frac{Dilution\ factor x volume}{weight\ of\ sample x slope x 10{,}000} \quad \ldots\ldots\ldots\ldots\ldots 1.0$$

Where:
Abs. = Absorbance; Dilution factor = 5; Volume = 20 ml

$$\%Starch = Abs - intercept x \frac{Dilution\ factor x Volume x 0.9}{weight\ of\ sample x slope x 10{,}000} \quad \ldots\ldots\ldots\ldots\ldots 2.0$$

Where:
Abs. = Absorbance; Dilution factor = 20; Volume = 25 ml.
Note: The slope and intercept used for the calculations was from standard glucose curve.

Determination of mineral contents

Ash was determined by combustion of the sample in a muffle furnace at 550°C for 12 h (AOAC, 2005). The ashed sample was poured into already labeled 50 ml centrifuge tubes and the crucible was rinsed with 5 ml distilled water into the centrifuge tube. The crucible was rinsed again with 5 ml of aqua regia (400 ml conc. HCl was added to 1.2 L of distilled water and 133 ml of 70% Nitric acid and made up to 2 L with distilled to prepare aqua regia). This was repeated two more times to make a total volume of 20 ml. The sample was vortexed for proper mixing and then centrifuged for 10 min at 3000 rpm. The supernatant was decanted into clean vials for minerals determination using atomic absorption spectrophotometer.

Sensory evaluation

Ten semi-trained panelists were selected from staff and graduates of International Institute of Tropical Agriculture (IITA), Ibadan, Oyo state, Nigeria. The panelists were screened with respect to their interest and ability to differentiate food sensory properties as described by (Iwe, 2002). The study was carried out in a well illuminated sensory evaluation room of IITA in the mid morning hours (10.00 am) and the booths were well partitioned to avoid distraction or interference of other panelists. Each panelist was provided with a glass of clean water to rinse their mouths between the four evaluation sessions of 3 min interval. The 100% maize flour kokoro samples served as control. The four samples were presented in two digit coded plates and were evaluated for appearance, taste, crispness, colour, aroma and overall acceptability using a nine point hedonic scale in which 1 represents the least score (dislike extremely) and 9 the most desirable score (like extremely) for all attributes (Iwe, 2002).

Statistical analysis

Determinations were carried out in triplicates and data generated from the study was subjected to Analysis of Variance (ANOVA) and the least significant difference (LSD) was determined using SPSS version 17 (SPSS Inc.Chicago, IL., USA) .Significance was accepted at $p<0.05$ level.

Results and Discussions

Proximate composition

Proximate composition of *kokoro* samples produced from varying compositions of MF and AYBF blends are presented in Table 1. The 20% AYBF kokoro samples consist of 10.88% protein, 2.13% moisture, 34.25% fat, 83.64% starch and 4.99% sugar content. Significant variation ($p<0.05$) was obtained in each of the kokoro samples with varying proportions of AYBF. The protein (10.88-13.11%), sugar (4.99-5.72%), ash (1.87-2.42%) and moisture (1.72-2.13%) contents increased, while fat

Table 1. Proximate composition of AYB-maize rings *(kokoro)* made from blends of maize and African yam bean flour

Parameter (%)	Samples A(MF:AYBF80:20)	B(MF:AYBF70:30)	C(MF:AYBF60:40)	D(MF:AYBF100:0)
Ash	1.87±0.50c	2.17±0.02bc	2.42±0.24a	2.21±0.02b
Moisture	1.72±0.02c	1.97±0.09b	2.13±0.10a	1.40±0.08d
Protein	10.88±1.82c	12.06±0.02b	13.11±0.21a	9.91±0.06d
Fat	34.25±0.41a	29.96±0.24b	29.58±0.76b	21.08±4.34c
Starch	83.64±0.70b	62.93±0.01c	62.79±0.42c	87.84±0.72a
Sugar	4.99±0.05c	5.32±0.06b	5.72±0.05a	4.29±0.06d

Values with the different letters along the row are significantly different at p≤0.05

Table 2. Mineral composition of Maize flour (MF)-African Yam Bean flour (AYBF) blends

Samples	Ca (%)	Mg (%)	K (%)	Na (ppm)	Mn (ppm)	Fe (ppm)	Cu (ppm)	Zn (ppm)
0%AYBF	0.49c	0.12.	0.56c	8.24d	12.02d	31.84c	0.35c	9.16a
20%AYBF	0.55b	0.15b	0.84c	39.23c	16.08c	32.01c	0.88b	9.67a
30%AYBF	0.58b	0.17b	0.93b	56.40b	16.08c	32.02c	0.88b	10.12a
40%AYBF	0.62b	0.16b	0.98b	62.37b	17.34b	47.87a	0.88b	9.41a
100%AYBF	0.74a	0.21a	1.41a	144.78a	21.20a	38.07b	2.42a	8.90a

Values with different letter along the column is significantly (p<0.05) different

(34.25-29.58%) and starch (83.64-62.79%) contents decreased with increasing quantity of AYBF in the product. The increase in the protein content could be attributed to high protein contents reported for African yam bean (Eneche, 2005). A similar trend was obtained for production of cakes from wheat and African yam bean composite flour. Increase in value obtained in the sugar content may improve the energy values of the snacks in addition to higher levels of protein. Increase in ash contents of the samples (Table1) with increasing AYBF could be because AYB contains high ash content as reported by Uwaegbute *et al.* (2012). The higher ash content of the snack may be attributed to the presence of some minerals in the AYB flour. This further buttresses the nutritional importance of African yam bean. Therefore, incorporation of AYBF into kokoro production could enhance the mineral intake of its consumers, since ash is indicative of the amount of minerals contents in any food sample. Higher moisture content was obtained in the samples containing AYBF than the sample without AYBF. This could be attributed to the residual moisture absorbed by the AYB seed during the dehulling process. However, the moisture contents were minimal and may not have adverse effect on the quality attributes of the products.

The decrease in value obtained for the fat contents of *kokoro* samples with increasing quantity of AYBF may be attributed to the fact that AYBF has been reported to contain low values of crude fat (Amoatey *et al*., 2000). This makes products from African yam bean desirable since less fat contents implies consumption of less calories which is beneficial from health standpoint as obesity, coronary heart diseases and other illnesses attributed to consumption of too much fat could be minimized. Also, low fat food products are less susceptible to rancidity and hence, more shelf stable. The starch contents of the products decreased, with 100% MF having the highest value. This could also be because MF has higher starch content than AYBF.

Mineral composition

The mineral contents in the Maize and African yam bean flour blend was found to vary significantly (p<0.05) with increasing AYBF in the flour blends (Table 2). The mineral composition of the sample showed that potassium was the predominant mineral, followed by calcium and magnesium. Other elements were found in comparatively low concentrations. This is similar to the report of Edem *et al.* (1990) that low concentrations were found in sodium and zinc. Higher mineral contents were found in flour blends containing higher quantity of AYBF. In agreement with the results obtained in this study, Uwaegbute *et al.* (2012) reported similar values for calcium content of ungerminated African yam bean seeds.

Sensory evaluation

Sensory evaluation results of *kokoro* sample produced from different MF-AYBF blends were presented in Table 3. Sensory perception varied significantly (p<0.05) among the products. Values obtained for taste showed a high level of acceptance of the products even with increasing levels of AYBF. However, no significant (p>0.05) difference was obtained for appearance of the samples with change in quantity (%) of AYBF. Higher sensory score for aroma with increasing AYBF in the sample shows the undesirable beany flavor usually associated with legumes is negligible in the *kokoro* samples. This may be attributed to the use of onions and other ingredients that might have off-set the beany flavor. Result from Table 3 shows that the crispness of the products increased with increasing supplementation with AYBF. A similar result was reported for biscuit supplemented with cowpea (a similar legume), where crispness of the biscuits increased with higher

Table 3. Sensory Evaluation scores of AYB-maize rings (kokoro) samples

Parameter	Samples A(MF:AYBF80:20)	B(MF:AYBF70:30)	C(MF:AYBF60:40)	D(MF:AYBF100:0)
Appearance	7.4a	7.5a	7.8a	6.7b
Taste	6.7b	6.6b	7.2a	6.6b
Crispiness	5.8c	7.5a	7.2a	6.3b
Colour	7.0b	7.2b	8.0a	6.9c
Aroma	6.7c	7.0b	7.8a	6.7c
overall acceptability	6.9c	7.3b	7.8a	6.9c

Values with the different letter s along the row are significantly different at P≤0.05

quantity of cowpea (Okaka and Isieh, 1990).

All *kokoro* samples were generally accepted for all attributes evaluated as none scored below the minimum acceptable rating of 5 on the 9 point hedonic scale. Also, closeness of values obtained for all AYBF-MF kokoro samples to the control sample indicate a high level of acceptance of the AYBF-MF kokoro, thereby improving the nutritional contents of kokoro as well as increasing the utilization of African yam bean.

Conclusion

Kokoro enriched with African yam bean are richer in protein than those without African yam bean. The sensory evaluation results show that acceptable *kokoro* can be produced from maize flour supplemented with African yam bean flour which is nutrient-dense but underutilized. This may be a way of increasing consumption and utilization of African yam bean as well as increasing nutritional content of *kokoro*. African yam bean flour could therefore serve as ingredients in food formulation to reduce malnutrition among vulnerable groups in Nigeria.

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