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Enrichment of 'Apula'-A Roasted Maize Meal with African Yam Bean and Plantain Fruit Flour

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Abstract: This study was carried out to determine the effect of blending African yam bean (*Sphenostylis stenocarpa*), firm ripe plantain fruit (*Musa paradisiaca*) flour with maize (*Zea mays*), on the chemical and sensory properties of 'Apula' -a roasted maize meal. Roasted maize grain was blended with African yam bean and firm ripe plantain fruit flour at different proportions of 100:0:0 (Maize, African Yam Bean and Plantain), 70:20:10 and 50:30:20. The samples were coded A, B and C respectively. The chemical composition and sensory evaluation were determined using standard methods of analysis. The results of the chemical analysis showed significant ($p<0.05$) increase in the protein, fat, fibre, vitamins A and C, calcium and potassium contents of the blended samples. Sensory assessment revealed that blended samples (sample B and C) received higher ratings than the control (Sample A) in taste, flavour and in the overall acceptability. Sample A (control sample) was rated high in colour. The study demonstrated that 'Apula' blended with African yam bean and firm ripe plantain is of higher nutritional quality when compared with 'Apula' obtained from 100% maize. The enriched Apula was generally accepted by consumers.

Key words: Apula, chemical properties, sensory, maize

INTRODUCTION

Food insecurity and malnutrition are serious problems in the sub-saharan region of the tropics, despite all the efforts to combat them. Global nutrition survey revealed that the most dietary deficit is protein of high biological value. This is because animal foods which are rich sources of protein are expensive and out-of-reach of the common man. The low income groups who constitute the bulk of the population are particularly at risk. They usually have no alternative but to depend on cereals and legumes which are cheaper than animal products (Okoh, 1998).

Cereals are widely cultivated and consumed crops on a global basis especially in the northern parts of Nigeria and are the major sources of energy and protein in the diet of the people. In Nigeria, a lot of traditional food products are made from cereals; one of such traditional food products is 'Apula' a roasted, ready to eat maize meal. Apula is a cereal based food product made principally from maize. The product is common among the middle belt people of Nigeria basically Kogi and Benue States (Onuh and Abdulsalam, 2009). The traditional unit operations for the preparation of Apula include, cleaning of grains, parboiling, toasting, winnowing and milling into powder. The meal is reconstituted in water with honey or sugar which is added to taste and taken as beverage, snacks or convenient food by both adult and children (Ingbian and Adegoke, 2007). Despite these potentials, like most other traditional foods, Apula is yet to be widely accepted due to its low nutritional quality.

African yam bean (*Sphenostylis stenocarpa*) is an underutilized legume crop that is predominantly cultivated in Western Africa. It produces nutritious pods, highly protenous seeds and capable of growth in marginal areas where other pulses fail to thrive (Yusufu *et al*., 2013). Enwere (1998) reported that African yam bean grains contain 21 to 29% protein, it is a good source of fibre, carbohydrates and rich in minerals.

Plantains (*Musa paradisiaca*) are potent sources of micronutrients especially Vitamins A and C, potassium and fibre. FAO (2005) reported that over 2.3 million metric tons of plantains are produced in Nigeria annually. However, about 35 to 60% post harvest losses was reported and attributed to lack of storage facilities and inappropriate technologies for food processing (Abioye *et al*., 2011). Firm ripe plantains are good sources of Vitamins and minerals and low in fat. USDA (2009) reported that plantains provide a better source of Vitamin A than most other staples. Plantains contain low sodium in dietary terms, hence recommended for low sodium diets.

There is a dire need to upgrade the nutritional quality of our traditional foods in order to meet the food security needs of the sub-saharan region of the tropics. Apart from the use of soybean as an alternative to animal

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protein, proteins from other plant sources are less exploited. Enriching 'Apula-a roasted maize meal' with African yam bean and plantain flour could improve its nutrient quality and acceptability. The present research therefore aimed at determining the effect of African Yam Bean (AYB) and firm ripe plantain fruit flour on the chemical and sensory properties of Apula.

MATERIALS AND METHODS

Procurement of raw materials: The white specked type of African yam bean (*Sphenostylis stenocarpa*) seeds, white variety of maize (*Zea mays*) and firm ripe plantain fruits (*Musa paradisiaca*) were obtained from "Anyigba Market" in Anyigba Town of Kogi State Nigeria. The Department of Food, Nutrition and Home Sciences, Kogi State University, Anyigba provided the facilities for this work.

Preparation of traditional apula: Traditional Apula was prepared according to the method described by Onuh and Abdulsalam (2009). About 2 kg of maize (White variety) grains were sorted with hand, washed with tap water to remove sand and any foreign material from the grains. The cleaned grains were parboiled with the aid of water bath at 90°C for 10 min. The grains were drained and dried in an oven (Uniscope 9053 Laboratory Oven) at 60°C for 1 h. Toasting was carried out at 150°C for 30 min till golden brown colour was obtained. The toasted grains were dehulled, winnowed, milled and sieved to 500 µm particle size.

African yam bean (AYB) flour: AYB flour was prepared according to the method described by Yusufu *et al.* (2013). AYB seeds were cleaned of dirts, parboiled (100°C for 20 min) in an aluminum pot with lid. The parboiled seeds were drained for 5 minutes, dehulled manually and washed with clean water. The seeds were oven dried and toasted at 150°C for an h. The toasted seeds were milled in a hammer mill and sieved through a 500 µm mesh and the flour was packaged in an air tight container.

Preparation of plantain flour: The method described by Enwere (1998) was used to prepare the plantain flour. Firm ripe plantain fruits were washed to remove adhering soil particles, peeled and sliced into thin thickness of about 2 mm. 5.25 mL of 2.0% sodium metabisulphite was added to each weighed chopped pulp for 20 min and dried in the cabinet dryer at 50°C for 24 h. The dried plantain slices were milled into flour using a hammer mill and sieved through 500 µm sieve. The flour was packaged and sealed in polyethylene food bag.

Blending: The maize, African yam bean and plantain flour were mixed in a proportion of 100:0:0 to produce sample A, 70:20:10 to produce sample B and 50:30:20 to obtain sample C.

Analytical procedures

Chemical analysis: Samples were analyzed in duplicates for protein, ash, fat, crude fibre, beta-carotene and moisture, contents using AOAC (2006) methods. The determination of total carbohydrates was done by difference. The soluble solids expressed as °Brix were determined using a refractometer as described by Akubor (2011). Vitamin C, calcium and potassium contents were determined according to the methods described by Onwuka (2005).

Sensory evaluation: Sensory evaluation of samples were determined by a preference method as described by Iwe (2002). A-10-member panel who were regular consumer of "Apula" was trained on sensory attributes for the evaluation. The scores were based on the intensity of preference for organoleptic attributes of taste, colour, flavour, texture and the general acceptability. Using a 9-point hedonic scale (9 = liked extremely and 1 = disliked extremely). Samples were reconstituted at ratio 1:3 (Composite flour: water) in warm water (60°C) and coded for the participating judges' ratings.

Statistical analysis: Data were subjected to analysis of variance, Egbekun and Akubor (2013). Least significance difference test was used to separate means where significant. Significance was defined at $p<0.05$.

RESULTS AND DISCUSSION

The chemical composition of Apula from blends of maize, African yam bean and firm ripe plantain fruit at different levels of formulation is presented in Table 1. Blending improved the protein content of Apula significantly ($p<0.05$) from 9.50% in sample A (control) to 15.00% in sample B and 20.20% in sample C. This was as a result of the high protein content of African yam bean (Enwere, 1998). The increased protein content in the formulated Apula is nutritionally significant in combating malnutrition among the vulnerable groups. The fat content of the samples increased steadily with the increased levels of AYB and plantain flour addition (2.57 to 6.00%). This implies that the blended samples will produce more energy when consumed. But may go rancid quickly if not well stored, thereby leading to the deterioration in the quality of the products. The mean ash content of the samples ranged between 1.88% to 2.80%. African yam bean and plantain flour addition increased the ash content o f Apula which indicates high levels of minerals in the blended samples (Akubor, 2011). The fibre content significantly ($p<0.05$) increased from 2.31% in sample A to 6.70% in Sample C. The nutritional benefits of dietary fibre are well documented. Dietary fibre plays a role in colon for bowel movement which keep the colon clean (Akubor, 2011). There was no significant ($p>0.05$) difference in the mean

Table 1: Chemical composition of enriched apula

Composition	A	B	C
Protein (%)	9.50[c]	15.00[b]	20.20[a]
Fat (%)	2.57[c]	3.70[b]	6.00[a]
Ash (%)	1.88[b]	2.30[a]	2.80[a]
Fibre (%)	2.31[c]	4.80[b]	6.70[a]
Moisture (%)	8.50[a]	8.21[a]	8.00[a]
CHO (%)	71.95[a]	67.99[b]	63.69[c]
Vit. C. (Mg/100g)	0.00[c]	3.03[b]	6.01[a]
Beta-Carotene (Mg/100 g)	5.21[c]	6.55[b]	8.52[a]
Ca (Mg/100 g)	4.10[c]	10.20[b]	15.31[a]
K (Mg/100 g)	287.01[c]	310.10[b]	390.21[a]
°Brix	0.00[c]	1.21[b]	3.51[a]

Values are means of triplicate determinations. Means followed by the same superscript along rows were not significantly (p>0.05) different

A = Apula obtained from 100% maize

B = Apula obtained from blends of maize, AYB and Plantain at the ratio of 70:20:10 (Maize, AYB, Plantain)

C = 50:30:20 (Maize, AYB, Plantain) Apula

Table 2: Mean sensory scores of enriched apula

Sample	Taste	Colour	Flavour	Texture	Overall Acceptability
A	5.0[c]	7.5[a]	4.8[b]	6.0[a]	6.1[c]
B	6.5[b]	6.2[b]	5.2[a]	6.0[a]	7.1[b]
C	7.5[a]	6.3[b]	5.7[a]	6.1[a]	8.2[a]

Values are triplicate determinations. Means followed by the same letter within column were not significantly different (p>0.05)

Sample were evaluated on a 9-point hedonic scale (9 = liked extremely and 1 = disliked extremely)

A = 100% Maize Apula

B = 70:20:10 (Maize, AYB, Plantain) Apula

C = 50:30:20 (Maize, AYB, Plantain) Apula

values of the moisture content of samples. The highest moisture content was 8.50% for sample A. This is an indication that the samples will have good storage stability since most spoilage organisms need water for their activities. Significant (p>0.05) reduction in the carbohydrate level was noticed with the increased level of AYB and plantain flour addition.

Vitamin C, Beta carotene, calcium, potassium and soluble solids measured in Brix increased steadily with the substitution of AYB and plantain fruit flours. The increased content of Vitamin C from 0.00% in sample A to 6.00% in sample C was as a result of the high Vitamin C content of plantain fruit. These results agree with the report of Abioye *et al.* (2011) on the chemical composition of plantain flour. Vitamin C is very vital in iron metabolism and subsequent fight against iron deficiency anaemia (Manoranja and Sood, 2010). Beta carotene content showed similar trend. Beta carotene is a 'Provitamin A'. Vitamin A is a powerful natural antioxidant and required by the body for maintaining the integrity of skin and mucus membranes. It is also an essential vitamin for good visual sight. Research studies suggest that natural foods rich in vitamin A help a body protects against lung and oral cavity cancer (USDA, 2009). Enriching Apula with AYB and plantain fruit flour improved the level of K and Ca in 'Apula'. Potassium is frequently supplied in limited quantities in foods and is readily lost by person taking diuretics (Smith, 1983). Calcium is necessary for healthy bone and teeth. Potassium is an important component of cell and body fluids that help control heart rate and blood pressure countering the negative effect of sodium. A diet which contains high amounts of potassium and calcium is encouraged.

The soluble solids measured in Brix increased steadily from 0.00% in sample A to 3.51% in sample C. The high Brix level obtained in sample C is attributed to the firm ripe plantain flour which is reported to be high in fruit sugar (Lillian, 2004). Firm ripe plantain addition to 'Apula' could serve as natural sweetner and a possible replacement for refined sugar used as sweetner in Apula.

The mean sensory result of Apula enriched with African yam bean and firm ripe plantain flour is presented in Table 2. There were increasing higher scores (acceptance) with the increasing level of AYB and plantain flour substitution. Sample C was rated high by the panelists. This could be attributed to the inclusion of ripe plantain flour which had some of the starches broken down to form sugars (Zakpaa *et al.*, 2010). The control (100% maize) was rated high in term of colour. This might be due to the fact that the panelists were more familiar with it than the blended samples.

All the samples did not differ significantly in terms of texture. The enriched samples were rated high for flavour and general acceptability. Interaction between these food constituents possibly improved the overall quality of the enriched Apula with African yam bean and firm ripe plantain flour.

Conclusion: Incorporation of African yam bean and firm ripe plantain flour increased the protein, fat and fibre contents of Apula. The blend containing 50% maize, 30% AYB and 20% plantain fruit flour (Sample C) had significant (p<0.05) increase in Vitamin C, Beta carotene, calcium and potassium contents. Sample C. had a higher overall acceptability. Thus, firm ripe plantain flour and AYB flour could be use to improve the protein, fibre, Vitamin A and C as well as the taste of Apula. The presence of antioxidant Vitamins such as Vitamins A and C as well as high content of protein and fibre in Apula product could combat malnutrition and would be of health benefits.

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