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Research Article
Proximate Composition and Sensory Properties of *Ukpo oka*: A Steamed Maize Pudding Formulated from Maize and African Yam Bean Flour

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Abstract

Background and Objective: The proximate and sensory properties of supplemented food products determine their acceptability. *Ukpo oka* (a steamed maize pudding) as a cereal product is generally low in protein content thus requiring supplementation from other food sources like African yam bean. Supplementing *ukpo oka* with African yam bean may likely improve the nutritional content of *Ukpo oka* and help solve the problem of protein-energy malnutrition and hidden hunger. This study was designed to determine the effect of supplementing maize flour with African yam bean flour based on the proximate composition and sensory properties of *Ukpo oka*. **Materials and Methods:** Mixtures of processed maize flour and African yam bean flour were formulated in the ratios of 100:0, 50:50, 80:20, 60:40, 20:80, respectively to produce *Ukpo oka*. Proximate composition and sensory properties of the products were determined according to the method of the Association of Official Analytical Chemist and Iwe, respectively. **Results:** The protein (3.91-11.08%), ash (2.90-6.60%) and fiber (0.67-1.82%) content of the flour blends increased with addition of African yam bean flour while carbohydrate content of maize-African yam bean flour blends decreased with increase in the level of African yam bean flour. Flour blend 100:0 had the highest energy value while flour blend 20:80 had the least energy value. Sensory evaluation of products revealed that the products were highly rated in all sensory attributes. Flour blend 50:50 was the most preferred in terms of general acceptability. **Conclusion:** The study showed that poor nutritional quality of *ukpo oka* can be improved through supplementation with African yam bean. It can serve as a high nutritious and energy given food that is accepted at household level.

Key words: African yam bean flour, maize flour, nutritional quality, proximate analysis, sensory evaluation, supplementation, *Ukpo oka*

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Maize (*Zea mays*) is the third most popular cereal crop after rice and wheat in the world and fourth in Nigeria after millet, sorghum and rice[1]. It is cultivated in the tropical and sub-tropical regions of the world. As a high carbohydrate containing cereal it is processed and used in food preparations such as breakfast cereal, weaning foods and other snacks (maize pudding and maize cake). *Ukpo oka* is a steamed maize pudding. It is cereal based food product made from maize. As a cereal, it is very rich in carbohydrate but has low protein content. It lacks the essential amino acid, lysine which is useful in the growth of tissues and absorption of calcium from the intestinal mucosa[2].

The acceptability of any food product for consumption depends on its functional properties (proximate composition and sensory properties). Certain foods are highly rich in some specific nutrients but deficient in others. It is therefore necessary to supplement these foods to acceptable level that will promote the growth and development of the consumer while satisfying their taste.

African yam bean (*Sphenostylis stenocarpa*) is a proteinous food with well-balanced amino acid content, vitamins and minerals than other legumes, such as cowpea and pigeon pea. It is a good supplement for cereal-legume based diet[3]. African yam bean (AYB) however is poorly utilized and classified as neglected underutilized species[4,3]. Its poor utilization is as result of rigorous steps during processing, long cooking time, hard seed coat, near extinction of the seed and poor research interest[4]. African yam bean has the ability to provide the daily requirement of protein for people whose diet is deficient in protein when fully utilized as supplement in cereal based diets. Its protein content is reported to range from 20.2-21.2%. Amino acid profile indicates that lysine and methionine levels in the protein are equal to or better than those of soybeans. Most of the essential amino acid corresponds to WHO/FAO recommendations[5].

Researchers have shown that cereal-legume supplementation significantly improved the nutritional content of the cereal- legume based diets[6-8]. However no study has been done to enrich *Ukpo oka* a popular maize pudding in the South East Nigeria. *Ukpo oka* is consumed as breakfast or lunch among the low income class. It is eaten by children, adults and the elderly. Supplementing *Ukpo oka* with African yam bean will likely improve the protein of the people where the diet is mostly consumed, solve the problem of protein- energy malnutrition (PEM) and encourage wider utilization of the legume. This study therefore determined the effect of supplementing maize with African yam bean based on the proximate composition and sensory properties of the product called *Ukpo oka*.

MATERIALS AND METHODS

Collection of Food Samples: The yellow variety of maize (*Zea mays*) and African yam bean (*Sphenostylis stenocarpa*) were purchased from Nkwo Inyi market Oji River Enugu State, Nigeria. Palm oil and other ingredient were purchased from Abakpa meat market, Abakaliki, Ebonyi State, Nigeria. All analyses were carried out in the laboratory of the Department of Food Science and Technology, Ebonyi State University Abakaliki, Nigeria.

Preparation of Samples: Maize and African yam bean was processed into flour for production of *Ukpo oka*.

Preparation of maize flour: Maize flour was prepared according to the method of Idowu[3] with slight modification. Maize grains were cleaned manually by removing the stones, damaged kernels and other extraneous materials. The cleaned grains were then tempered by sprinkling 5% water (v/w) on the grains coupled with thorough mixing. This was followed by decortications of the grains on a Grantex decorticating machine, which removed the brans and the germ to obtain the grits. The grits were finally milled using a disc attrition mill (Agrico model 2A, New Delhi, India) to obtain the flour followed by sieving using a sieve with 300 µm mesh size.

Preparation of African yam bean: African yam bean (AYB) flour was prepared according to the method of Eke[9]. African yam bean were cleaned and soaked in portable water containing 0.1% sodium metabisulphite solution at room temperature (28±2°C) for 12 h. The soaked seeds were drained, rinsed and dehulled manually by rubbing in between palms. The dehulled seeds were boiled at 100°C for 1 h, drained and spread on a tray dryer (model HC 409 G) at 60°C for 8 h. The dried cotyledons were milled into flour using attrition milling machine (Lister Inc, England). The flour was sieved to pass through 500 µm particle size.

Production of *Ukpo oka*: As shown in Fig. 1, blends of maize and African yam bean flour were mixed according to the following ratios; 100:0, 50:50, 80:20, 60:40, 20:80, respectively. The ingredients used include, 2 big onions, 2 table spoons of grounded crayfish, 20 cl of oil, 2 cubes of magi, 3 red bell pepper, 1 table spoon of salt and addition of 250 mL of water. The blends were thoroughly mixed in a laboratory Hobart

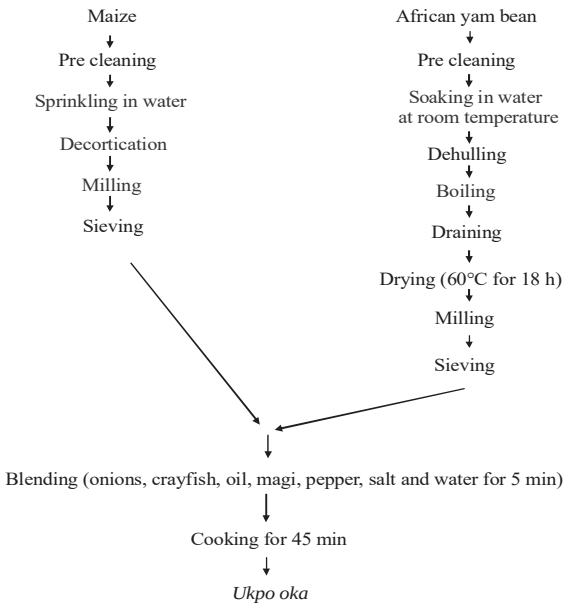

Fig. 1: Flow diagram for the production of *Ukpo oka*

mixer at medium speed for 5 min and then packaged with plantain leaves (*Musa paradisiaca*). This was followed by cooking for 45 min.

Proximate composition: Five grams was used to determine moisture content in a Genlab (Widnes, England) air oven while 2 g was used to determine ash, crude protein, fat and fiber contents of the flour blends according to the method of AOAC[10]. Carbohydrate content (CHO) of the samples were determined by difference method as CHO = 100-(% moisture+%protein+%ash+% fat+fiber). Food energy value (K/cal) was determined according to the method of Marero *et al.*[11] using the factor [(4×%protein)+(4×% carbohydrate)+(9×% fat)].

Sensory analysis: The product (*Ukpo oka*) was assessed for organoleptic quality attributes of colour, texture, appearance, taste, mouth feel, aroma and general acceptability by 32 panelist familiar with the taste of *Ukpo oka*. The panelist was made up of students and staff of the Department of Food Science and Technology, Ebonyi State University. A questionnaire describing the quality was given to each panelist. The panelist assigned scores for each parameter as against the maximum score of 9. Each sensory attribute was rated on 9 point hedonic scale (1= dislike extremely and 9 like extremely) as described by Iwe[12]. The products were coded and served to the panelist. Water and unsalted crackers were provided for the panelists to cleanse their palate between samples. After palate cleaning, a pause (15s) was imposed before the panelists could assess the next sample.

Statistical analysis: Data obtained were subjected to a one way analysis of variance (ANOVA) using a statistical package for social science (SPSS) version 20 to detect significant difference among sample mean. Turkeys test was used to separate means. Significance difference was accepted at 5% confidence level.

RESULTS AND DISCUSSION

Proximate composition: The result of the proximate composition of maize- African yam bean (AYB) flour blends are presented in Table 1. Moisture content can affect the physicochemical properties of food which directly corresponds to the freshness and stability of food products for consumers. The result from this study showed that the moisture content ranged from 5.50-10.00%. The values obtained in this study were within the range of 8.26-10.04 as reported by Jipara *et al.*[13] for powdered weaning food fortified with germinated cowpea flour. Flour blend of 60:40 had the highest value of moisture content while the flour blend 80:20 had the least. The moisture content obtained in this study is desirable since high moisture content might affect the storability and quality of the product[6]. Low moisture content will extend the storage stability of complementary foods and other flour based food products[14]. The protein content of the flour blend increased significantly with the addition of African yam bean. Increase in protein content may be attributed to the complementary role of African yam bean flour[3]. Olaoye *et al.*[15] also observed an increase in protein content with corresponding increase in the proportion of soy flour supplementation in bread produced from composite flour of wheat plantain and soybean. The findings also agree with the report of Adebowale *et al.*[16] who observed an increased trend in the protein content (7.06-11.84%) of cookies made from sorghum-wheat flour blends. Protein content in this study ranged from 3.91-11.08%. Flour blends of 20:80 had the highest protein content while flour blend of 100:0 had the least protein content. Ash content of the blends ranged from 2.90-6.60% which gave an indication of the mineral composition of the blends. The values were higher than those reported for weaning food from maize, soybean and fluted pumpkin seed flour (0.6-2.0%) as reported by Agu and Aluyah[6]. Significant increase was observed in ash content of the flour blends with increasing quantity of AYB flour. Minerals help in the breakdown of other compounds such as fat, protein and carbohydrate[17]. High ash content indicates high levels of minerals in the flour that will provide more mineral nutrient to the consumers.

Table 1: Proximate composition of maize and African yam bean blend

	Proximate composition (%)						
Samples	Moisture	Protein	Ash	Fat	Fiber	Carbohydrate	Energy k/cal
A	9.00^{a}	3.91^{c}	2.90^{c}	3.67^{a}	1.59^{a}	78.93^{a}	360.33^{a}
B	6.17^{b}	7.40^{b}	4.70^{bc}	3.17^{b}	1.07^{b}	77.49^{ab}	322.14^{b}
C	5.50^{b}	5.30^{b}	5.23^{b}	2.97^{b}	0.67^{c}	80.33^{a}	334.52^{c}
D	10.00^{a}	5.90^{b}	6.60^{a}	3.37^{ab}	1.82^{a}	72.31^{bc}	308.45^{d}
E	9.00^{a}	11.08^{a}	6.50^{a}	1.62^{c}	0.88^{b}	70.92^{c}	291.84^{e}
LSD	1.25	2.15	1.35	0.49	0.44	9.21	9.27

Means in the same column with different superscripts are significant different ($p<0.05$). A =100% maize flour, B = 50% maize flour: 50% AYBF, C = 80% maize flour: 20% AYBF, D = 60% maize flour, 40% AYBF, E = 20% maize flour: 80% AYB

Table 2: Sensory properties of *Ukpo oka* made from blends of maize and African yam bean flour

	Sensory properties					
Sample	Aroma	Colour	Texture	Taste	Mouth feel	General acceptability
A	6.41^{a}	6.75^{a}	4.31^{b}	5.69^{b}	4.66^{b}	5.69^{b}
B	6.34^{a}	5.66^{b}	6.16^{a}	6.6^{ab}	6.47^{a}	6.75^{a}
C	6.70^{a}	6.72^{a}	6.19^{a}	6.69^{a}	6.34^{a}	6.73^{a}
D	6.19^{a}	6.16^{ab}	5.94^{a}	6.03^{ab}	6.03^{ab}	6.5^{ab}
E	5.80^{a}	4.25^{c}	5.75^{a}	5.31^{b}	5.16^{b}	4.94^{b}
LSD	0.90	0.98	0.98	0.98	0.98	0.90

Means in the same column with different superscripts are significant different ($p<0.05$). A = 100% maize flour, B = 50% maize flour: 50% AYBF, C = 80% maize flour: 20% AYBF, D = 60% maize flour: 40% AYBF, E = 20% maize flour: 80% AYBF

Fat content of the blends ranged from 1.62-3.67%. The values reduced with increasing quantity of AYB flour. This may be attributed to low fat content of AYB flour[4]. The fat content obtained from the flour blends is lower than the recommended value[18]. The decrease in fat content is of interest to consumers interested in consumption of low fat food products. This is also beneficial because a number of health organizations including the World Health Organization (WHO) have made recommendations to reduce daily fat intake for improved health[19]. The shelf life of the blends may however be increased due to low fat content, since all fats containing foods contain some unsaturated fatty acids and hence are potentially susceptible to oxidative rancidity. The fiber content decreased with increase in maize flour. This could be due to low fiber content in maize[3]. High fiber content in African yam bean is desirable since it may contribute to bulkiness in food and aid bowel movement while preventing many gastrointestinal diseases in man[20]. Fiber content ranged from 0.67-1.82%. The carbohydrate content ranged from 70.92-80.33%. Flour blend of 80:20 had the highest carbohydrate content while flour blend 20: 80 had the least. The carbohydrate content of maize-African yam bean blends decreased with increase in the level of African yam bean. This is due to the fact that maize being a cereal is rich in carbohydrate. Statistical analysis showed significant difference ($p<0.05$) between flour blend 80:20 and 20:80. There was no significant difference ($p>0.05$) between flour blend of 100:0 and 80:20. Flour blend100:0 had the highest energy value while flour blend 20:80 had the least. Food energy measured the amount of energy expanded. The protein, fat and carbohydrate constituents of the blends could contribute to the energy value of *Ukpo oka*.

Sensory properties: The result of the sensory properties of *Ukpo oka* is shown in Table 2. The products were highly rated in all attributes evaluated. Aroma decreases with increase in levels of African yam bean. The product made of flour blend of 80:20 was the most preferred in terms of aroma while 20:80 was least preferred. The product made of flour blend of 80:20 had the highest colour value while 20:80 had the least. Statistical analysis showed no significant difference ($p>0.05$) on texture of *Ukpo oka* at different flour blends except flour blend of 100:0. The product made of flour blend of 80:20 was most preferred in terms of taste while the product made of flour blend 20:80 was least preferred. Mouth feel was found to be high in product made of flour blend of 50:50 and least in product made of flour blend 100:0. In general acceptability, product made of flour blend 50:50 was the most preferred, followed by product made of flour blend of 80:20. While the product made of flour blend of 20:80 was the least preferred.

CONCLUSION

The study showed that poor nutritional quality of *Ukpo oka* (a steamed maize pudding) can be improved through supplementation with African yam bean. This is reflected in the improved protein (3.91-11.08%), ash (2.90-6.60%) and fiber (0.67-1.82%) contents of the samples.

This implies that *Ukpo oka* could serve as a high nutritious and energy given food at household level. The production of enriched *Ukpo oka* with African yam bean is simple and the ingredients are available in the market, cheap and affordable. The products were highly rated in all sensory attributes evaluated however the product made of flour blend of 50:50 was the most preferred in terms of general acceptability.

SIGNIFICANCE STATEMENT

This study discovered that the poor nutritional content of *ukpo oka* can be improved by supplementing with African yam bean. Cereal-legume supplementation will improve macronutrient content, solve the problem of protein energy malnutrition, hidden hunger and will help researchers in area of macronutrient deficiency.

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