



Original Article

Evaluation of the proximate and functional properties of Aadun, Kokoro and Kango made from mixture of three different ratios of maize, alligator pepper and kidney beans

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ABSTRACT

Maize or corn is a cereal crop that is grown widely throughout the world in a range of agro-ecological environments. More maize is produced annually than any other grain. It has been used for the production of many snacks in Nigeria. The white and yellow varieties are preferred by most people depending on the region. Kidney beans are good source of cholesterol-lowering fiber; prevents blood sugar levels from rising and is a good choice for individuals with diabetes, insulin resistance or hypoglycemia. The evaluation of the proximate and functional properties of Aadun, Kokoro and Kango made from mixture of three different ratios of maize varieties, alligator pepper and kidney beans was carried out using standard methods of analysis. The three maize varieties are ART, BR99 and SUWAN, all mixed with alligator pepper and kidney beans in the ratio 720:260:20; 826:157:16 and 759:236:5 respectively. The result of the analysis showed that at 100%, SUWAN maize variety has the highest moisture content (9.64 ± 0.01), ash (1.36 ± 0.01) and fat (5.64 ± 0.02), while ART maize variety had the highest crude protein (14.46 ± 0.03), fiber (0.91 ± 0.01) and carbohydrate (72.54 ± 0.23). The anti-nutrients found in alligator pepper and kidney beans were tannin, phenol, oxalate and phytate in an increasing order. Comparatively, phytate was higher in kidney beans (52.51 ± 0.30) than alligator pepper (33.43 ± 0.24). Aadun made from BR99 maize in ratio 826:157:16 had the highest carbohydrate content (77.86 ± 0.08) while the one made with SUWAN and ART in ratios 720:260:20 and 759:236:5 had the highest protein contents of 20.06 ± 0.04 and 19.91 ± 0.02 respectively. Kokoro made with SUWAN in ratio 759:236:5 had the highest protein content of 20.96 ± 0.01 . On the other hand, kango made with ART in ratio 759:236:5 had the highest protein content of 22.59 ± 0.09 . The functional properties such as water holding capacity, oil holding capacity and foaming capacity increased in these varieties while least gelation concentration and emulsifying capacity

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decreased. The mixing of maize variety in different ratios with alligator pepper and kidney beans can therefore be used to improve the nutritional content of aadun, kokoro and kango significantly.

Introduction

Maize or corn is a cereal crop that is grown widely throughout the world in a range of agro-ecological environments. More maize is produced annually than any other grain. About 50 species exist and consist of different colours, textures, grain shapes and sizes. White, yellow and red are the most common types. The white and yellow varieties are preferred by most people depending on the region (Bazzano *et al.*, 2003). Maize is processed and prepared in various forms depending on the country. Ground maize is prepared into porridge in Eastern and Southern Africa, while maize flour is prepared into porridge in West Africa. Ground maize is also fried or baked in many countries. In all parts of Africa, green (fresh) maize is boiled or roasted on its cob and served as a snack (Smith and Andrew, 2013). Popcorn is also a popular snack. Locally, maize is used to produce aadun, kokoro and kango in Yoruba land (South West Nigeria).

The kidney bean is a variety of the common bean (*Phaseolus vulgaris*). It is named for its visual resemblance in shape and color to a kidney. Red kidney beans can be confused with other beans that are red, such as adzuki beans. In Jamaica, they are called "red peas". It is said to be rich in protein and iron. Both dried and canned kidney beans are available throughout the year (Queiroz *et al.*, 2012). Kidney beans are a very good source of cholesterol-lowering fiber, as are most other beans (Phytoagglutinin, 2009). In addition to lowering cholesterol, kidney beans' high fiber content prevents blood sugar levels from rising too rapidly after a meal, making these beans an especially good choice for individuals with diabetes, insulin resistance or hypoglycemia (Queiroz *et al.*, 2012). Alligator pepper is a West African spice which corresponds to the seeds and seed pods of *Aframomum danielli*, *A. citratum* or *A. exscapum*. It is a close relative of grains of paradise, obtained from the closely related species of *Aframomum melegueta* (Mennoti *et al.*, 2009).

Aadun is a savory snack of Yoruba origin; the snack is made from a combination of roasted corn flour, palm oil and spices. A variation of this snack contains fried red cowpeas. Aadun is sold primarily as a street snack and often it's present at festive functions like naming ceremonies and traditional marriages (Idowu *et al.*, 2012). Kango is made from corn just like akara is made from black eyed peas. They are sister products but Kango is much cheaper in price to make (just because corn is cheaper than beans). Kokoro on the other hand is a popular crunchy snack with western Nigeria origins. It's really not unusual to find street hawkers carrying this tasty snack around in trays placed strategically on their heads. There are two types of kokoro sold in the local markets with the difference being only in shape and taste namely; the Crunchy plain type and the Crunchy Spicy type (Otunola *et al.*, 2012).

This research is therefore focused on the preparation of these local snacks using different varieties of maize as well as mixing different ratios of alligator pepper and kidney beans with the maize in order to evaluate the proximate analysis and functional properties of the snacks.

MATERIALS AND METHODS

Antinutrient determination

Determination of Tannin

Gravimetric determination of tannin was done according to the method of Makkar *et al.* (1993). Zero-point-two millilitres (0.2ml) of the samples were weighed into test tubes and tannin was extracted in ten millilitres (10ml) 70% acetone. The test tubes were then placed in cold water bath for 10minutes to allow for complete extraction of tannin. Zero-point-two millilitres (0.2ml) was filtered into test tubes and made up to one millilitre (1ml) with

distilled water. Two-point-five millilitres (2.5ml) of 20% Na₂CO₃ and zero-point-five millilitres (0.5ml) with distilled water were added and the content was mixed properly. The solution was incubated for 45min at room temperature to develop colour (blue colour). The absorbent of each samples were read at wavelength 700nm using a Coring colorimeter 253, Corning Ltd, Essex, England.

Determination of phytate

Phytate was determined according to the method of Young and Greaves (1990). Four grams (4g) of the samples was soaked in one hundred millilitres (100ml) of 2% HCl for 3 hours and then filtered, twenty-five millilitres (25ml) of the filtrate was placed in a conical flask. Five millilitres (5ml) of 0.3% ammonium thiocyanate (NH₄SCN) solution was added as indicator and diluted with distilled water. This was titrated with standard FeCl₃ solution until a brownish yellow colour persisted for 5minutes.

Determination of oxalate

The determination was done according to the method of Day and Underwood (1986). One gram (1g) of the samples were placed into labelled plastic bottles followed by the addition of seventy-five millilitres (75ml) of H₂SO₄. The content was mixed properly and allowed to extract for one hour with constant agitation using a mechanical shaker. This was then filtered and twenty-five millilitres (25ml) of the filtrate was titrated with zero-point-one millilitres (0.1ml) of KMnO₄ while hot (80 – 90°C) until a purple colour was observed. The titre value was then multiplied by 0.9004 to give the result expressed as mg/g.

Phenol determination

Ten grams (10g) of samples were extracted repeatedly with 100ml of 80% aqueous methanol at room temperature. The whole solution was filtered through what man filter paper No 42 (125mm). The filtrate was later transferred into a crucible and evaporated into dryness over a water bath and weighed to a constant weight (Boham and Kocipal-Abyazanb, 1994).

The following physical properties were determined: pH, least gelation, swelling capacity, bulk density, water absorption capacity, oil absorption capacity.

The method Ukpabi and Ndimele (1990) was used 1g of each sample was dispersed in 10mls distilled water. The content was then stirred for 2 to 3 minutes using a magnetic stirrer. The sample as then poured into a 50ml centrifuge tube and then centrifuged in a cyclo-mixer at 3500rpm for 30 minutes.

At the end of the centrifuging the sample in the tubes were allowed to stabilize and the supernatant of each tubes were carefully drained into a graduated cylinder of 10ml the volume of the supernatant was noted, the density of water was assumed to be 1gm/ml.

$$\text{Weight} = D \times \frac{\text{volume of bound water}}{\text{weight of sample}}$$

Least gelation determination

The method of Coffman and Garcia (1977) was followed with slight modification. Appropriate sample suspensions of 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8g were weighed into 5ml distilled water each to make 2-20% (w/v) suspension. The test tubes containing these suspensions were heated for 1 hour in boiling water (bath) followed by rapid cooling under running tap water. The test tubes were then cooled for an hour, the least gelation concentration were determined as concentration, when the sample from the inverted test tube did not fall down or slip.

$$\text{Least gelation concentration \%} = \frac{\text{weight of sample} \times 100}{5(\text{ml})\text{of water}}$$

Proximate Analysis

The proximate analysis of the samples were carried out using the standard procedure of Association of Analytical Chemist (AOAC, 2000).

Moisture Content Determination

Moisture content was determined by the method described by AOAC (2000) using the air oven method. Clean and well labeled petri dishes were washed, oven dried and cooled then the weight was recorded as W_1 . Two grams (2g) of each sample was weighed into the petri dish and the weight was taken as W_2 , the sample as oven dried at 105°C for 3 hours. It was transferred into the desiccators, cooled for an hour and the weight was observed until constant weight was attained as W_3 .

Calculations:

$$\% \text{M.C} = \frac{\text{loss in weight}}{\text{weight of sample before drying}} \times 100$$

$$\% \text{ moisture content} = \frac{W_3 - W_1}{W_2 - W_1} \times 100$$

Where

W_1 = weight of petri dish

W_2 = weight of petri dish and sample

W_3 = weight of petri dish and sample after drying

Crude fat determination

Crude fat was determined by the method described by AOAC (2002). Crude fat was determined by using soxhlet apparatus. Approximately three grams of sample was put into a thimble and extracted with n-hexane for about 6 hours. The solvent were removed from the extracted oil by evaporation. The oil was further dried in a hot –air oven at 100°C for 30 mins to remove residual organic solvent and moisture. This was cooled and weighed. The quantity of the oil was expressed as percentage of the original sample used.

Calculation

$$\% \text{ crude fat} = \frac{W_4 - W_3}{W_2 - W_1} \times 100$$

W_1 = weight of Thimble

W_2 = weight of Thimble and sample

W_3 = weight of round bottom flask

W_4 = Weight of round bottom flask and residual oil

Crude protein determination

The total crude protein content was determined using the micro kjeldahl method (AOAC, 2002).

Sample of 0.2g was weighed into a Kjeldhal flask. Ten milliliter of concentrated sulphuric acid was added followed by one Kjeltec tablet. The mixture was digested to obtain a clear solution. The digest was cooled and 75ml distilled water was added followed by 50ml of sodium hydroxide solution. The ammonia formed in the mixture was subsequently distilled into 25ml, 2% boric acid solution containing 0.5ml of indicator methyl red. The distillate collected was then titrated against 0.1M of Hcl. Blank titration was also carried out on the reagent and the nitrogen in the sample was calculated. The nitrogen content was multiplied by 6.25 to obtain crude protein content.

$$\% \text{g Nitrogen} = \frac{\text{titrate value} \times M \times 0.014}{\text{weight of sample}} \times 100$$

Crude protein = %g Nitrogen x 6.25

N is the tot Nitrogen, 6.25 is the conversion factor.

Total Ash Content Determination

The total ash content was determined by using the procedure of AOAC (2002). About 2g of the sample was weighed into clean crucible of weighed W_1 and together weighed as W_2 . The crucible was then placed into a muffle furnace chambers at 6000C until the samples turned into ashes. The crucible were removed from the furnace, cooled in desiccators and allowed to cool to room temperature and reweighed as W_3 .

Calculation

$$\% \text{ Ash} = \frac{W_3 - W_1}{W_2 - W_1} \times 100$$

$$\% \text{ Organic matter} = 100 - \% \text{ Ash}$$

W_1 = Weight of Crucible

W_2 = Weight of Crucible and sample before drying

W_3 = Weight of Crucible and sample after drying

Crude Fibre Content Determination

Crude fibre content was determined using a method as described by AOAC (2002). Two grams of samples was weighed (W_1) which was extracted with n-hexane. This was transferred into a 1 litre flask. Sulpruic acid (1.2%, 200ml) was added and the flask was placed on a hot plate and boiled for 30 mins. The content was filtered and the residue was washed with 70ml distill water the residue was removed and 200ml boiling 1.25% sodium hydroxide (NaOH) was added and boiled for 30 mins. The content was filtered and the residue was washed with distilled water. The residue was then transferred to ashing dish and dried at 130°C for 30 mins cooled in a dessicators and weighed W_2 . This was then ignited at 600°C cooled and reweighed (W_3).

$$\% \text{ crude fibre} = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

W_1 = sample weight

W_2 = sample weight + dish after drying

W_3 = sample weight + dish after ignited

Carbohydrate content

Carbohydrate content was determined by subtracting the value of the analysed components i.e moisture content, protein, crude fat, ash content, crude fibre, from 100%, and was expressed in percentage.

$$100 - (\% \text{ crude protein} + \% \text{ total ash} + \% \text{ crude fibre} + \% \text{ crude fat} + \% \text{ moisture content})$$

Energy Value

The energy value was determined by a standard calculation using Atwater factor

$$\text{Protein} \times 4 \text{ joule/g} + \text{carbohydrate} \times 4 \text{ joule/g} + \text{fat} \times 9 \text{ joule/g}$$

STATISTICAL ANALYSIS

The results was pooled and expressed as mean \pm SE. Data was analyzed using analysis of variance (ANOVA) and the Least significance Difference test were carried out using Duncan's Multiple Range test at 5% level of significance i.e. $P \leq 0.05$.

Results

The result of the analysis showed that at 100%, SUWAN maize variety has the highest moisture content (9.64 ± 0.01), ash (1.36 ± 0.01) and fat (5.64 ± 0.02), while ART maize variety had the highest crude protein (14.46 ± 0.03), fiber (0.91 ± 0.01) and carbohydrate (72.54 ± 0.23). The highest ash content of 3.77 ± 0.02 was in kidney beans while the highest fat content of 6.82 ± 0.01 and fibre of 6.71 ± 0.01 were both in alligator pepper. The anti-nutrients found in

alligator pepper and kidney beans were tannin, phenol, oxalate and phytate in an increasing order. Comparatively, phytate was higher in kidney beans (52.51 ± 0.30) than alligator pepper (33.43 ± 0.24). These results are represented in figures 1 and 2 respectively.

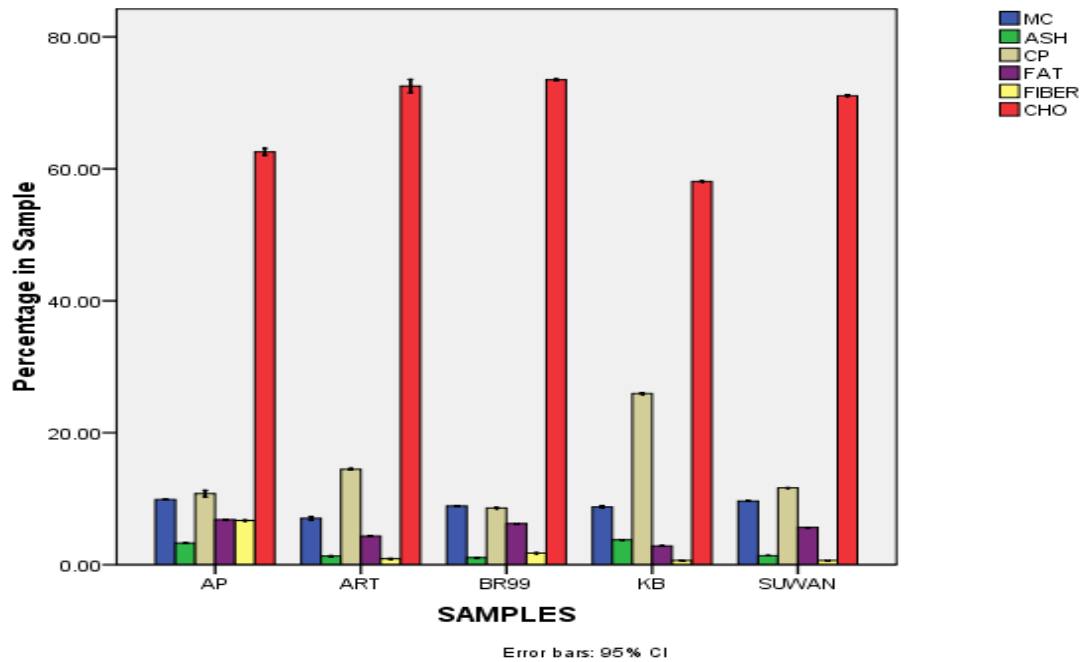


Figure 1: Proximate analysis of the maize varieties, alligator pepper and kidney beans used. Legends: MC=Moisture content; CP= crude protein; CHO= carbohydrate; AP= alligator pepper; KB= kidney beans; ART= maize variety; BR99= maize variety, SUWAN= maize variety.

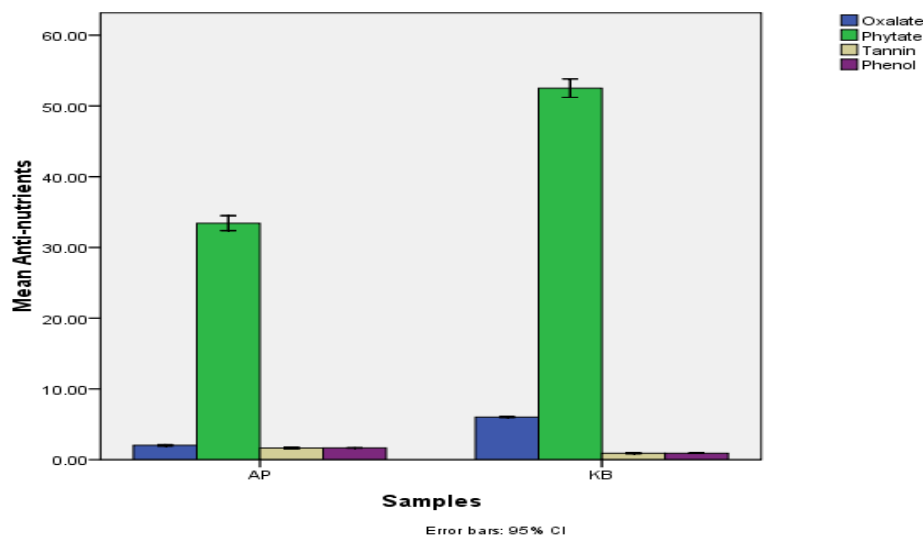


Figure2: Mean anti-nutrients present in alligator pepper and kidney beans. Legends: AP= Alligator pepper; KB= Kidney beans

Aadun made from BR99 maize in ratio 826:157:16 had the highest carbohydrate content (77.86 ± 0.08) while the one made with SUWAN and ART in ratios 720:260:20 and 759:236:5 had the highest protein contents of 20.06 ± 0.04 and 19.91 ± 0.02 respectively. Kokoro made with SUWAN in ratio 759:236:5 had the highest protein content of 20.96 ± 0.01 . On the other hand, kango made with ART in ratio 759:236:5 had the highest protein content of 22.59 ± 0.09 . The functional properties such as water holding capacity, oil holding capacity

and foaming capacity increased in these varieties while least gelation concentration and emulsifying capacity decreased. These results are shown in figures 3-8.

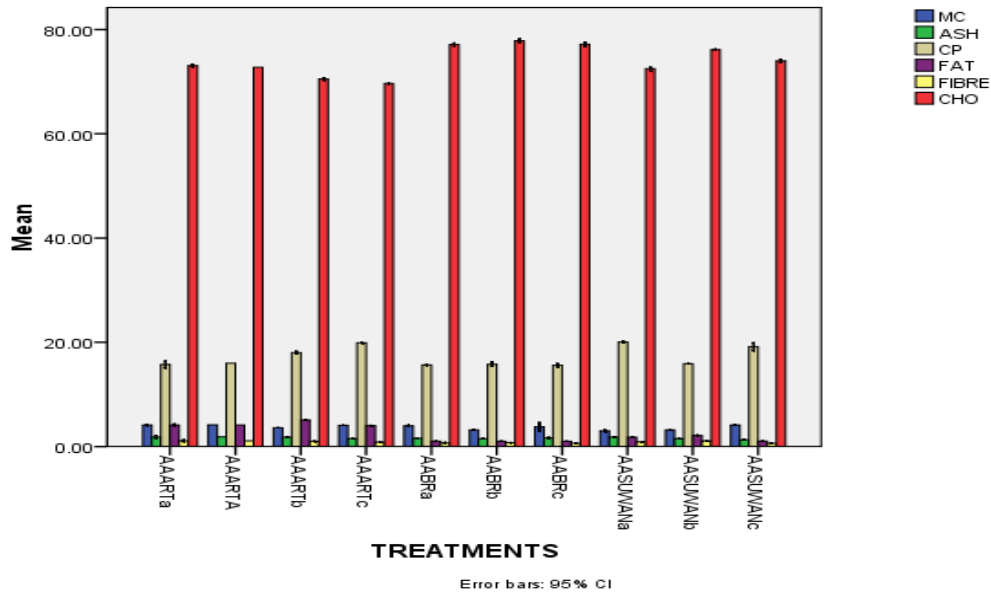


Figure 3: Proximate analysis of aadun made by mixing different ratios kidney beans and alligator pepper with three maize varieties. Legends: MC=Moisture content; CP= crude protein; CHO= carbohydrate; AAARTa=ART720:260:20; AAARTb=ART826:157:16; AAARTc=ART759:236:5; AABRa=BR720:260:20; AABRb=BR826:157:16; AABRc=BR759:236:5; AASUWANA=SUWAN720:260:20; AASUWANb=SUWAN826:157:16; AASUWANc=SUWAN759:236:5.

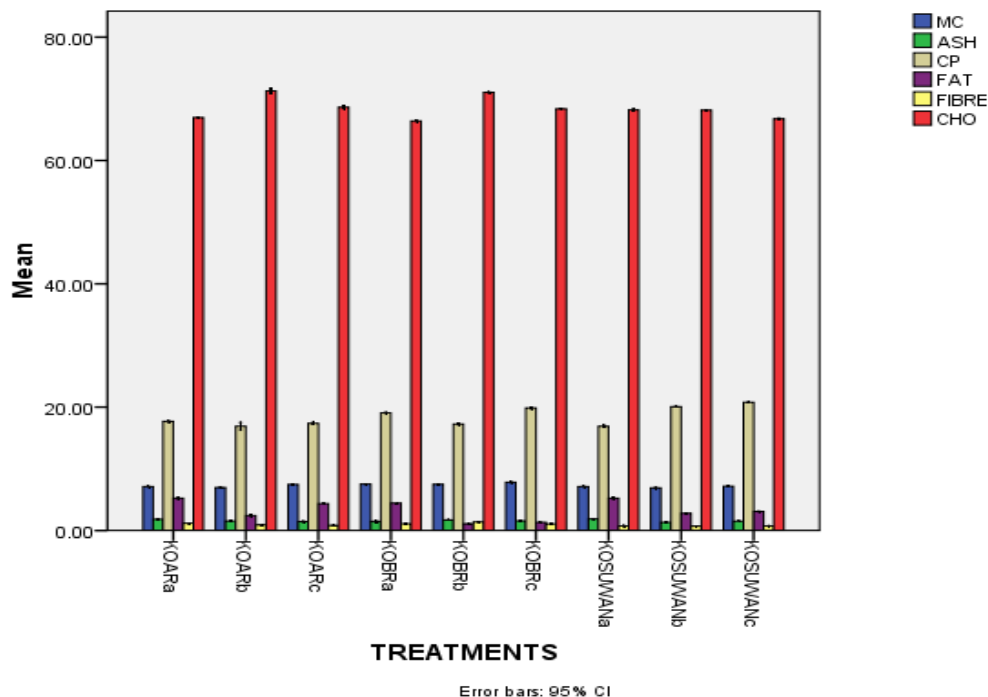


Figure 4: Proximate analysis of kokoro made by mixing different ratios kidney beans and alligator pepper with three maize varieties. Legends: MC=Moisture content; CP= crude protein; CHO= carbohydrate; AAARTa=ART720:260:20; AAARTb=ART826:157:16; AAARTc=ART759:236:5; AABRa=BR720:260:20; AABRb=BR826:157:16;

AABRc=BR759:236:5;

AASUWANA=SUWAN720:260:20;

AASUWANb=SUWAN826:157:16; AASUWANc=SUWAN759:236:5.

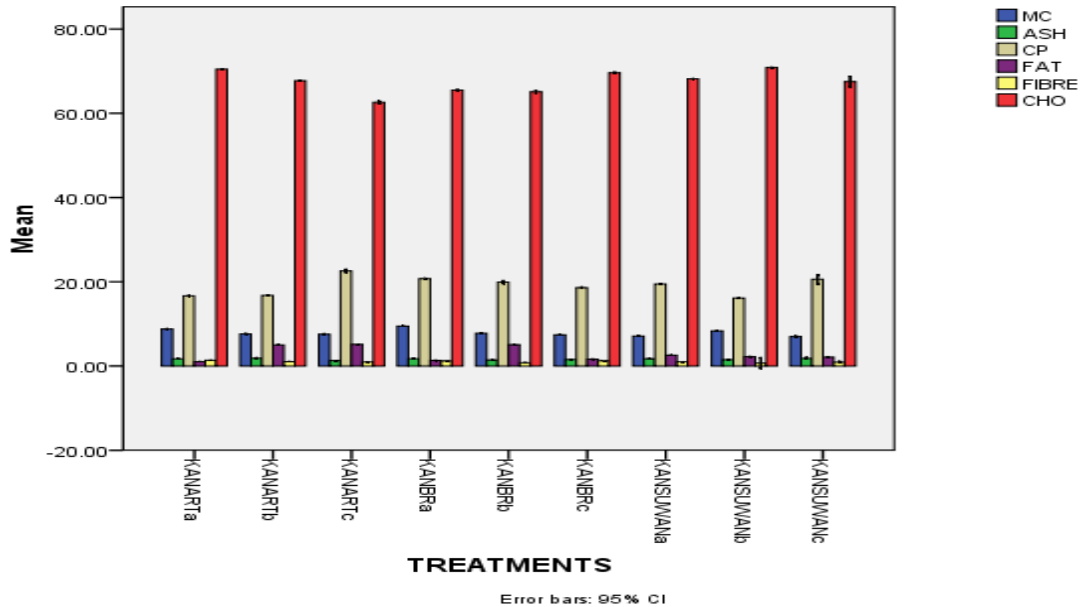


Figure 5: Proximate analysis of kango made by mixing different ratios kidney beans and alligator pepper with three maize varieties. Legends: MC=Moisture content; CP= crude protein; CHO= carbohydrate; AAARTa=ART720:260:20; AAARTb=ART826:157:16; AAARTc=ART759:236:5; AABRa=BR720:260:20; AABRb=BR826:157:16; AABRc=BR759:236:5; AASUWANA=SUWAN720:260:20; AASUWANb=SUWAN826:157:16; AASUWANc=SUWAN759:236:5.

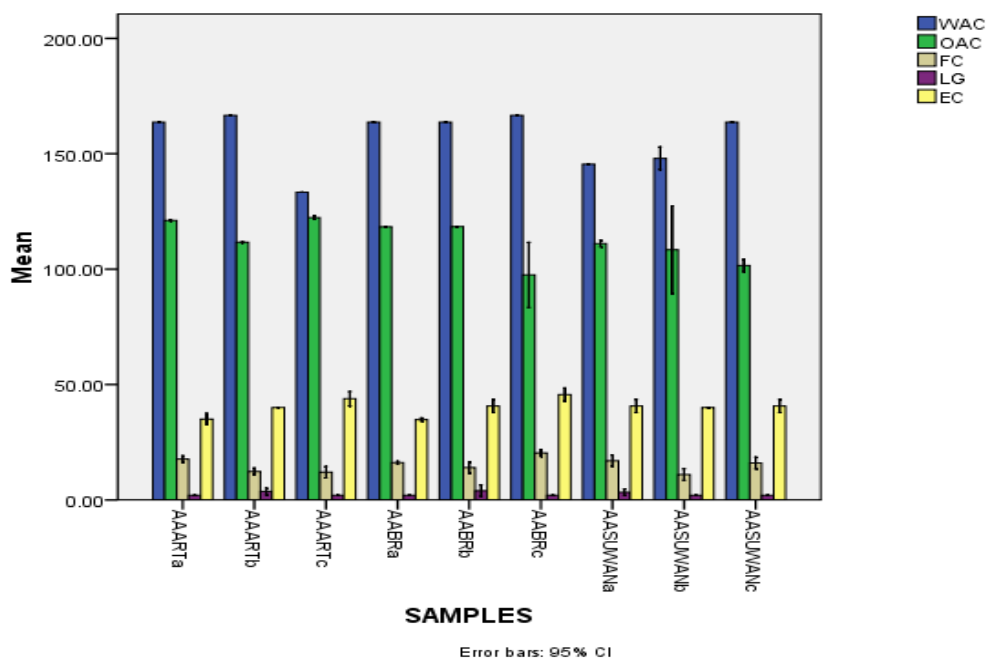


Figure 6: Functional properties of aadun made by mixing different ratios kidney beans and alligator pepper with three maize varieties. Legends: MC=Moisture content; CP= crude protein; CHO= carbohydrate; AAARTa=ART720:260:20; AAARTb=ART826:157:16;

AAARTc=ART759:236:5; AABRa=BR720:260:20; AABRb=BR826:157:16;
 AABRc=BR759:236:5; AASUWANa=SUWAN720:260:20;
 AASUWANb=SUWAN826:157:16; AASUWANc=SUWAN759:236:5.

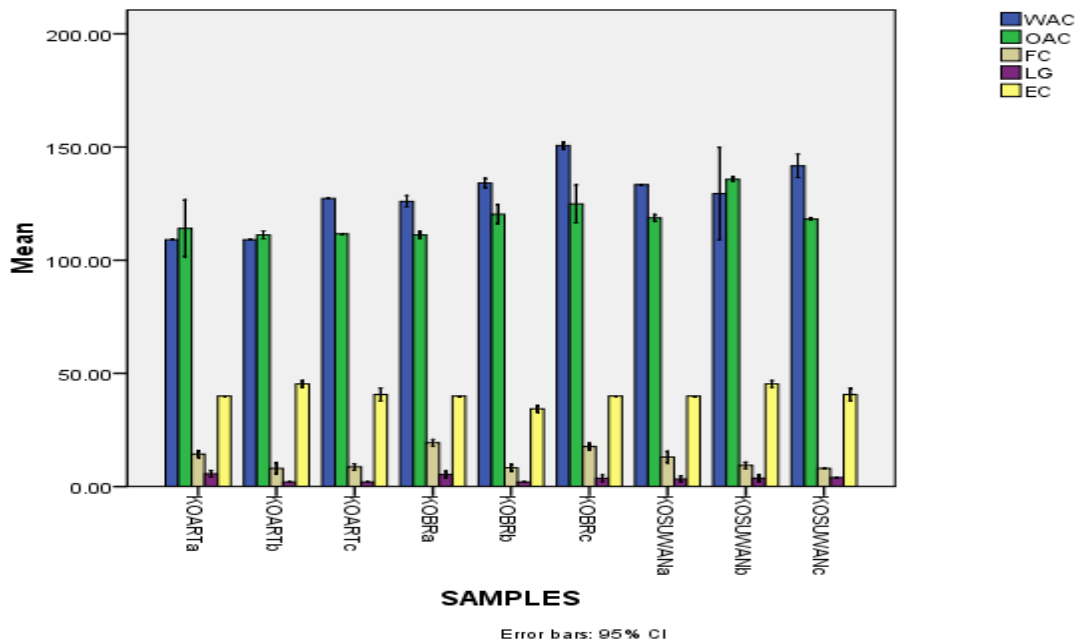


Figure 7: Functional properties of kokoro made by mixing different ratios kidney beans and alligator pepper with three maize varieties.

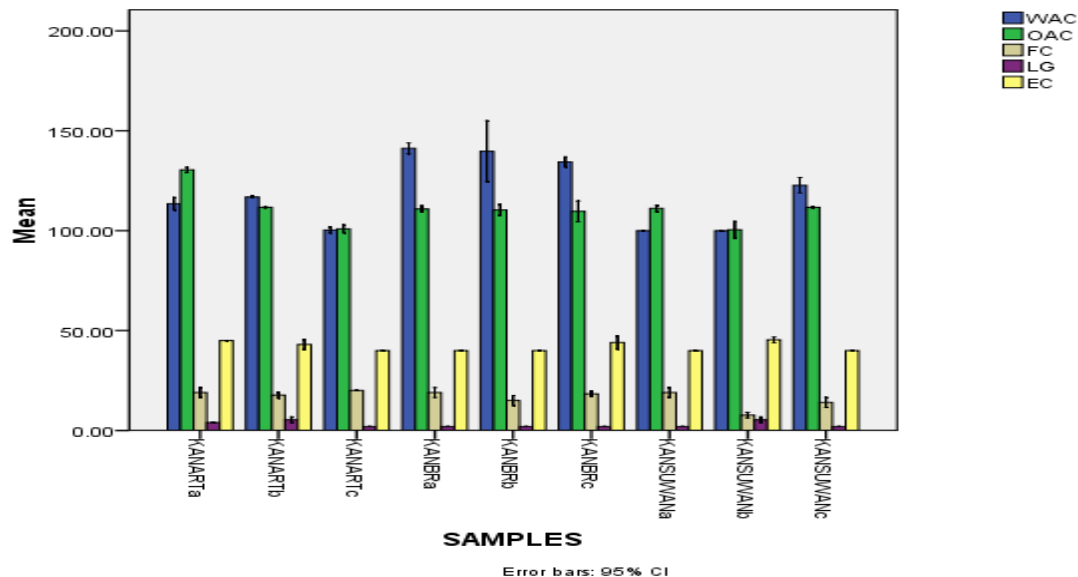


Figure 8: Functional properties of kango made by mixing different ratios kidney beans and alligator pepper with three maize varieties. Legends: MC=Moisture content; CP= crude protein; CHO= carbohydrate; AAARTa=ART720:260:20; AAARTb=ART826:157:16; AAARTc=ART759:236:5; AABRa=BR720:260:20; AABRb=BR826:157:16; AABRc=BR759:236:5; AASUWANa=SUWAN720:260:20; AASUWANb=SUWAN826:157:16; AASUWANc=SUWAN759:236:5.

DISCUSSIONS

The different ratios in which the different maize varieties were combined with kidney beans and alligator pepper significantly improved the nutritional content of the prepared snacks. This mixture caused an increase in the protein value of the snacks making them good alternatives for protein source. According to Olorunfemi *et al.*, (2006), one major nutritional challenge of the developing countries is how to combat kwashiorkor through the use of protein in snacks that are eaten by school children. Since aadun, kokoro and kango are snacks eaten by children and adults respectively in South West Nigeria, and then this new way of protein increase in these snacks cannot be over emphasized. Idowu *et al.*, (2012) stated that an average child in Primary school eats aadun at least twice a day. Since protein is an essential food nutrient, the production of aadun using SUWAN and ART in ratios 720:260:20 and 759:236:5 will give the highest protein value of 20.06 ± 0.04 and 19.91 ± 0.02 respectively when one gramme of the snack is consumed by a child for adequate form of it. The presence of phenol which is a hydroxyl benzene anti-nutrient according to Stedman's Medical Dictionary (2000) and Counous, (2000), is a good agent that can help in lowering cholesterol. The use of kidney beans are very high in fiber content prevents blood sugar levels from rising too rapidly after a meal. Phenol, according to Oladunmoye, (2007) is escharotic in the concentrated form and neurolytic in 3-4% solution and may help to eliminate invading microorganisms that may cause stomach disease and since this is present in alligator pepper, it may also help fight microbial infections in man. The results obtained on the increase in protein level of these snacks is similar to the results obtained by Counous, (2000) who observed that whey protein concentrates (WPC) and glutathione modulation can be used in cancer treatment. According to Dan *et al.*, (2004) and Dutta, (2004), alligator pepper when added to snacks can be eaten to help in treatment of ulcer. The functional properties such as water holding capacity, oil holding capacity and foaming capacity increased in these snacks, an indication that their shelf life has equally been increased. According to Oshodi *et al.*, (2012), increase in water activity of food substances, especially snacks will mean that they have longer shelf life than those with lower water activity. The results obtained in this work has shown that the mixing of maize variety in different ratios with alligator pepper and kidney beans can therefore be used to improve the nutritional content of aadun, kokoro and kango significantly.

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