Proximate, Mineral and Sensory Properties of Plantain–Soy Flour Blends

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***Abstract*:-The study investigated the fortification of food product comprising of plantain flour and soy flour. It also evaluated the proximate, mineral composition and sensory characteristics of the blends with a view to increase the protein quantity and quality of the blends and use soy bean to substitute plantain flour. The blends comprising of plantain-soy flour were in the ratio (100:0, 95:5, 90:10, 85:15, 80:20). The samples were evaluated for proximate analysis (moisture content, crude fat, crude protein, ash content, crude fibre, carbohydrate and the kilocalories), mineral analysis (calcium, phosphorus and iron) using standard method. Sensory evaluation which includes (aroma, extensibility, colour, taste and overall acceptability), and sensory characteristics were evaluated (when reconstituted in hot water) using a 9 point hedonic scale. All data obtained were subjected to statistical analysis. The following result were obtained: moisture content, 11.92%-13.25%, ash content, 0.84%-1.28%, crude fat, 0.20%-0.58%, crude protein 4.50%-6.31%, crude fibre, 0.40%-0.72%, carbohydrate, 78.71% - 81.18%,kcal 343.47-345.41.The result of mineral analysis in (mg/100mg) were as follow: iron content 8.09-18.25, phosphorus content 132.98-170.80, calcium content 102.86 150.03. All the samples were moderate in terms of colour, taste, extensibility, aroma, and overall acceptability except the sample with 80:20 blends that have the highest overall acceptability. It was concluded that 80:20 blend has the highest overall acceptability because of high protein content.**

Keywords: **fortification, proximate analysis, Sensory evaluation, protein content**

I. INTRODUCTION

The problem of malnutrition is prevalent in Africa most especially in rural communities where starchy foods like wheat, cassava, plantain, yam, rice, etc., are consumed as staple food which has enhanced a deficiency in protein and thereby resulting in protein malnourishment [1]. However, with a key strength in large production of plantain as one of the major starchy crops grown in most Africa countries, it is crystal clear that the people in these regions consume mostly energy rich and protein deficient foods.

More so, 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 [2]. In view of this, there are ongoing research works targeted towards producing blends of protein-calorie food products through a process called dumpling.

Dumpling is a broad classification for a dish that consists of small pieces of dough (made from a variety of starch sources), often wrapped around a filling. It can be prepared using different starchy foods like wheat, plantain, cassava, yam, rice, etc., when processed into flours and reconstituted in hot water to form pastes which are often accompanied with soup [3]. A reasonable and nutrient - dense dumpling can be produced using unripe plantain and other root and tubers giving dumpling its pasting property and fortifying it with soy beans, a seed rich in protein.

Soybean (*Glycine max*) is a species of legume native to East Asia, widely grown for its edible bean which has numerous uses. It 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 contains a reasonable amount of methionine lacking in plantain, making it a good supplement for plantain [4].

This soybean can be used to produce soybean flour which can be used effectively in fortification of unripe plantain flour. It has been recognized as an ideal legume for meeting protein and energy requirement of man. The protein content is about two times that 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" [5]. It has great potential in overcoming protein – energy malnutrition (P.E.M). Although, not indigenous to Africa, it has received tremendous popularity as cheap protein source in some part of Africa [6].

Moreover, reconstituted paste from plantain 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. However incorporating soy-flour into plantain flour may change the physicochemical properties of the flour as well as the acceptability of the paste, hence this study aimed at producing an enriched flour from plantain flour (Musa paradisiaca) fortified with soybean flour. Proximate, mineral and sensory evaluations were also carried out on the blends.

II. MATERIALS AND METHODS

Matured unripe plantain (*Musa paradisiaca)* and soybean seeds (*Glycine max*) were purchased at Oje market, Ede, Osun state.

2.1 Preparation of plantain flour

Matured unripe plantain was washed, peeled and the pulp was sliced with a knife into small round pieces. It was then subjected to extreme heat at 70^0C for 24h using a cabinet dryer to avoid high moisture content so as to extend the shelf life of the product. It was brought out of the cabinet dryer immediately after 24h, milled and sieved. The plantain flour was then package in an air tight container and stored under a conducive environment.

2.2 Preparation of soybean flour

Soybean flour was processed by modifying the method described by [7]. Soybeans were sorted to remove particles, defective seeds and stones. The seeds were then boiled for 25mins so as to inactivate the trypsin inhibitors, and the other anti-nutritional component of the seed. The soybean seeds were drained and dried in cabinet dryer for 24h for proper heat treatment of anti-nutrients and to ensure adequate drying to avoid high moisture content which can result to spoilage. After drying the soybeans were dehulled by rubbing with both palm and were winnowed. The dried samples was milled to fine powder and sieved. The flour was packaged in an air tight container and stored under a conducive environment.

2.3 Preparation of plantain – soy flour

The plantain and soy bean flour was mixed at different proportion (100:00 (A), 95:5 (B); 90:10 (C); 85:15 (D); 80:20 (E)). The two flours were mixed in a Hobart mixer at speed 1 for 10 mins to ensure homogeneity of the flours. The control sample contains 100% plantain flour. The flow chart for the processing of plantain soy flour is shown in Fig.2.

The proximate composition of the plantain-soy flour was determined according to the standard methods of AOAC, 2001 [8]. The result was subjected to SPSS version 23 for further analysis arithmetically. Also, Sensory evaluation was carried out on the plantain soy flour and was reconstituted in hot water to form a 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 color, taste, texture, extensibility, aroma, and overall acceptability. Analysis of variance was performed on the data gathered, while the least significant test was done to detect a significant difference between the mean.

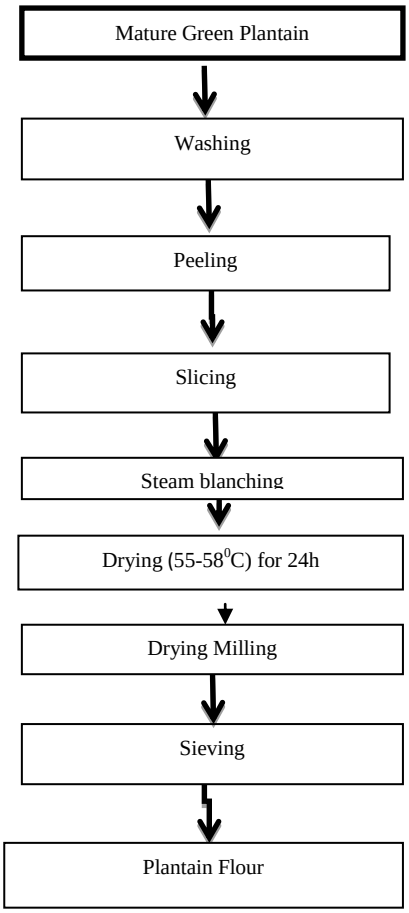

Fig. 1 Flow diagram of preparation of plantain flour. [9]

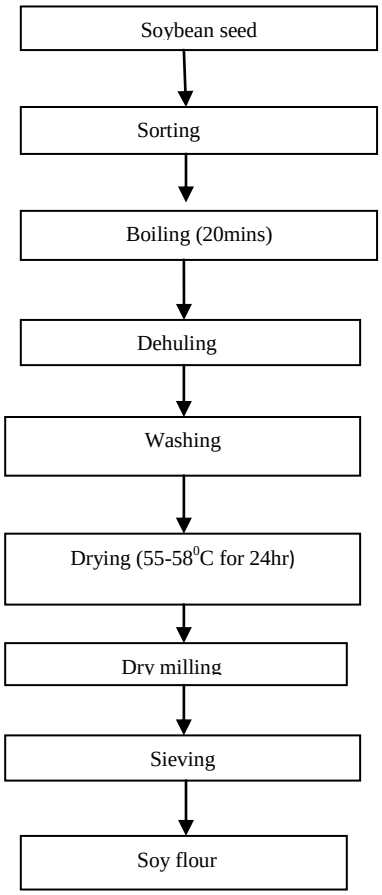

Fig 2. Flow chart for the preparation of soy flour. [7]

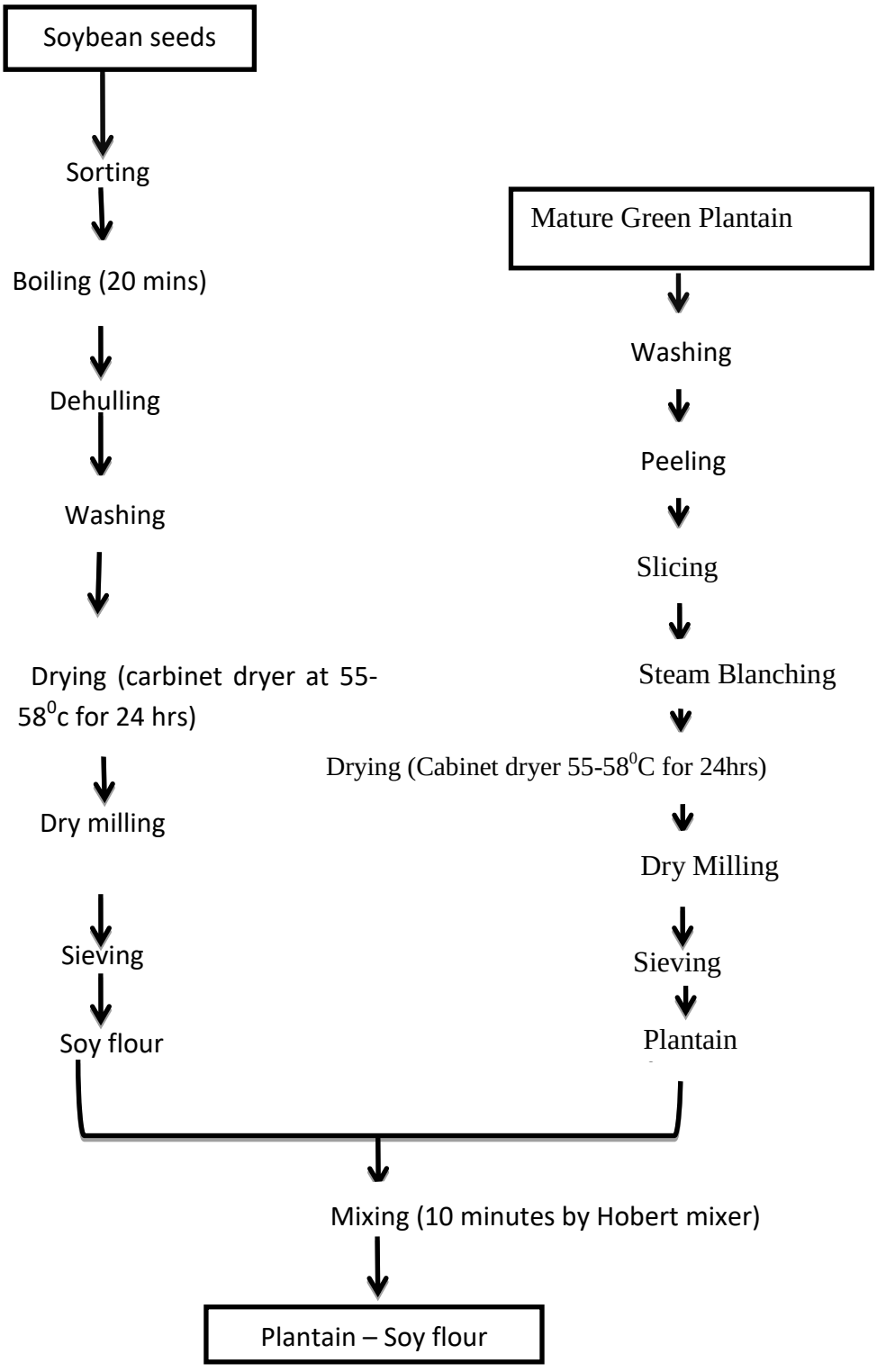

Fig. 3.Flow Chart for the Processing of Plantain – Soy Flour

III. RESULTS AND DISCUSSIONS

Table 1 Proximate composition (%) of Plantain- Soy flour

SAMPLES	MOISTURE (%)	FAT (%)	PROTEIN (%)	ASH (%)	FIBRE (%)	CHO (%)	KCAL (%)
A	12.88^{b}±0.08	0.20^{e}±0.02	4.0^{e}±0.02	0.08^{e}±0.01	0.40^{e}±0.01	81.18^{a}±0.08	344.49^{b}±0.42
B	13.25^{a} ±0.03	0.30^{d}±0.02	6.3^{d}±0.07	0.95^{d}±0.03	0.47^{d}±0.02	78.89^{b}±0.09	342.79^{c}±0.04
C	12.86^{b}±0.03	0.35^{a}±0.02	6.4^{c}±0.06	1.11^{c}±0.03	0.52^{c}±0.03	78.85^{b}±0.03	343.82^{a}±0.05
D	12.25^{c}±0.03	0.47^{b}±0.02	6.6^{b}±0.04	1.19^{b}±0.03	0.61^{b}±0.02	78.73^{c}±0.01	346.86^{a}±1.25
E	11.92^{d}±0.04	0.58^{a}±0.03	6.9^{a}±0.05	1.28^{a}±0.03	0.72^{a}±0.02	78.71^{c}±0.05	347.65^{a}±0.74

Data are presented as Mean ±Standard Deviation($n = 3$). Values with the same super script letter down the column are not significantly different at P>0.05.

TABLE 2 Mineral Concentrations (mg/100gm) of Plantain –Soy Flour

S/code	**Fe**	**P**	**Ca**
A	18.25^{a} ±0.05	$170{:}80^{a}$±0.53	150.03^{a}±0.40
B	15.98^{b}±1.00	162.08^{b}±1.00	142.78^{ab}±1.00
C	13.43^{c}±1.00	155.54^{c}±1.00	143.87^{ab}±1.00
D	9.43^{d}±1.00	143.22^{d}±1.15	112.09^{c}±1.00
E	8.09^{d}±1.00	132.98^{e}±1.00	102.86^{d}±1.00

Data are presented as Mean ±Standard Deviation($n = 3$). Values with the same super script letter down the column are not significantly different at P>0.05.

Table 3 Mean Sensory Evaluation Score of Plantain - Soy flour

S/code	Colour	Taste	Extensibility	Aroma	Overall Acceptability
A	$4.40^{e} \pm 1.83$	$5.47^{d} \pm 0.73$	$5.43^{c} \pm 1.77$	$6.17^{a} \pm 0.87$	$6.43^{b} \pm 0.67$
B	$4.53^{b} \pm 1.52$	$5.33^{c} \pm 1.34$	$5.53^{a} \pm 8.60$	$4.93^{ab} \pm 1.20$	$5.46^{a} \pm 1.07$
C	$4.40^{b} \pm 1.29$	$4.83^{ab} \pm 0.13$	$5.33^{a} \pm 9.58$	$5.10^{a} \pm 1.15$	$5.10^{a} \pm 1.12$
D	$4.10^{a} \pm 1.84$	$4.00^{a} \pm 1.80$	$4.23^{a} \pm 1.71$	$4.33^{a} \pm 1.74$	$4.76^{a} \pm 9.35$
E	$4.83^{a} \pm 1.74$	$5.20^{a} \pm 1.42$	$5.50^{a} \pm 1.39$	$5.10^{a} \pm 1.39$	$5.50^{a} \pm 1.10$

Data are presented as Mean ±Standard Deviation($n = 3$). Values with the same super script letter down the column are not significantly different at P>0.05.

3.1 Proximate Composition of Plantain Soy Flour

The proximate composition of plantain-soy flour was recorded in table 1. From the table, the protein values ranges between 4.0 to 6.9%. There was significance difference (P<0.05) in the protein constituent of the flour. This disagrees with earlier report by Balogun *et, al.* 2016 [10] whereby the result of proximate analysis on the protein constituent of the flour ranges between 6.56%-16.29% on maize flour. This could obviously be due to different substitution level in soy flour and significant quantity of protein in soy bean seeds [11].

Also, the result shows that the fat content value obtained from the samples ranges between 0.30% and 0.58% with sample A having the lowest while E having the highest fat percentage. The plantain flour with the highest percentage of soy flour have reasonable health benefit because, soybeans are rich in lipids of excellent qualities [11].

The analysis revealed that the fibre (undigestible polysaccharide) content of the samples ranged between 0.40% and 0.72% which shows that the sample has very low percentage of (indigestible polysaccharide), hence reducing indigestion. There was significant difference between the fibre values for each sample

More so, the ash content of the flour which shows the approximate values of all minerals present in flour ranges between 0.84% and 1.28% in which sample E is having the highest ash content there by indicating presence of minerals in large quantity. There is significant difference in the values obtained for the ash content.

Analysis of the proximate composition shows that the moisture content of the samples are greater than 10% and it ranged between 11.92% to 13.25% in which E has the lowest moisture content while A has the highest moisture content percentage. Therefore, the other samples with lower moisture can be stored longer than A.

Flour with high moisture content greater than 14.5% attract mould, bacteria and insect, all of which causes deterioration during storage [12]. The above result shows that the moisture content range is favorable for the flour because low moisture of the product prolongs shelf life of product.

The composition value for carbohydrate ranges from 78.71% and 81.18% in which A is having the highest carbohydrate content while E has the lowest carbohydrate content. Studies have shown that the total carbohydrate decreases with increasing soybean fortification [1].

The result shows that the value obtained as the total energy content in (Kcal) in the samples ranged between 342.79 and 347.65 where E is having the highest energy content while B has the lowest value.

3.2 Mineral Concentration of Fortified Plantain Soy Flour

From table 2 the Fe content of the samples ranges between 8.09-18.25(mg-100g).There was significant difference in the values. Sample A has the highest value of Fe while E has the least value of Fe. The Calcium content of the sample ranged from 102.86mg -150.03mg where A has the highest calcium content. There was significance difference in the values of the calcium content. Also, the phosphorus content of the sample ranges from 132.98mg -170.80mg where E is having the lowest phosphorus and A the highest. This may be due to the fact that soybean flour is no a good source of the macro nutrients.

3.3 Sensory Evaluation On Dumpling Produced From Plantain Flour

Colour is an important quality of many foods and it influences the sense of judgment of consumer. It plays an important role by making food product more appealing. The result of table 3 revealed that colour acceptability ranges between 4.10 and 4.83 in which E has the highest acceptability in terms of colour. There were no significant difference in the sample (P>0.05).Thus, the colour of the dumpling was generally accepted.

Taste is also a very important quality attribute of foods, the taste acceptability ranged from 4.00 and 5.47 where A has the overall acceptability in terms of taste. The result indicate that there was no significant difference (P>0.05) in taste of the samples.

Extensibility is one of the modifications of a food product, the extensibility of the food sample which is the ability of the substance to stretch ranged between 4.23 and 5.53 in which B has the highest acceptability in terms of extensibility and there were no significant difference between the extensibility of the samples.

Aroma stimulate the appetite and may cause satiety, it impact a pleasing or displeasing sensory experience to a consumer [13]. The aroma acceptability ranged from 4.33 to 6.17, A has the highest aroma acceptability, and there were no significant differences (P>0.05) between the samples.

In overall acceptability, dumpling made from sample E has the highest mean sensory score by the panelist and was rated best among the samples. The mean score values for the overall acceptability of the dumpling ranges between 4.76 and 6.43 indicating that the samples were all moderate, and there were no significant difference(P>0.05) in the mean sensory scores for all the samples

From the scores it was concluded that unripe plantain and soy bean can be incorporated up to 80:20 ratios in preparation of dumpling without affecting the sensory properties.

IV. CONCLUSION

This study examined the potential of fortifying plantain flour with soy flour using different substitution ratio **(100:00, 95:5, 90:10, 85:15, 80:20)** in making dumpling.

The flour with the highest substitution ratio has the highest nutrient composition. This implies that the fortification of plantain with soy flour will help in correcting nutritional diseases. Due to the high amount of iron content in plantain substituting with soy flour will be of great advantage to maintain a good nutritional status and soybean is a locally available food which can be obtained at a minimum cost.

The sensory properties displayed in the study indicates that dumpling made from all the samples were moderate in terms of colour, taste, texture, and extensibility while aroma and overall acceptability were liked very much.

The mineral content of the sample increases with increase in soy substitution indicating that food fortification is essential for the prevention and correction of nutritional diseases.

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