NUTRITIONAL AND SENSORY EVALUATION OF DUMPLING (*AMALA*) PRODUCED FROM PLANTAIN - SOY FLOUR BLENDS

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ABSTRACT
The study investigated the formulation of blends comprising of Plantain flour and Soy flour. It also evaluated the Proximate, Mineral compositions and Sensory properties of the blends and the dumpling (Amala) with a view to increasing the protein quality and quantity of the blends and dumpling (Amala) for staple food production. Unripe Plantain and Soy bean was obtained from New market, Ile-Ife, Osun State. The unripe plantains were cut into smaller sizes and dried in cabinet drier at 40^0 for 24hrs while the Soy bean were sorted and soaked and sun dried for 48hrs before milling to powder form. Both the Unripe plantain flour and soy flour were mixed into different proportions of ratio 90:10, 80:20,70:30 and 100 was used as control for both the flour and dumpling (Amala). The samples were evaluated for Proximate Analysis (Moisture, Ash, Crude Fat, Crude Protein, Crude Fibre and Carbohydrates), Mineral Analysis (Sodium, Potassium, Calcium, Zinc, Iron, Magnesium and Phosphorus) using standard methods. Sensory Attributes were also evaluated (by reconstituting the flour to make dumpling (Amala) using a seven point hedonic scale. All data obtained were subjected to appropriate statistical analysis. The results shows that Moisture ranges from 10.42% to 11.25% and 76.87% to 79.01%, Ash ranges from 2.44% to 2.15% and 0.30 to 0.67%, Fibre ranges from 0.55% to 1.30% and 0.02% to 0.10% Fat ranges from 0.32% to 4.09% and 0.04% to 0.13%, Protein ranges from 3.56% to14.09% and 1.53% to 2.05%, Carbohydrate ranges from 67.91% to 81.43% and 18.12% to 21.18% for flour and dumpling (Amala) respectively. Also Calcium ranges from 438.76% to 579.86% and 31.07% to 47.54%, Sodium ranges from 320.89% to 365.83% and 16.44% to 26.07%, Iron ranges from 14.97% to 18.97% and 1.64% to 1.98%, Potassium ranges from 218.06% to 276.10% and 30.75% to 39.07% and Magnesium ranges from 380.83% to 403.13% and 47.96% to 52.10% for flour and dumpling (Amala) respectively. The sensory attributes were evaluated in terms of Colour, Taste, Texture, Extensibility, Aroma, Mouldability and all samples were generally accepted (6.13 to 6.43).

Key words: Nutritional Composition, Sensory Evaluation, Dumpling, Plantain, Soy, Flour, Blends

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1. INTRODUCTION

According to FAO (2009), over 2.3 million metric tons of plantains are produced in Nigeria annually. However, about 35 to 60% post-harvest losses had been reported and attributed to lack of storage facilities and inappropriate technologies for food processing. Plantain is a popular dietary staple due to its versatility and good nutritional value. It is starchy, less sweet variety of banana that can be used either ripe or unripe. They are invaluable source of carbohydrate, comparable in nutritive value to yam or potato and are useful as a variant on the usual staple foods. It is consumed mainly in Nigeria as snacks in form of chips, dodo ikire etc.

In Nigeria and many African countries, plantains *(Musa paradisiaca)* are used as an inexpensive source of calories (Akubor *et al*., 2003). It is an important starchy staple and commercial crop in the West and Central Africa where fifty percent of the world's plantain crop is produced (Swennen, 1990). Unripe plantain is traditionally processed into flour in Nigeria and in other west and central African countries (Ukhum and Ukpebor, 2000 ; Ogazi *et al*.,1996). The flour produced is mixed with boiling water to prepare an elastic pastry ("amala" in Nigeria and foufou or fufu in Cameroon) which is eaten with various sauces. It is however gradually finding applications in weaning food formulation and composite flour preparations (Olaoye *et al*., 2006; Otegbayo *et al*., 2002; Mepba *et al.*, 2007; Ogazi *et al.*, 1996).

Soybean (*Glycine max*) is a cheap source of quality protein that is superior to all other plant foods because it has good balance of the essential amino acids and it contains a plantain (Ogazi *et al*., 1996). In addition to its rich protein (35–45%) and oil content (15–25%), soybean seed also contains about 33% carbohydrates, up to 16.6% of which are soluble sugars (Hou *et al*. 2009). Although soybean is rich in nutrients but its acceptability as raw food is limited due to the presence of antinutritional factors such as trypsin inhibitor, phytic acid and phenols (Liener, 1981). The soy protein has a very significant amino acid composition as it complements to that of cereal. The protein content of soybean is about two times of other legumes, four times of wheat, six times rice grain and twelve times that of milk. This is why it is being referred to as "the protein hope of the future" (Islam *et al.,* 2007). Soybeans have great potential in overcoming protein – energy malnutrition (P.E.M). Although, it is not indigenous to Africa, it has received tremendous popularity as cheap protein source in Nigeria.

Dumpling is a type of food which is widely consumed in Nigeria. It can be prepared using different starchy foods like wheat, cassava, yam, rice, etc. which are often taken with soup (Ihekoronye and Ngoddy, 1985). Proteinous foods are usually expensive and beyond the reach of most of the populace. This scarcity has greater impact on children, whose physical and mental development requires nutritionally balanced diets. Malnutrition leads to wasting, stunting and underweight (Mahan & Escott-Stump, 2002). Soybean (*Glycine max*) has been recognized as an ideal legume for meeting protein and energy requirement of man. Hence, nutrient - dense composite flour will be a with soy flour (cassava -soy flour), fermented yam flour supplemented with soy flour (yam -soy mixture) for "amala", a popular west African food (Akingbala *et al*., 1995). Ogazi et al. (1996) reported that feeding mainly on plantain cannot meet up with the daily protein requirement, therefore protein supplementation is essential

The protein-calories sources of vegetable origin have been proposed as a solution to this problem. The reconstituted paste from plantain reasonable amount of methionine lacking in plantain, making it a good supplement for developed from plantain flour and soybean flour into different blends which can be reconstituted into dumpling also known as swallow or morsel. The objectives of this work are to; process and produce plantain flour and soy flour; produce and process blends of plantain flour and soy flour using different proportions, produce dumpling '*Amala*" from plantain-soy flour blends of different proportions, evaluate the nutritional composition of blends of plantain flour and soy flour, evaluate the nutritional composition of dumpling "Amala" made from Plantain- Soy flour blends and determine the sensory characteristics of dumpling "Amala" made from blends of plantain flour and soy flour.

There is an increase in the rate of malnutrition, especially PEM (Protein Energy Malnutrition) in Nigeria which was confirmed by United Nation Children's Fund (UNICEF) in which the estimate of 1.1 million children are threatened with severe acute malnutrition in this country (FAO, 2009). The nutritional problem has persisted in Nigeria because most of the foods consumed in this country as staple foods are full of carbohydrate. This has caused increase in mortality and morbidity of growing children and older people who are nutritionally susceptible.

In recent years, research efforts in the developing countries have focused on the improvement of protein quality of cereals and tuber Crops. Various degrees of success has been reported in this area such as fortification of maize with soybean (soy-ogi), cassav

flour is gaining importance among the people in Nigeria therefore fortifying it with soybean has the potential of providing a relatively cheap protein source for low income earners in the country (Abioye *et. al*, 2011). However incorporating soy-flour into plantain flour may change the physicochemical properties of the flour as well as acceptability of the paste (Amala). Hence this work is aimed at determining the effect of soy flour additions on the chemical and physic -chemical properties

of plantain flour for probable uses in industries and also to evaluate the consumer acceptability of the reconstituted thick paste (a common food in Nigeria). Therefore, to meet the nutritional need of an individual, there is a need to fortify it.
Consumers' awareness of the need to eat high quality and healthy food known as functional foods, that is, foods which contain ingredients that provide additional health benefits beyond the basic nutritional requirement is increasing (Ndife and Abbo, 2009). Therefore a reasonable and nutrient - dense dumpling can be produced using unripe plantain fortified with Soy flour making the products of this work a great significance in solving the problem of malnutrition in this country because, the fortification of plantain flour with soybean flour will improve the nutritional quality of the flour being used for dumpling.

2. MATERIALS AND METHODS

Materials

Procurement of Materials

The materials i.e. the matured dried unripe plantain (*musa paradisiaca)* and soybean seeds (*Glycine max*) were purchased at New Ife market, Ile-Ife, Osun state.
The equipment used during the processing of plantain - soy flour and its blends include:
Milling machine, Hobart mixer, Cabinet dryer, Tray, Bowl, Sieve, knife

Preparation of materials

Unripe plantain was traditionally processed into flour using the methods described by Akubo and Ukwuru, (2003). This method was done by peeling the unripe plantain, cutting the pulp into small round pieces and drying them for 24hrs using the cabinet dryer. The dried pulp was then grounded with milling machine, sieved and stored. The flour produced was mixed with boiling water to prepare an elastic dumpling (amala in Nigeria) which was eaten with sauces.
Soybean flour was processed by modifying the method described by Fabiyi, (2006). Soybeans were sorted to remove particles, defective seeds and stones. The seeds were boiled for 25minutes so as to inactivate the trypsin inhibitors. The soybean seeds were washed, de-hulled and sun dried for 48hrs for proper heat treatment and high retention of protein (Ojo, 2014). The dried samples were milled to fine powder and sieved. The flour was packaged in a Ziploc bag and stored prior blending.

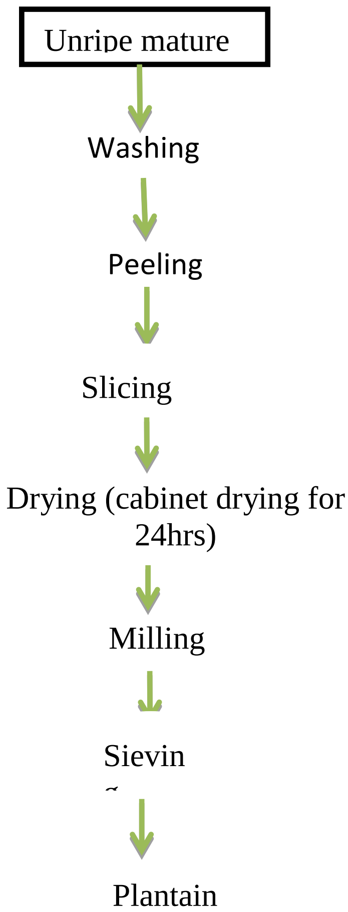

Figure 1 Flow diagram of preparation of plantain flour (Source: Ojo, 2014.)

Formulation of Plantain – Soy Flour blends

The plantain and soy bean flours were mixed at different proportion (90:10; 80:20; 70:30 and 100:0) using Hobart mixer
For blend 90:10, 900g of the plantain flour were measured using a measuring scale into an uncontaminated dried bowl. Thereafter, 100g of soy flour was measured as well into another uncontaminated dried bowl. The two flours were poured into a Hobart mixer and the flour was mixed in a Hobart mixer at speed 1. The mixing was done for 10 minutes in other to ensure homogeneity of the flours.

The procedure was employed in preparation of the remaining blends i.e. for 80:20 (800g of plantain and 200g of soy flour were mixed together) using the same speed in Hobart mixer in 10 minutes); For 70:30 (700g of plantain flour were mixed together with 300g of soy flour); But, for 100:0 which is the control, 1000g (1kg) of plantain was used in order to determine the improvement in nutrients of the main flour in thisresearch.

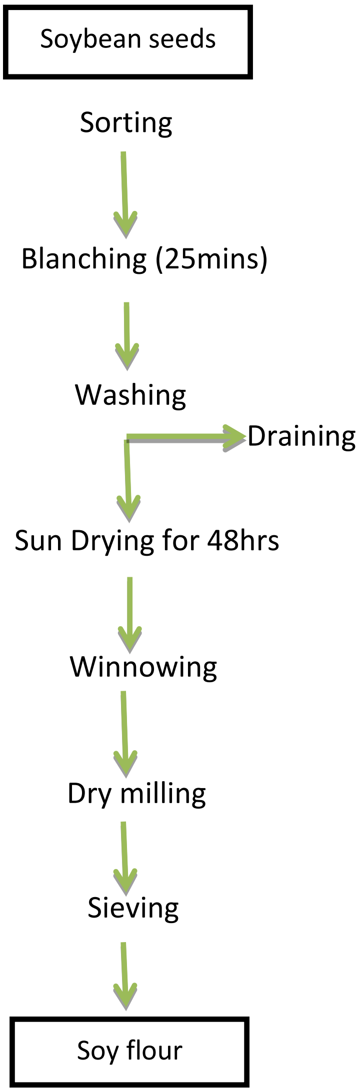

Figure 2: Flow chart for the preparation of soy flour
Source: Fabiyi, 2006(Modified)

TABLE 1: Distribution of Plantain Flour and Soy Flour Blends

FORMULATION	CODE	WEIGHT OF PLANTAIN FLOUR (g)	WEIGHT OF OFSOY FLOUR (g)
100:0	**A**	**1000**	**0**
90:10	**B**	**900**	**100**
80:20	**C**	**800**	**200**
70:30	**D**	**700**	**300**

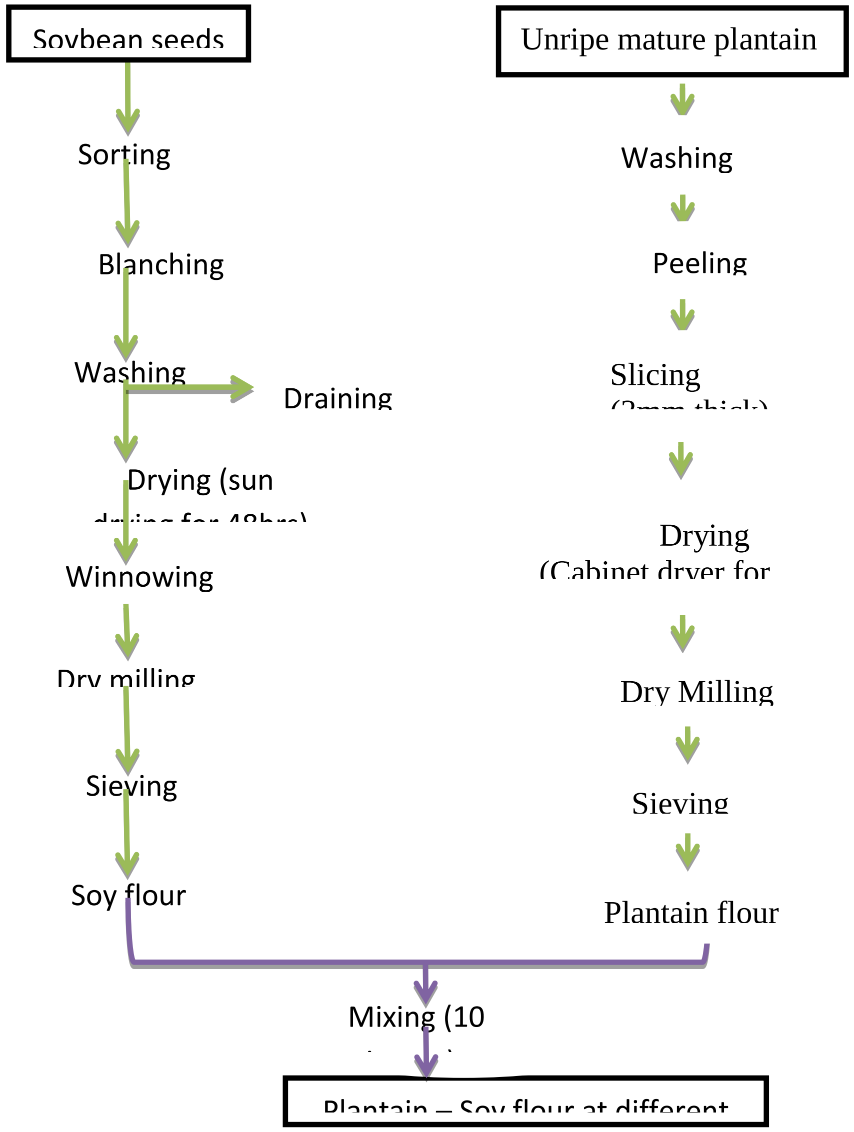

Figure 3: Flow chart for the processing of plantain – soy flour.

Proximate Analysis

The proximate analysis was carried out in triplicate for each sample and mean was calculated for each as follows:

Moisture Content Determination

Moisture content was determined by the standard AOAC (2000) official method by drying 1 g (W_1) of the sample in a hot air-oven (Uniscope, SM9053, England) at 105 ± 1 ºC until constant weight (W_2) was obtained, the samples were removed from the oven, cooled in a dessicator and weighed. The results were expressed as percentage of dry matter as shown in the equation below:

$$M.C = \frac{(W_1-W_2)}{W_1} \times 100$$

where,

M.C= Moisture content (%)

$w_1 = mass\ of\ flour\ before\ drying(g),$

$W_2 = mass\ of\ flour\ after\ drying\ (g)$

Determination of Ash Content

Ash content was determined by the official AOAC (2000) method using muffle furnace (Carbolite AAF1100, United Kingdom). Two grams (W_3) of the sample was weighed into already weighed (W_2) ashing crucible and placed in the muffle furnace chambers at 700 ºC until the samples turned into ashes within 3 h. The crucible was removed, cooled in a dessicator and weighed (W_1). Ash content was expressed as the percentage of the weight of the original sample as shown in equation below;

$$Ac = \left(\frac{W_1-W_2}{W_3}\right) \times 100$$

where,

Ac= Ash content (%)

$W_1 = mass\ of\ crucible + ash\ (g)$

$W_2 = mass\ of\ empty\ crucible\ \ (g)$

$W_3 = mass\ of\ sample\ (g)$

$W_3 = weight\ of\ sample$

Crude Fibre

Crude fibre was determined as described by AOAC (2000) using 2 g (W_3) of sample. About 200 ml of 1.25 % (*v/v*) sulphuric acid was added and the flask was placed on a hot plate and boiled for 30 min. The content was filtered using filter paper (Whatman No.1) and the residue on the filter paper was washed with 50-70 ml distilled water. The washed residue was transferred back into the flask and about 200 ml 1.25 % (w/v) NaOH was added and boiled for 30 min. The content was then filtered as described earlier and the residue obtained was washed with distilled water and then filtered again using filter paper (Whatman No.1). The residue was then transferred to an ashing dish and dried at 130 ºC for 2hr, cooled in a desiccator and weighed (W_1). This was then ashed at 550 ºC inside the muffle furnace chamber (Carbolite AAF1100, United Kingdom) for 30 min, cooled and reweighed (W_2). The ash obtained was subtracted from the residue and the difference expressed as percentage of the starting material as shown in equation below;

$$Cf = \left(\frac{W_1 - W_2}{W_3}\right) \times 100$$

where,

Cf = *Crude fibre* (%)

$W_1 = mass\ of\ crucible\ with\ the\ dried\ residue\ (g)$

$W_2 = mass\ of\ crucible\ with\ the\ ash\ (g)$

$W_3 = mass\ of\ sample(g)$

Crude Fat

Crude fat was determined by the AOAC (2000) method using soxhlet apparatus (Sunbim, India). Approximately 5 grams (W_3) of the ground sample was placed into a thimble which was placed inside soxhlet extractor and n-hexane was poured into a pre-weighed round bottom flask (W_2), used to extract the oil from the sample. The extraction was carried out for about 6 hours. The solvent was removed from the extracted oil by distillation. The oil in the flask was further dried in a hot-air oven at 90 ºC for 30 minutes to remove residual organic solvent and moisture. This was cooled in a desiccator and flask and its content weighed (W_1). The quantity of oil obtained was expressed as percentage of the original sample used using equation (iii) given below:

$$Ether\ extract\ (\%) = \frac{W_1-W_2}{W_3} \times 100$$

$W_1\ = weight\ of\ flask + oil$

$W_2 = weight\ of\ empty\ flask$

Crude Protein

The total protein content was determined using the Kjeldahl method (AOAC, 2000). Ground sample (0.20 g) was weighed into a Kjeldahl flask. Ten milliliter of concentrated sulphuric acid was added followed by one Kjeltec tablet (Kjeltec-Auto 1030 Analyzer, USA). The mixture was be digested on heating racket to obtain a clear solution. The digestate was cooled, and made up to 75ml with distilled water and transferred onto kjeldahl distillation set up followed by 50 ml of 40 % sodium hydroxide solution, the ammonia formed in the mixture was subsequently distilled into 25 ml, 2 % boric acid solution containing 0.5 ml of the mixture of 100 ml of bromocresol green solution (prepared by dissolving 100 mg of bromocresol green in 100 ml of methanol) and 70 ml of methyl red solution (prepared by dissolving 100 mg of methyl red in 100 ml methanol) indicators. The distillate collected was then titrated with 0.05M HCl. Blank determination was carried out by excluding the sample from the above procedure

$$Cp = \frac{1.401 \times M \times F\ (ml\ titrant - ml\ blank)}{sample\ weight}$$

where,

Cp= Crude protein (%)

$M = Molarity\ of\ acid\ used = 0.05\ (\frac{mol}{dm}$

$F = kjeldahl\ factor = 6.25$ (-)

Determination of Carbohydrate

Carbohydrate was expressed as a percentage of the difference between the addition of other proximate chemical components and 100% as shown in equation below:

Carbohydrate=100-(protein + crude fat + ash + fibre + moisture)

Minerals Determination

The analyses for essential mineral elements were investigated using atomic absorption spectrophotometric method. 0.5g of the sample was weighed into a digestion flask and 10 ml of nitric acid and 10 ml of HCl were added. The mixture was digested for 10 min. The digested mixture was filtered using No 1 whatman filter paper. The filtrate was made up to 50ml with distilled water. An aliquot was transferred to the Auto-analyser for total phosphorus analysis at 420nm. The left over digest was used to determine the other elements (calcium, sodium, magnesium) using the Atomic Absorption Spectrophotometer (Perkin Elmer, model 402) while sodium and potassium were determined using flame photometry.

Sensory Evaluation

Sensory evaluation were carried out on the reconstituted flour (dumpling) using a seven point hedonic scale. Thirty semi-trained panelists were used. The panelists were asked to indicate their preference for the samples in terms of colour, taste, texture, flavour, extensibility, aroma and overall acceptability with 7 been the highest which is Like extremely, 6 is Like very much; 5- like moderately; 4- Neither liked nor Disliked; 3- Dislike moderately; 2- Dislike very much and 1 is disliked extremely.

Statistical Analysis

All experiments were conducted in triplicate. All data obtained were subjected to statistical analysis of variance (ANOVA) using SPSS version 24.0. Mean values were compared using Turkey's Test to find out any statistical difference.

3. RESULTS AND DISCUSSION

Proximate Composition of Plantain-Soy Flour

The results of the mean proximate composition of Plantain-Soy flour blends are shown on Table 2. The moisture contents ranges from 10.42% to 11.25% with the PF100% having the highest amount and PSF 70:30 having the least amount there are significant differences ($p \geq 0.05$) between the moisture contents. The protein and fat contents increased with increasing level of soy flour substitution indicating nutrients enhancement with soy flour substitution ranging from 3.56% and 0.32% (0% soy flour substitution) to 14.09% and 4.09% (30% soy flour substitution) respectively there are significant differences ($p \geq 0.05$) between the fat and protein contents of all the samples. This could obviously be due to the significant quantity of protein in soy bean seeds (Olaoye *et al.,* 2006). This high

TABLE 2: Mean Distribution of the Proximate Composition of Plantain-Soy Flour

Sample	Moisture	Ash	Fibre	Fat	Protein	Carbohydrate
100% PF	11.25±0.03[a]	2.15±0.01[c]	1.30±0.02[a]	0.32±0.01[d]	3.56±0.02[d]	81.43±0.04[a]
90:10PSF	11.08±0.04[b]	2.20±0.02[c]	1.12±0.01[b]	1.42±0.01[c]	6.75±0.02[c]	77.43±0.07[b]
80:20PSF	10.89±0.03[c]	2.28±0.01[b]	1.07±0.01[b]	3.73±0.01[b]	9.75±0.01[b]	72.28±0.03[c]
70:30PSF	10.42±0.04[d]	2.44±0.01[a]	0.55±0.73[c]	4.09±0.03[a]	14.09±0.04[a]	67.91±0.04[d]
LSD(P≤ 0.05)	0.01	0.01	0.01	0.01	0.01	0.01

± Standard Deviation (n=3) Mean in the same column with the same superscript are not significantly different at p≤ 0.05
KEY: PF (Plantain Flour), PSF (Plantain-Soy Flour)

TABLE 3: Mean Distribution of the Proximate Composition of Plantain-Soy *Amala*

Sample	Moisture	Ash	Fibre	Fat	Protein	Carbohydrate
90:10PSA	76.87±0.16[b]	0.30±0.02[b]	0.10±0.02[a]	0.04±0.01[b]	1.53±0.02[c]	21.18±0.20[a]
80:20PSA	78.76±0.31[a]	0.31±0.01[b]	0.08±0.01[ab]	0.06±0.01[b]	1.88±0.01[b]	18.92±0.29[b]
70:30PSA	79.01±0.03[a]	0.67±0.03[a]	0.02±0.01[b]	0.13±0.01[a]	2.05±0.03[a]	18.12±0.08[b]
LSD(P≤ 0.05)	0.01	0.01	0.01	0.01	0.01	0.01

± Standard Deviation (n=3) Mean in the same column with the same superscript are not significantly different at p≤ 0.05
KEY: PSA (Plantain-Soy *Amala*)

protein content in plantain soy mixes will be of nutritional importance in most developing countries, Nigeria inclusive where many people can hardly afford high proteinous foods because of the costs. The increase in protein content is similar to some other research study in which soy flour was used in supplementation, such as in soy- maize for "agidi"; wheat-soy plantain in bread (Olaoye *et al*.,2006). The Ash, Iron, and Fibre contents assumed the same trend as the protein content also due to the same reason while carbohydrate decreased with increasing level of soy flour substitution supporting claims of Akpapunam (1997) with the Ash content ranging from 2.44% to 2.15%, there are no significant differences (p≤ 0.05) in sample 100PF and 90:10PSF. Fibre content ranges from 0.55% to 1.30% there are no significant differences (p≤ 0.05) in sample 90:10PSF and 80:20PS.

Proximate Composition of Plantain-Soy *Amala*

The proximate composition of the Plantain Soy *Amala* blends is shown above in Table 3. The moisture content ranges from 76.87% to 79.01% there are no significant difference (P<0.05) between sample 80:20 PSA and sample 70:30PSA. Ash content determines the level of mineral element present in the dumpling. The ash content ranges from 0.30%-0.67% with sample with the highest soy flour substitution with the highest ash content, there is no significant difference (P<0.05) between sample 90:10PSA and sample 80:20PSA. . The ash content of a food material could be used as an index of mineral constituents of the food (Sanni *et al*, 2008). Legumes have been reported to be good source of ash.

Result further showed that the crude fat increases with increasing soybean. There is no significant difference (P<0.05) between sample 90:10PSA and sample 80:20PSA. The crude fat ranges from 0.04% to 0.13% with sample 70:30PSA having highest fat content and sample 90:10 having lowest fat content. The dumpling with highest ratio of soy flour has the highest crude fat. However, soybeans have been reported to be a good source of fat (Ojo, 2014). The crude protein is the highest in the sample whose soy flour is highest ranging from 1.53% to 2.05%. There are significant difference among the samples (P> 0.05).

The crude fibre is the organic residue of vegetable origin. There is significant difference (P>0.05) among the samples. The crude fibre ranges from 0.02% to 0.10%.

However, the carbohydrate content of the sample with least soy flour has the highest amount of carbohydrate, as the carbohydrate decreases as the ratio of soy flour increase. This could be a desirable attribute for weight watchers and diabetic patients who require less carbon.

Mineral Composition of Plantain-Soy Flour

The result of the mineral analysis of Plantain soy flour is shown in Table 4. The Calcium content of the sample ranges from 438.76% to 520.86%, there are significant difference (P>0.05) between the samples 100% PF and sample 90:10PSF, 80:20PSF but there is no significant difference (P<0.05) among sample 100%PF and 70:30PSF.

The sodium content of the samples ranges from 320.89% to 365.75%, there is no significant difference (p<0.05) between sample 80:20PSF and 70:30PSF. The amount of sodium is below the RDA requirement and could be recommended for hypertensive patients.

The result for Zinc ranges from 1.67% to 2.15% for100%PSF and 70:30PSF respectively. There are significant differences (P>0.05) among the samples. The result for Iron ranges from 14.97% to 18.97% for 100PSF and 70:30PSF respectively. There are no significant difference (P<0.05) among the samples 90:10PSF and 80:20PSF.

The result further shows the value for Potassium ranges from 1870.05% to 1965.06% for 100PSF and 70:30PSF respectively. There are significant difference (P>0.05) among the samples. Phosphorus content of Samples 100PSF and 70:30PSF ranges from 218.06% to 276.10% respectively. There are significant difference (P>0.05) among the samples.

Magnesium content ranges from 380.83% to 403.12% for 100PSF and 70:30PSF respectively. Results shows that magnesium content increase with increase in soy flour substitution and there are significant difference (P>0.05) among the samples.

The result for Mineral composition of the composite flour presented in Table 4 indicates that the Iron, Calcium, Zinc, Sodium, Phosphorus, Magnesium and Potassium increases with increase in soy flour. High Calcium and Iron content of both Plantain Soy Flour shows that it would be nutritionally beneficial for both children and elderly people who requires high Calcium and Iron intake for strong bone, blood formation and body development. The presence of Zinc in the composite flour indicates that composite flour will be good for pregnant women. The relatively high phosphorus content of the composite flour is an indication that the flour products will help in the formation of teeth and bones in children and their proper development.

Mineral Composition of Plantain-Soy *Amala*

The result of the mineral analysis of Plantain soy Amala is shown in Table 5. The Calcium content of the sample ranges from 31.07% to 47.54%, there are significant difference (P> 0.05) between the samples. The result for calcium shows that the calcium level increased as the soy flour increases in the difference level. The studies suggest that food should be fortified with soy flour to increase the iron level of food thereby purifying the prevalent of aneamia among women also calcium combined with phosphorus is a vital component of the bones and teeth giving them strength and hardness (Otitiola, 2008).

The sodium content of the samples ranges from 16.44% to 26.07%, there are significant difference (P> 0.05) between the samples. The amount of sodium is below the RDA requirement and could be recommended for hypertensive patients. The result for Zinc ranges from 0.07% to 0.74%. There are significant difference (P>0.05) among the samples.

The result for Iron ranges from 1.64% to 1.98% for 100PSA and 70:30PSA respectively. There are significant difference (P>0.05) among the samples. The Iron content increase with increasing soy flour substitution.

The result further shows the value for Potassium ranges from 65.10% to 82.08% for 90:10PSA and 70:30PSA respectively. There are significant difference (P>0.05) among the samples. Phosphorus content of Samples 90:10PSA and 70:30PSA ranges from 30.75% to 39.07% respectively. There are significant difference (P>0.05) among the samples.

Magnesium content ranges from 49.08% to 52.10% for 90:10PSA and 70:30PSa respectively. Results shows that magnesium content increase with increase in soy flour substitution and there are significant difference (P>0.05) among the samples.

TABLE 4: Mean Distribution of the Mineral Composition of Plantain-Soy Flour

Sample	Ca(mg/100 g)	Na(mg/100 g	Zn(mg/100 g)	Fe(mg/100 g)	K(mg/100 g)	P(mg/100 g)	Mg(mg/100 g)
100%PF	438.76±0.01[a]	320.89±0.02[c]	1.67±0.03[c]	14.97±0.01[c]	1870.05±0.01[d]	218.06±0.03[d]	380.83±0.10[d]
9:10PSF	449.10±0.01[c]	321.93±0.08[b]	1.75±0.01[c]	17.89±0.03[b]	1886.56±0.70[c]	228.10±0.01[c]	391.95±0.09[c]
80:20PSF	520.44±0.02[b]	365.82±0.07[a]	2.06±0.02[b]	17.95±0.03[b]	1902.02±1.36[b]	229.10±0.02[b]	396.21±0.02[b]
70:30PSF	579.86±0.77[a]	365.75±0.02[a]	2.15±0.02[a]	18.97±0.02[a]	1965.06±0.03[a]	276.10±0.01[a]	403.12±0.06[a]
LSD P≤ 0.05	0.01	0.01	0.01	0.01	0.01	0.01	0.01

± Standard Deviation (n=3)
Mean in the same column with the same superscript are not significantly different at p≤ 0.05
KEY: PF (Plantain Flour); PSF (Plantain-Soy Flour)

TABLE 5: Mean Distribution of the Mineral Composition of Plantain-Soy *Amala*

Sample	Ca(mg/100 g)	Na(mg/100 g	Zn(mg/100 g)	Fe(mg/100 g)	K(mg/100 g)	P(mg/100 g)	Mg(mg/100 g)
9:10PSA	31.07±0.04[C]	16.44±0.01[c]	0.07±0.01c	1.64±0.01[c]	65.10±0.01[c]	30.75±0.01[c]	47.96±0.01[c]
80:20PSA	42.94±0.07[b]	18.65±0.01[b]	0.68±0.01[b]	1.88±0.01[b]	69.10±0.01[b]	37.10±0.02[b]	49.08±0.03[b]
70:30PSA	47.54±0.02[a]	26.07±0.02[a]	0.74±0.01[c]	1.98±0.00[a]	82.08±0.01[a]	39.07±0.01[c]	52.10±0.04[a]
LSD P≤ 0.05	0.01	0.01	0.01	0.01	0.01	0.01	0.01

± Standard Deviation (n=3)
Mean in the same column with the same superscript are not significantly different at p≤ 0.05
KEY: PA (Plantain *Amala*); PSA (Plantain-Soy *Amala*)

TABLE 6: Mean Distribution of the Sensory Evaluation Properties of Plantain-Soy Amala.

Sample	Colour	Taste	Texture	Aroma	Mouldability	Extensibility	Overall acceptability
100% PA	4.40±1.83[b]	5.47±0.73[b]	5.07±1.14[b]	6.17±0.87[a]	5.47 ± 0.73[a]	5.43 ± 1.77[a]	6.43 ± 0.67[a]
90:10PSA	5.30±1.24[a]	5.57±0.64[a]	5.67±0.72[a]	5.47±0.93[b]	5.57 ± 0.19[a]	5.35 ± 0.80[a]	6.17 ± 0.59[b]
80:20PSA	5.20±1.47[a]	5.60±0.72[a]	5.43±0.89[a]	5.77±1.07[b]	5.80 ± 0.80[a]	5.67 ± 0.84[a]	6.50 ± 0.57[b]
70:30PSA	4.67±1.37[a]	5.70±0.53[a]	5.70±0.79[a]	5.77±1.07[b]	5.67 ± 0.71[b]	5.80 ± 1.24[a]	6.13 ± 1.10[c]

± Standard Deviation (n=3) Mean in the same column with the same superscript are not significantly different at p≤ 0.05
KEY: PA (Plantain Amala); PSA (Plantain-Soy Amala)

Sensory Evaluation of Plantain Soy *Amala*.

The result for the sensory evaluation of the plantain soy dumpling is shown in table 4.5 above. There were significant difference (P<0.05) in almost all the sensory attributes evaluated in all the samples.

Colour is an important quality of many foods and it influences the sense of judgment of consumers. Colour plays an important role in food because consumers are sometimes moved by what they see. The result of the colour obtained shows there were significant difference (P>0.05) among samples 100PSA and 90:10PSA, 80:20PSA, 70:30PSA.

Taste is also a very important quality attribute of food. The result showed there are significant difference (P>0.05) in the samples 100%PSA and 90:10PSA, 80:20PSA and 70:30PSA.

Texture is another quality attribute of food; it was characterized by smoothness, coarseness, grittiness etc. there were significant difference (P>0.05) between samples 100%PSA and 90:10PSA, 80:20PSA and 70:30PSA.

The Aroma is an important parameter of food. Result shows there are significant difference among the samples. The unfortified sample were rated best in all the tested parameters. This might be due to the beany taste of soybean used in the fortification (Adesokan *et al*, 2011).

The result for the Mouldability, Extensibility shows there are no significant difference (P<0.05) among the samples.

The result for overall acceptability shows that there were significant difference (P>0.05) in the samples. The control sample has the highest mean value followed by sample with 20% soy bean substitution. All samples were liked moderatel.

4. CONCLUSIONS

This study examined the difference in nutrient composition of plantain-soy flour and plantain-soy *Amala* using different substitution ratio (90:10, 80:20, 70:30 and 100 been the control) also it examined the potential of fortifying plantain flour with soy flour using different substitution ratio (90:10, 80:20 and 70:30).

The proximate analysis carried out indicates that the composite flour and the *Amala* can serve as a cheap source of protein to African populace which will help in dealing with problem of malnutrition especially Protein-Energy Malnutrition by supplying the nutrients needed with readily or locally available material (soy bean) at minimum cost.

The sensory evaluation shows that all the flours were liked very much after reconstituting them into dumpling. There were significant differences (P > 0.05) for all the samples in terms of colour, taste, texture, flavor, and overall acceptability. This is an indication that the sensory attributes of the food has impact on the consumers' acceptability of the enriched flour.

Further research can be carried out on this work based on the rheological properties and functional properties of the products.

5. REFERENCES

[1] Abioye. VF., Ade-Omowaye BIO., Babarinde G.O and Adesigbin MK. (2011) "*Chemical, Physico-Chemical and Sensory Properties of Soy-Plantain Flour*". African. Journal of Food Science, 5(4): 176 – 180.

[2] Adesokan I.A., Fawole A.O., Ekanola Y.A., Odejayi D.O. and Olanipekun O.K.(2011) "*Nutritional and Sensory properties of soybean fortified composite ogi- A Nigerian fermented cereal gruel*" African. Journal of Food Science. 45 1532-1536.

[3] Akingbala JO., Oguntimeyin GB, Sobande AO (1995) "*Physicochemical Properties and Acceptability of Yam Flour Substituted with Soy Flour*". Plant Foods Human Nutrition 48:73-80.

[4] Akubor PI, Adamolekun FO, Oba CO, Obari H, Abudu I.O (2003). "*Chemical composition and functional properties of cowpea and plantain flour blends for cookie production*", 58(3): 1-9.

[5] Akubor, PI and Ukwuru MU 2003. "*Functional properties of Soy flour and Plantain flour blends*". Plants Food. Human. Nutrition, 58: 1-12.

[6] AOAC (2000). Official method 996.06 "*official methods of analysis of AOAC*" (17th ed.). Gaithersburg, Maryland, USA: AOAC International Press.

[7] A.O.A.C. 2001 – "*Official Method of Analysis–18th Ed*". Assoc. Official Analysis Chemist, Washington D.C.

[8] Akpapunam MA, Badifu GIO, Etokudo EP (1997) "*Production and quality characteristics of Nigerian "Agidi' supplemented with soy flour*". Food Science Technology Journal 34:143-145.

[9] Fabiyi E.F, (2006) "*Soy Processing, Utilization and benefits*" Pakistan Journal of Nutrition 5 (5): 453-457, 2006ISSN 1680-5194, Asian Network for Scientific Information, 2006.

[10] FAO (2009). Food and Agriculture Organization of the United Nations. Joint Meeting of the Fourth Session of the Sub-group on Bananas and the Fifth Session of the Sub-Group on Tropical Fruits held in Rome, 9 – 11th December 2009.

[11] Hou A, Chen P, Alloatti J, Mozzoni L, Zhang B, Shi A. (2009) "*Genetic variability of seed sugar content in worldwide soybean germ plasma collections*". Crop Science; 49:903–912. 10.2135/cropsci2008.05.0256.

[12] IITA, Annual Report (2000) Project 2, Improving Plantain and Banana Based Systems, International Institute of Tropical Agriculture (IITA) Nigeria.

[13] Irfan Hashmi (2007): *Sensory evaluation techniques*, 18th Annual IAOM Conference (MEA District) Muscat-Oman, ppt.

[14] Islam, T., Chowdhury, A., Islam, M., Islam, S. (2007); "*Standardization of Bread Preparation from Soy Flour*", International Journal. Sustain Crop Production, vol. 2 No. 6: Pp. 15 – 20.

[15] Ihekoronye, AI., Ngoddy, PO. (1985); "*Integrated Food Science and Technology for The Tropics*", Macmillan Publisher Ltd., London and Basing Stoke: pp. 274 – 291.

[16] Liener I.E.(1981) "*Factors affecting the nutritional quality of soya products*". American Journal of Oil and Chemical Science. 1981;58:406–415. doi: 10.1007/BF02582390.

[17] Mahan, LK., Escott – Stump, S. (2002); "*Food, Nutrition and Diet Therapy 10th Edition*", W. B. Saunders Company: Pp. 143 – 147.

[18] Mepba DH, Eboh L, Nwaojigwa S.U (2007). "*Chemical Composition, Functional and Baking Properties of Wheat-Plantain Composite Flours*".

African. Journal of Food Agricultural Nutrition. Development, 7(1): 1-22.

[19] Ndife, J., Abbo, E. (2009); "*Functional Foods; Prospects and Challenges in Nigeria"*; Journal of. Science Technology, vol. 1 No. 5: Pp. 1 – 6.

[20] Ogazi PO, Oyewusi FA, Ozumba AU, Ogundipe H.O, Osifo BOA, Lukambi FA (1996). "*Development and Sensory Evaluation of Soya: A Soybean-Plantain Baby Food"*. ISHS ActaHortic., pg.540: International Conference on Banana and Plantain for Africa.

[21] Ojo. A, Abiodun O.A, J.O Odedeji, O.A Akintoyese, (2014) "*Effect of drying methods on proximate and physicochemical properties of fufu flour fortified with soybean",*

[22] Olaoye OA, Onilade AA, Idowu O.A (2006). "*Quality Characteristics of Bread Produced from Composite Flours of Wheat, Plantain and Soybeans"*. African. Journal of. Biotechnology, 5(11): 1102-1106.

[23] Otegbayo BO, Sobande FO, Aina JO (2002). "*Nutritional quality of soyplantain extruded snacks"*. Journal of Food Nutrition, 42(5): 473-474.

[24] Otitola O.C (2008). *Basics of Nutrition*. Grams Publishers Limited, Pg 112-113 .

[25] Sanni SA, Adebowale AA, Olayiwola IO, Maziya D (2008) Chemical composition of and pasting properties of iron fortified maize flour Journal of Food Agricultural Environment 6:172-175.

[26] Swenen, R. (1990) "*Plantain cultivation under West African conditions"*. A reference manual. IITA Ibadan, Nigeria.

[27] Ukhum, ME, Ukpebor, IE (1991) *Production of Instant Plantain Flour, Sensory Evaluation and Physiochemical Changes during Storage Food Chemistry* 42: 287 – 299.

[28] Winston, M. (February 21, 2006). *Soy Protein, Isoflavones and Cardiovascular Health*: An American Health Association Science Advisory for Professionals from the Nutrition Committee. 113(7): 1034-1044.