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PHYSICOCHEMICAL, PASTING AND SENSORY PROPERTIES OF YAM/PLANTAIN FLOUR ENRICHED WITH SOYBEAN FLOUR

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ABSTRACT

This study was aimed at producing a high nutritious food that will meet nutritional requirements of consumers. The blend of yam, Plantain, Soybean Flour were processed and the resulting flour were formulated at ratio 100:00, 95:5, 80:10:10 and 60:25:15 (Yam, Plantain and Soybean flour). The resulting products were subjected to proximate composition, physicochemical, pasting and sensory evaluation. The result show that addition of soybean and plantain increased the moisture, fibre, fat and protein contents of the blend by about 6.12%, 6.47%, 9.8%, and 10.15%, the bulk density of the blends range from 0.83 (100% yam flour) to 1.56g/m (60% of yam, 25% of plantain and 5% of soybean flour). The least gelation of the diet range from 1.00% to 8.00%. The study also show the pasting properties of the diet. The organoleptic evaluation shows that there was a significant difference among the blend. The addition of soybean flour to yam and plantain flour to form blends successfully produce a high protein energy food.

INTRODUCTION

Yam are starchy staples in the form of tubers produced by annual and perennial vines grown in Africa, Americas, Caribbean, south pacific. Yam *Dioscorea spp* are important sources of carbohydrates for many people of the sub-saharan region especially in the yam zone of West Africa (Esteve *et al.*, 2013) and are the third most important tropical root crop after cassava and sweet potatoes (Onyeka *et al.*,2006). Yam contribute more than 200 dietary calories per capital daily for more than 150million people in west Africa and serve as an important source of income (Bakalaye., 2003). There are 600 species of yam (Amani *et al.*, 2004), but only six (*Dioscorea rotundata, Dioscorea alata, Dioscorea esculenta, Dioscorea* *bulbifera, Dioscorea dumetorum and Dioscorea cayenosis) are* mostly grown as staple foods in tropical nations (Otegbayo *et al.*, 2001).

In many parts of West Africa includingNigeria yam is processed into various food forms which include pounded yam boiled yam roasted yam grilled yam, yam bal, mashed yam, yam chips and flakes (Orkwor *et al.*, 1997). The processing of yams traditionally depends on the species. *Dioscorea rotundata* is more preferred for preparing boiled yam and pounded yam (Ajibola *et al*., 1988) .Out of the six species commonly found in West Africa, *Dioscorea rotundata* is the most widely grown and generally considered to be the best in terms of food quality, thus commanding the highest market value (Markson *et al.*, 2010), (Otegbayo *et al.*, 2001).There is need to expand utilization of yam through industrial processing while chemical and physical component of yam have been found to influence its end use.

Plantain is a staple food grown throughout the tropics and they constitute a major source of carbohydrate form millions of people in Africa, the Caribbean, Latin America, due to the perishable nature of the fruits. The rate of post-harvested losses of plantain varies from one country to another according to organization of market chains and modes of consumption (Adebesin *et al.*, 2009). Plantain is low in protein with estimated values of 4g per kg in green unripe finger, high level of potassium in plantain makes it an important raw material for indigenous soap manufacture and in the attachment of acidic soils (Kay, 1987).

Soyabean (*Glycine max*) has recently becomes popular in the West Africa sub-region due to their high protein content. It is an annual leguminous crop and is grown to provide food for human feeds for animals and raw materials for industries, soyabean is an excellent source of protein (35-40%), the soyabean seed is the richest in food value of all plant foods consumed flour (Kure., 1998). Soyabean is also processed into flour and its oil used in local plant, cosmetics and soap making industries. Soyabean is consumed in Nigeria as soymilk, the cake is used for livestock feeding and the flour is added to pap as food for infant and children. Soyabean is widely used, inexpensive and nutritional sources of dietary protein, its protein content is higher and more economical; soybean is also of particular interest as a vegetable protein sources because of its cholesterol lowering abilities in patients with type II hypolipoproteinemia. Soyabean is also rich in minerals and vitamins such as iron, zinc, copper, thiamine, riboflavin (McArthur, 1998). Most of these minerals and vitamins are well known hematinic and are essential in the formation of red blood cells (Singh *et al.*, 2000). However, this work was aimed at producing flour blends from plantain, yam and soybean and to determine the physicochemical, pasting and sensory properties of flour produced.

MATERIALS AND METHODS

Collection of Materials: Yam, plantain and soya bean used for this research were sourced from Emure-ile market in Owo Local Government Area of Ondo State, Nigeria. While the other equipment used for this research were from the Department of Food Science and Technology, Rufus Giwa Polytechnic Owo, Ondo State.

Production of Flour

Production of Yam flour: The yam was peel and wash. The peeled tubers are cut to pieces with the aid of knives. The yam cubes are immediately put in water containing sodium metabisulphate (1 gm to 1 litre of H2O) sulphiting for 20minutes helps to prevent browning reaction. The sulphated yam are blanch for 7 to 10 minutes and the yam was dried in cabinet dried in cabinet drier set at between 50oc and 60oc to a moisture content of about 5.7% and it was milled.

Production of Plantain Flour: matured freshly cut green plantain were brushed with tap water, peeled, washed and soak sliced into sodium metabisuphate small pieces and then placed in drying oven at 65oc to constant weight. The samples were ground and saved to obtain flour, stored in polythene bags before analysis at the Biochemistry laboratory of Rufus Giwa polytechnic Owo.

Production of Soybean flour: The matured soybean seeds were sorted to remove the stone, sand and foreign material from it. Soybean was washed in clean water one cup of soybeans was drop in six cups of boiling water and it was boiled for about 25 minute the soybean was drain and wash to remove the coat and the bean was separated from the hill cold water. The soybean seeds was dry and it was grind into flour and the flour was stored in a dry airtight container.

Preparation of Yam, Plantain and Soybean flour blends: Four different samples of Yam, Plantain and soybean flour were prepared for the analysis and named as,

Sample A - 100% Yam flour

Sample B – 95% Plantain flour with 5% soybean flour

Sample C – 80% yam flour with 10% Plantain flour and 10% soybean flour

Sample D – 60% yam flour with 25% Plantain flour and 15% soybean flour

Proximate Analysis: The proximate composition (Protein, fat, crude fibres, moisture and ash) of the flours was determined by the methods of analysis of the Association of Official Analytical Chemists (2005), while carbohydrate was determined by difference.

Determination of Functional properties of flour blends: The emulsifying and water absorption capacity of the flour samples were determined as described by Sathe *et al.* (1982). The method of Sathe and Salunkhe (1981) was used in determine the least gelation concentration of the flour blends. The bulk density of samples was determined by methods described by Oladele and Ana (2007). The foaming capacity and stability was determined as described by AOAC (2000).

Pasting Properties: The pasting properties of the flour samples were determined using Rapid Visco analyzer (RVA) (Newport Scientific, 1998).

Sensory evaluation: Plantain flour blends was prepared into a dough from each sample by mixing a measured product. The quantity of the flour with boiling water and continuously stirring the mixture using a turning stick until stiff dough was obtained, more water was added and the mixture was allowed to cook for few minutes and then turn properly until uniform in texture. Then the sensory analysis was carried out by untrained panelists (10 in number) on the bases of interest, availability and familiarity with the product. The results obtained was subjected to the analysis of variance. (ANOVA).

RESULTS AND DISCUSSION

TABLE 1: Proximate Composition of Yam, Plantain and Soybean flour blends

Parameters	100:00:00	95:5:00	80:10:10	60:25:15
Moisture (%)	15:00	4.50	2.50	2.50
Ash (%)	5:00	0.50	1.50	0.24
Fibre (%)	4:00	6.25	4.50	3.00
Fat (%)	3.50	4.50	6.00	8.00
Protein (%)	6.12	6.47	9.80	10.15
Carbohydrate (%)	66.38	77.78	75.70	76.11
Energy value (%)	321.50	377.50	396.00	417.04

Key

100:00 - Yam flour

95:5 - 95% plantain flour with 5% soybean flour

80:10:10 - 80% yam flour with 10% plantain flour, 10% soybean flour

60:25:15 - 60% yam flour with 25% plantain flour and 15% soybeanflour

Table 2: Physicochemical Properties of Yam, Plantain and Soybean blends

Parameters	100:00	95:5	80:10:10	60:25:15
Bulk Density (%)	0.83	1.47	1.56	1.51
Foaming Capacity (%)	ND	ND	ND	ND
Water Absorption (%)	100.00	150.00	150.00	150.00
Emulsifying (%)	13.33	20.68	24.13	20.8
Least Gelation (%)	4.00	6.00	8.00	1.00

Key

100:00 - Yam flour

95:5 - 95% plantain flour with 5% soybean flour

80:10:10 -80% yam flour with 10% plantain flour, 10% soybean flour

60:25:15 - 60% yam flour with 25% plantain flour and 15% soybean flour

Table 3: Pasting Properties of Yam, Plantain and Soybean blends

Parameters	**100:00**	**95:5**	**80:10:10**	**60:25:15**
Final viscosity (RVU)	2040.00	1834.00	2786.00	2203.00
Set Back (RVU)	570.00	564.00	1014.00	840.00
Pasting Time (Mins)	5.53	5.33	5.33	5.53
Pasting Temperature (o^C)	82.30	84.00	82.35	83.05

Key

100:00 - Yam flour

95:5 - 95% plantain flour with 5% soybean flour

80:10:10 - 80% yam flour with 10% plantain flour, 10% soybean flour

60:25:15 - 60% yam flour with 25% plantain flour and 15% soybean flour

Table 4: Sensory Qualities of Yam,Plantain and Soybean flour blends

Parameters	**100:00**	**95:5**	**80:10:10**	**60:25:15**
Colour	6.20 ± 1.22^{a}	5.50 ± 1.17^{d}	5.70 ± 0.94^{c}	6.00 ± 1.41^{b}
Taste	5.60 ± 0.84^{b}	5.30 ± 0.94^{c}	4.70 ± 0.94^{d}	5.60 ± 1.20^{a}
Aroma	5.30 ± 0.82^{b}	5.20 ± 1.22	4.60 ± 1.57^{d}	5.50 ± 1.43^{a}
Texture	5.00 ± 0.94^{b}	4.20 ± 1.03^{d}	4.50 ± 0.97^{c}	5.50 ± 1.08^{a}
General Acceptability	5.40 ± 1.26^{a}	4.60 ± 0.96^{c}	4.70 ± 0.94^{b}	4.50 ± 1.50^{d}

Key

100:00 - Yam flour

95:5 - 95% plantain flour with 5% soybean flour

80:10:10 - 80% yam flour with 10% plantain flour, 10% soybean flour

60:25:15 - 60% yam flour with 25% plantain flour and 15% soybean flour

Proximate Composition of Plantain, Yam and Soybean flour Blends

The proximate composition of the various blends are shown in Table 1. The moisture content of the diets ranged from 2.50% to 15.00%.Moisture content level less than 10% is recommended in order to keep the flouring products for a reasonable longer time (Del *et al.,* 2007). All the flour blends had less than the recommended moisture content and are expected to keep for areasonable long time without remarkable negative change, apart from the control sample which had a moisture content of 15.00%.The ash content is an indication of the level of mineral elements present in diet (Olson, 2001). The result obtained for the diets differ significantly and ranged between 0.24 to 5.00% Likewise, there was a decrease in the crude fibre content of the diets from 6.25% to 3.00 and as the level of yam and soybean flour increase in the blends.

The fat content of the diets varied between 3.50% to 8.00%. Fat content of the diets increased as the quantity of the soybean and plantain flour increase in the blends probably due to addition effect.There is a sharp increase in the carbohydrate content as the level of soybean flour increase in the diet, This may be as a result of the increase in fat, ash, protein and crude fibre content of the diet.

The 100% of the yam flour in this study had a protein content of 6.12, However, the protein contentincrease with increase in the quantity of soy flour, soybean contain 36% of protein.The energy value of 60% of yam flour was the highest with a value of 417.04, these may be due to that yam is a carbohydrate based food. This is further confirmed with the highest carbohydrate content (77.78%) in the sample. Yam flour substitute with 25% of plantain and 15% of soybean flour had highest energy value of 417.04kcal among the blends. This result shows that the blends will be rich in protein and be good energy producing food when consumed.

The Physicochemical properties of Plantain Yam, and Soybean flour Blends

The physicochemical properties of the various blends are shown in Table 2. The bulk density value was found to be 0.83 to 10.51 there was significant difference in all blends.
The bulk density is generally affected by the particle size and the density of the flour and it is very important in determining the package requirement, material handling and application in wet processing in foot industry (Karuna *et al.,* 1996).The foaming capacity and water absorption capacity followed a similar trend. Blends contained 100% of yam and 150% of plantain and soybean had the highest water absorption. The emulsifying blends with 13.33% to 24.13% that are 100% of yam and 80-10% of plantain yam and soybean flour contain higher emulsifying and least gelation blends with 4-8% contain higher least gelation.

Pasting properties of yam-plantain and soybean flour blends.

Results of the pasting properties of yam, plantain and soybean flour beans are shown in table 3. When starch based foods are heated in an aqueous environment, they undergo a series of changes known as gelatinization and pasting. These are two of the most important properties that influence quality and aesthetic consideration in the food industry, since they affect texture and digestibility as well as the end use of starchy food.

Food viscosity (peak viscosity) is the ability of starch to swell freely before their physical breakdown (Sanni *et al.*, 2004) and it ranged from 1834.00 to 2786.00. the 80% of yam flour had the highest peak viscosity value of 2786.00VU. High peak viscosity is an indication of high starch content (Osungbaro, 1990). The relatively high peak viscosity exhibited by 80% of yam flour is in active that the flour may be suitable for products requiring high gel strength and elasticity.

The set back (RVU) ranged from 564.00 to 1014.00 and that of 80% of yam was the highest with the mean of 1014.00 RVU and 95% of plantain flour and lowest mean value of 564.00VU. the higher the setback value the lower the staking rate of the product made from the flour (Adeyemi and Idowu, 1990). The pasting time, which is a measure of the cooking time ranged between 5.27 – 5.53 minutes the 100% yam flour and 60% of yam flour the highest value of 5.53 minutes, the 96% of plantain has the lowest pasting time of 5.27 minutes. The pasting temperature gives an induction of the gelatinization time during processing. Which the first detectable increase in viscosity is measured and is an index characterized by initial change due to the swelling of starch (Emola and Delarosa, 1981) at the temperature. The pasting temperature ranged from 82.30 – 84.00^{0}C. The 100% of yam flour had the lowest pasting temperature and 95% of plantain flour had the highest value of 84.00^{o}C.

Mean sensory evaluation scores of yam. Plantain and soybean flour blends past

Table 4 shows the mean sensory evaluation scores of yam plantain and soybean flour paste. There was significant difference in all sensory parameter of 100% and 80 of yam plantain and soybean flour paste. The value obtained for colour ranged from 6.20-5.50 where 95% of plantain 5% of soybean as the least panelist scores. The aroma of 60% yam flour blends are most preferred after 100%, paste, which had the value of 5.60 and the least preferred, is 80% which had the value of 4.70

The panelist score for texture show that there was slight significant difference between the blends paste. The blends that contain 100% of yam has the highest overall acceptability which the 60% had the least acceptability among the four blends. The results shows that blends of 100% and 80% of yam compared favorably in all the sensory qualities evaluated in the study.

CONCLUSION

The findings of this study indicate that the addition of yam flour, plantain flour and soybean flour blends in this study successfully produced a high protein energy food. The substitution of yam with plantain flour and soybean flour showed a remarkable improvement in the protein (6.47%- 10-15%) the formulated diet. Also the substitution at 15% of soybean increase the protein content. The increased in energy value is an indication that the food will give more energy and the increase level of protein would be able to alleviate the problems of protein malnutrition. Sensory panelist score showed that there is a significant difference in the sensory properties of 100% flour and other blends.

RECOMMENDATION

These samples, most especially at 15% level substitution is recommended for human consumption. The combination is capable of meeting the nutritional requirements of man and solving the issue of malnutrition by reducing it to the barest minimum level. Furthermore, research especially on the microbiology, mineral and antinational composition of those blends could be carried out.

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