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Evaluation of Nutritional Quality and Organoleptic Properties of Soy-poundo Yam Flour

J. I. Okoye [a*], J. I. Nwodo [a] and S. I. Eze [b]

[a] Department of Food Science and Technology, Enugu State University of Science and Technology, Enugu, Nigeria.
[b] Department of Home Economics, Federal College of Education, Eha-Amufu, Enugu, Nigeria.

Authors' contributions

This work was carried out in collaboration with all the authors. The authors read and approved the final manuscript.

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ABSTRACT

This study was designed specifically to evaluate the nutrient composition and sensory properties of soy-poundo yam flours produced from white yam and soybean flours. The white yam tubers and soybean seeds were processed into flours and blended in the ratios of 100:0, 90:10, 80:20, 70:30, 60:40 and 50:50, respectively and used to produce soy-poundo yam flours with 100 % instant yam flour used as control. The samples of soy-poundo yam flour produced were evaluated for nutrient composition and sensory properties using standard methods. The moisture, crude protein, fat, ash and crude fibre contents of the samples increased significantly ($p<0.05$) with increase in substitution of soybean flour from 7.56 - 8.36%, 4.41 – 21.14%, 4.18- 5.09%, 2.51- 4.16% and 2.76 - 4.06%, respectively, while their carbohydrate and energy contents decreased from 78.74-57.21% and 370.16- 359.15KJ/100g, respectively. The mineral composition of the samples revealed that the potassium, magnesium, manganese, iron, zinc and copper contents of the products ranged from 78.34 – 164.11mg/100g, 2.46 -17.14mg/100g, 20.48 -125.53mg/100g,1.56 -

**Corresponding author: Email: okoyejoseph6@gmail.com;*

2.23mg/100g, 1.78 -263mg/100g and 2.88 – 3.64mg/100g, respectively. The vitamin content of the samples showed that the vitamin A, pyridoxine, ascorbic acid, thiamine, vitamin E and niacin contents ranged from 12.00-12.70mg/100g, 2.28-2.59mg/100g, 16.1-17.07mg/100g, 56.07-74.46mg/100g, 3.34-4.10mg/100g and 2.29 -3.22mg/100g, respectively with the control sample having the least values for all the vitamins evaluated. The sensory properties of the soy-poundo yam flour doughs obtained upon reconstitution of the samples with boiling water also revealed that the colour, taste, texture and aroma of the control sample (Poundo yam prepared from 100% instant yam flour) were the most acceptable to the assessors compared to the samples prepared from the substituted samples. Although the poundo yam dough made from the control sample was the most acceptable, the other test samples prepared from soy-yam composite blends were equally acceptable based on their relatively high scores in all the sensory attributes evaluated by the judges. The study, therefore, showed that the enrichment of yam flour with soybean at different graded levels would not only improve the nutrient contents of soy-poundo yam flour but would also add varieties to poundo yam meal due to improvement in its colour and texture.

Keywords: Poundo yam; soybean flour; supplementation; nutrient composition; sensory properties.

1. INTRODUCTION

"In sub-sahara African countries including Nigeria, there have been several attempts at enhancing the nutritional values of cassava-based diets by fortifying them with soybean, which has high content of good quality protein" [1,2]. "The use of full-fat, defatted soybean flours, cowpea flour and African yam bean-based diets have been explored" [3,4,5]. In addition, Akanbi and Oladeji [6] have "fortified yam flour with cocoyam, breadfruit and plaintain flours inorder to improve its viscosity and the texture of the yam flour paste".

"Various species of yam tubers among them are *Discorea rotundata, Dioscorea alata and Dioscorea cayenensis* have been processed into yam flour and results showed that they are good sources of raw materials for the production of yam flour". [7,8,9] "The results of previous studies on the fortification of yam, casava and plantain flours by the use of soybean have shown that fortification has the capacity to improve the nutritional quality of the resulting meals including amala" [10]. However, fortification can also affect the functional and pasting properties of flour oriented food products [1,6]. The processing of yam tubers into yam flour is the simplest method of preserving yam product in a storable form so as to make it available during the off-season thereby reducing the storage as well as marketing and transportation cost of the product [4].

Soybean (*Glycine max*) has been recognized to be an ideal leguminous seed crop that could be widely used in food preparations inorder to meet the protein and energy requirements of both man and animal. Soybean is probably the world's most valuable crop, used as feed by billions of livestock, as a source of dietary protein and oil by millions of people, and in the industrial manufacture of thousands of products. Soybean is extremely rich in protein, fat, energy, vitamins, minerals, phytochemicals and bioactive compounds" [11,12]. "Soybean is a cheap source of quality protein that is superior to the proteins of all other plant foods because it has the protein content and amino acid profile that are fairly close to that of cow's milk" [13]. "It contains eight essential amino acids and is also a rich source of polyunsaturated fatty acids (including the Omega-3-fatty acids). The fat obtained from soybean is free from cholesterol and hence, it is good for heart disease patients" [11,14]. "Soybeans have great potential in overcoming the problem of protein-energy malnutrition that is prevalent especially among the poor and low income earners in Nigeria and other developing countries where there is inadequate consumption of animal proteins because they are quite expensive. Although soybean is not indigenous to Africa, it has received tremendous popularity as a cheap source of protein in Nigeria" [15]. Therefore, the study was designed to evaluate the nutrient composition and organoleptic properties of soy-poundo yam flours.

2. MATERIALS AND METHODS

2.1 Procurement of Raw Materials

The white variety of yam tubers (*Dioscorea rotundata)* and the soybean seeds (*Glycine max*) used for the study were purchased from Abakpa Market, Enugu, Enugu State, Nigeria.

2.2 Preparation of Yam Flour

The instant yam flour was prepared according to the method described by FIIRO [16] with slight modifications. One kilogram (1kg) of the yam tubers were washed with 2.5 litres of potable water to remove dirt and other adhering materials. The cleaned tubers were peeled manually with kitchen knife and sliced into smaller slices of 2cm thickness. The yam slices were dipped in 2 litres of potable water containing 1.5% Sodium metabisulphite so as to prevent the enzyme-induced browning reaction. After that, the yam slices were drained and washed repeatedly for three consecutive times with excess water to remove Sodium metabisuphite. The washed yam slices were boiled with 2.5 litres of potable water in a stainless pot at 100°C for 10 min on a hot plate. The cooked yam slices were drained, rinsed, spread on the trays and dried in a hot air oven (Model Gallenkamp 300 Plus, England) at 60°C for 18 h with occasional stirring of the slices at intervals of 30 min to ensure uniform drying. The dried yam slices were milled in a hammer mill and sieved through a 400 mesh sieve. The instant yam flour produced was packaged in a covered plastic container, labelled and kept in a refrigerator until needed for further use.

2.3 Preparation of Soybean Flour

The boiled soybean flour was prepared according to the method described by Jimoh and Olatidoye [5] with slight modifications. One kilogram (1kg) of soybean seeds were washed with 2 litres of potable water to remove dirt and other foreign materials. The cleaned seeds were soaked in 3 litres of potable water at room temperature (29±2°C) for 4 h. The soaked seeds were drained and dehulled manually by rubbing them in-between palms to remove the hulls. The dehulled seeds were put into a stainless pot and boiled with 3 litres of potable water at 100°C for 25 min on a hot plate. The boiled seeds were drained, rinsed, spread on the trays and dried in a hot air oven (Model Gallenkamp 300 Plus, England) at 60°C for 20 h with occasional stirring of the seeds at intervals of 30 min to ensure uniform drying. The dried seeds were milled in a hammer mill and sieved through a 400 mesh sieve. The boiled soybean flour produced was packaged in a covered plastic container, labelled and kept in a refrigerator until needed for further use.

2.4 Formulation of Flour Blends

The soy-poundo yam composite blends were formulated according to the method described by Jimoh and Olatidoye [5] with slight modifications. The instant yam flour was mixed thoroughly with soybean flour in the ratios of 100:0, 90:10, 80:20, 70:30, 60:40 and 50:50 in a Kenwood blender (Model SE-505R, Philips England) to obtain homogenous soy-poundo yam composite blends. The soy-poundo yam composite flours produced were packaged separately in covered plastic containers, labelled and kept in a refrigerator until needed for analysis and preparation of soy-poundo yam doughs.

2.5 Preparation of Soy-poundo Yam Doughs

The soy-poundo yam doughs were prepared manually in the laboratory according to the method described by Malomo et al. [1] with slight modifications. During preparation, the samples of soy-poundo yam composite blend produced and the control sample (100% instant yam flour) were further milled separately to fine powders and reconstituted into thick doughs with boiling water. One hundred and fifty grams (150g) of each sample of the soy-poundo yam flour blends was individually reconstituted into thick dough by the addition of one hundred millilitres (100mL) of boiling water, boiled on a gas cooker with continuous stiring with a wooden stirrer in an aluminum pot until it gelatinizes into a thick dough. Thereafter, thirty millilitres (30mL) of boiling water was added to each sample of the dough to allow the dough to cook properly and stirring was continued until a stiff dough was obtained. The doughs produced were separately packaged in airtight plastic containers, labelled and used for sensory evaluation within 1 h after preparation.

2.6 Proximate Analysis

The moisture, crude protein, ash, fat and crude fibre contents of soy-poundo yam flours were determined on dry weight basis according to the standard analytical methods of AOAC [17]. Carbohydrate was calculated by difference. % carbohydrate = 100 - % (Moisture + Crude Protein + Fat + Ash + Crude Fibre). The energy content was calculated by multiplying the percentage values of protein, fat and carbohydrate by the Atwater factors of 4, 9 and 4, respectively. All determinations were carried out in triplicate samples.

2.7 Mineral Analysis

The mineral elements were extracted by dry-ashing of the samples in a muffle furnace at 550^{0}C to constant weight followed by the dissolution of the ash obtained from each sample in a volumetric flask by the addition of 50mL of de-ionized water and a few drops of Hydrochloric acid. The potassium and iron contents of the samples were determined using the Techcomp AA600 atomic absorption spectrophotometer and further confirmed by the use of a digital flame photometer. The magnesium, manganese, zinc and copper contents were also determined using the atomic absorption spectrophotometer. All determinations followed the methods of AOAC [17] and were carried out in triplicate samples on dry weight basis.

2.8 Vitamin Analysis

The ascorbic acid, thiamine and niacin contents of the samples were determined on dry weight basis using the atomic absorption spectrophotometer (Perkin-Elmer Model 300, Norwalk, CT) after extraction. The pyridoxine content was determined using a digital fluorimeter. The vitamins A and E contents were determined using the ultraviolet absorption spectrophotometer after extraction with chloroform. All determinations followed the AOAC [17] procedures and were carried out in triplicate samples.

2.9 Sensory Properties of Soy-Poundo Yam Flours

The samples of soy- poundo yam doughs produced from both the soy-poundo yam flours and the control sample (100% instant yam flour) after reconstitution with boiling water were separately coded, placed in plain coloured plates with egusi soup (melon seed soup) and served to a panel of twenty (20) semi-trained judges comprising of staff and students of the Department of Food Science and Technology, Enugu State University of Science and Technology (ESUT), Enugu, Nigeria who were well known poundo yam consumers at ambient temperature (29$\pm$2°C). The panelists were also provided with plastic spoons and asked to evaluate the samples for the attributes of colour, taste, texture, aroma and overall acceptability using a nine point Hedonic scale with I and 9 representing dislike extremely and like extremely, respectively [18]. Clean water was provided to the judges to rinse their mouth in-between testing of each sample to avoid residual effect. The panelists were instructed to taste, assess and score each of the samples based on their preference and acceptance of the products. Expectoration cups with lids were also provided for the judges who would not like to swallow the samples after testing each of them.

2.10 Statistical Analysis

The data generated were subjected to one-way analysis of variance (ANOVA) using Statistical Package for Social Sciences (SPSS, version 20) software. Significant means were separated using Turkey's least significant difference (LSD) test at p<0.05.

3. RESULTS AND DISCUSION

3.1 Proximate Composition of Soy - Poundo Yam Composite Blends

The proximate composition of soy–poundo yam composite flours are presented in Table 1.

The moisture content of the samples varied significantly (p<0.05) from each other. The moisture content ranged from 7.56 to 8.36% with the control sample (100% instant your flour) having the least value (7.56%), while the sample substituted with 50% soybean flour had the highest value (8.36%). The moisture content of the soy-poundo yam flours reported in this study were within the recommended moisture contents (7.62 – 8.46%) required for adequate storage of dried food products reported by Ndife *et al.* [15]. The lower the moisture content of a food product, the longer the shelf stability of that product. The low moisture contents observed generally in the formulated composite blends is a good indicator of their longer shelf life with proper packaging and storage.

The protein content of the samples ranged from 4.41 to 21.14%. The observed increase in the protein content of the sample substituted with 50% soybean flour could be attributed to the addition of high proportion of soybean flour to the blend. The increase in protein content of the sample is in agreement with the report of Oluwamukomi and Adeyemi [19] for poundo yam enriched with defatted soybean flour. The high protein contents of soy-poundo yam composite blends produced in this study would be of great importance in reducing the protein-energy malnutrition resulting from high cost of conventional animal products particularly in less developed and developing countries of the world including Nigeria. The high levels of protein observed in the composite blends produced clearly demonstrates the effect of supplementation of yam flour with soybean in the formulation of soy-poundo yam composite flours. Protein is also very important for growth and tissue replacement in the body [20].

The fat content of the samples ranged from 4.18 to 5.09%. The fat content of the control sample (100% instant yam flour) was significantly ($p<0.05$) lower than the fat content of the substituted samples. "The variation in the fat content could be due to the differences in the raw materials used in the formulation of soy-poundo yam composite blends. The level of soybean flour in the formulation might be responsible for the slight increase in the fat content of the resultant products because there was an increase in fat content with the addition of soybean flour to the yam flour" [21]. "The high fat content of a food product may be desirable to consumers interested in the consumption of high fat food products. This is because fat increases the energy density and also provides essential fatty acids needed in the body for proper development of neurones and other fatty tissues" [20]. Fat also helps the body to absorb certain nutrients and maintain core body temperature [22].

The ash content of the samples increased significantly ($p< 0.05$) with increase in the substitution of soybean flour from 2.51 to 4.16% with the control sample (100% instant yam flour) having the least value (2.51%), while the sample substituted with 50% soybean flour had the highest value (4 .16%). The increase in ash content might be attributed to the substitution of yam flour with soybean flour as it could be observed that an increase in soybean flour in the formulation led to a similar increase in the ash content of the sample. The values (2.51 – 4.16%) obtained in this study were similar to the ash content (2.49 – 4.12%) of yam flour fortified with soy-pomace reported by Gbenga *et al.* [22]. The ash content of a food material could be used as an index for estimating the mineral constituents of such a food product [23].

"The fibre content of the samples was observed to increase with increase in substitution of soybean flour. The fibre content ranged from 2.76 to 4.06% for control (100% instant yam flour) and the sample substituted with 50% soybean flour, respectively. The increase in crude fibre content with increase in soybean flour substitution is an indication that soybeans are good sources of crude fibre" [11,24]. "The values (2.76 – 4 0.6%) obtained in this study were higher than the fibre content (1.65 – 1.59%) of soy-fortified yam flour reported by Jimoh and Olatidoye [5]. Fibre is needed to assist in digestion and in keeping the gastrointestinal track healthy. It also makes the blood sugar to be stable by slowing down the process of glucose digestion" [25]. The feacal bulking action of insoluble fibre makes it useful in the treatment of constipation and diverticular diseases [26].

The carbohydrate content of the soy–poundo yam composite flours ranged from 57.21 to 78.74% with the control (100% instant yam flour) having the highest value (78.74), while the sample enriched with 50% soybean flour had the least value (57.21%). The carbohydrate contents of the samples substituted with soybean flour at different graded levels were significantly ($p< 0.05$) lower than the control. The result showed that an increase in the amount of soybean flour addition led to a corresponding decrease in the carbohydrate content of the blends. Similar decrease in carbohydrate content has been also reported by Gbenga *et al.* [22] for yam flour fortified with soy-pomace.

The energy content of the samples varied from 359.15 to 370.16KJ/100g with the control sample having the highest value (370.16kg/100g), while the sample substituted with 50% soybean flour had the lowest energy value (350.15KJ/100g). The energy content was observed to decrease with increase in substitution of the soybean flour in the blends. The result is in agreement with the findings of Nwamarah and Uwaegbute [27] who reported similar decrease in the energy content of soy-fortified yam snacks. Energy content represents the amount of energy in food that can be supplied to the body for the maintenance of basic body functions. Generally, the substitution of yam flour with soybean flour in the preparation of soy-poundo yam composite blends greatly increased the protein, ash, fat and crude fibre contents of the samples, while their carbohydrate and energy contents were drastically reduced.

3.2 Mineral Composition of Soy-Poundo Yam Composite Blends

The mineral composition of soy-poundo yam flours are presented in Table 2. The potassium, magnesium, manganese, iron, zinc and copper contents of the samples increased significantly ($p<0.05$) with increase in substitution of soybean flour in the blends.

The potassium content of the samples ranged from 78.34 to 104.11mg/100g with the control (100% instant yam flour) and the sample substituted with 50% soybean flour having the least (78.34mg/100g) and highest (104.11mg/ 100g) values, respectively. The increase in the potassium content is an indication that soybeans are a good source of potassium (Liu, 2006).The values (78.34 - 104.11mg/100g) obtained in this study were lower than the potassium content (86.64 - 121.12mg/100g) reported by Achi [3] for fermented yam flour supplemented with soybean flour. Potassium is useful in the regulation of heartbeat and in the proper functioning of the muscles and nerves. It is also vital for the synthesis of protein and metabolism of carbohydrate in the body [28].

The magnesium content of the soy-poundo yam composite flours varied from 2.46 to 7.44mg/100g. The control sample had the least value (2.46mg/100g), while the sample substituted with 50% soybean flour had the highest value (7.44mg/100g). There were significant ($p< 0.05$) differences in magnesium content of the soy-poundo yam composite blends produced in this study. The increase in magnesium content is an indication that soybeans are a good source of magnesium [29]. Magnesium plays a vital role in the body metabolic process, nerve transmission as well as in the synthesis and stability of deoxyribonucleic acid (DNA) [30].

The manganese content of the samples ranged from 20.48 to 125.53mg/100g with the control (100% instant yam flour) and the sample substituted with 50% soybean having the least (20.48mg/100g) and highest (125.53mg/100g) values, respectively. The manganese contents of soy-poundo yam composite blends were generally superior to that of the control and this is an indication that soybeans are a rich source of manganese [31]. Manganese helps the body in the formation of connective tissues, bones, blood clotting factors and sex hormones. It also plays significant roles in fat and carbohydrate metabolism as well as in calcium absorption and in the regulation of blood sugar level in the body [23].

The iron content of the samples ranged from 1.56 to 2.23mg/100g with the control having the least iron content (1.56mg/100g), while the sample substituted with 50% soybean flour recorded the highest value (2.23mg/100g). The increase in iron content could be attributed to the addition of soybean flour which certainly demonstrates the effect of substitution of yam flour with soybean flour in the formulation of soy-poundo yam composite blends. Iron is a component of haemoglobin, a protein that provides oxygen to the muscles and supports metabolism in humans [32]. Inadequate intake of iron causes iron deficiency anemia (IDA) and this is very common around the world especially among women and children in developing countries.

The zinc content of the samples increased significantly ($p<0.05$) with increase in substitution of soybean flour from 1.78 to 2.63mg/100g with the control (100% instant yam flour) and the sample substituted with 50% soybean flour having the least (1.78mg/100g) and highest (2.63mg/100g) values, respectively. The result also showed an increase in zinc content with subsequent increase in the amount of soybean flour added to the formulation. Similar increase in zinc content has been reported by Folake et al. [33] for soy-enriched tapioca. Zinc which is a component of every living cell plays a critical role in the body. It supports growth and development during pregnancy, childhood and adolescence [34].

The copper content of the samples also increased significantly ($p<0.05$) from 2.88 to 3.64mg/100g with the addition of soybean flour to the blends. The control sample (100% instant yam flour) and the sample substituted with 50% soybean flour had the least (2.88mg/100g) and highest (3.64mg/100g) values, respectively. The copper content (2.88 – 3.64mg/100g) obtained in this study was lower than the values (3.28 - 4.78mg/100g) reported by Gbenga et al. [22] for yam flour fortified with soy-pomace. Copper is very useful for the synthesis of red blood cells and it also helps to improve the flow of the blood as well as in the maintenance of nervous and immune systems in the body [35,36]. Generally, the substitution of yam flour with soybean flour in the preparation of soy-yam composite blends drastically increased the mineral contents of the blends.

3.3 Vitamin Composition of Soy-Poundo Yam Composite Blends

The vitamin composition of soy-poundo yam flours are presented in Table 3. The vitamin A, pyridoxine (vitamin B_6), ascorbic acid, thiamine, vitamin E and niacin contents of the samples increased as the level of substitution with soybean flour increased in the blends.

The vitamin A content of the samples varied from 12.00 to 12.70mg/100g with the control (100% instant yam flour) and the sample substituted with 50% soybean flour having the least (12.00mg/100g) and highest (12.70mg/100g) values, respectively. The increase could be due to substitution effect which clearly showed that vitamin A content increased with increase in addition of soybean flour to the formulation. Similar increase in vitamin A content has been reported by Jimoh and Olatidoye [5] for soybean fortified yam flour. Vitamin A which is a fat soluble vitamin plays a vital role in the maintenance of good sight [20].

The pyridoxine (Vitamin B_6) content of the samples increased significantly ($p < 0.05$) with increase in substitution of soybean flour in the blends. The control sample had the lowest pyridoxine content (2.28mg/100g), while the sample substituted with 50% soybean flour had the highest value (2.59mg/100g). The pyridoxine content (2.28 - 2.59mg/100g) of the soy-poundo yam composite blends produced in this study was similar to the values (2.27- 2.58mg/100g) reported by Achi [3] for fermented yam flour supplemented with soybean flour. Vitamin B_6 plays a vital role in maintenance of nerves, skin and blood cells in the body [23].

The ascorbic acid content of the samples also varied from 16.21 to 17.07mg/100g with the control and the sample substituted with 50% soybean flour having the least (16.21mg/100g) and highest (17.07mg/100g) values, respectively. The ascorbic acid contents of the soy-poundo yam composite blends were generally higher than that of the control (100% instant yam flour), and this is an indication that soybeans are a good source of ascorbic acid [29]. Similar increase in ascorbic acid content was reported by Oluwamukomi and Adeyemi [19] for poundo yam enriched with defatted soybean flour. Vitamin C which is a water-soluble vitamin plays a vital role in the body building process and in disease prevention [37].

The thiamine content of the samples increased significantly ($P<0.05$) with increase in substitution of soybean flour in the blends. The control sample had the least thiamine value (56.07mg/100g), while the sample substituted with 50% soybean flour had the highest thiamine content (74.46/100g). The observed increase in the thiamine content of the soy-poundo yam composite blend could be attributed to addition of high proportion of soybean flour in the blend. Similar increase in thiamine content was reported by Folake et al. [33] for soy-enriched tapioca. Thiamine is essential for glucose metabolism and it also plays a vital role in the proper functioning of the nerves, muscles and hearts [20,38].

The vitamin E content of the samples ranged from 3.34 to 4.10mg/100g with the control and the sample substituted with 50% soybean having the least (3.34mg/100g) and highest (4.10mg/ 100g) values, respectively. The observed increase could be attributed to substitution effect which showed that vitamin E content increased with subsequent increase in the amount of soybean flour added to the formulation. Vitamin E which is a fat-soluble vitamin plays an important role in the strengthening of immune function and in the maintenance of healthy skin and eyes. It is also a strong antioxidant that aids in the absorption of iron in the body [39].

The niacin content of the samples varied significantly ($p<0.05$) from each other. The sample substituted with 50% soybean flour had the highest value (3.22mg/100g), while the control (100% instant yam flour) had the least niacin content (2.29mg/100g). The niacin content (2.29-3.22mg/100g) of the samples produced in this study was lower than the niacin content (3.43 – 4.56mg/100g) reported by Jimoh and Olatidoye [5] for soybean fortified yam flour. Niacin is useful in the lowering of serum cholesterol and high blood pressure. It also helps in the prevention of fatty acids build up in the liver and in the maintenance of the nervous system. Poor bioavailability of niacin lead to the well-known niacin deficiency disease called Pellegra [40]. Generally, the substitution of yam flour with soybean flour in the preparation of soy-poundo yam composite blends greatly enhanced the vitamin A, pyridoxine, ascorbic acid, thiamine, vitamin E and niacin contents of the blends.

3.4 Sensory Properties of Poundo Yam Doughs Prepared From Soy- Poundo Yam Composite Flours

The sensory properties of soy-poundo yam dough samples prepared from soy-poundo yam composite blends are presented in Table 4.

The sensory scores of the soy-poundo yam doughs prepared from both the control (100% poundo yam dough) and soy-poundo yam composite blends showed significant ($p<0.05$) differences in colour, taste, texture, aroma and overall acceptability. The control sample (100%

Table 1. Proximate composition (%) of soy-poundo yam composite blends

Samples	% Substitution IYF: BSF	Moisture	Protein	Fat	Ash	Fibre	Carbohydrate	Energy (KJ/100g)
A	100 : 00	7.56^{f}±0.01	4.41^{f}±0.01	4.18^{f}±0.01	2.51^{f}±0.01	2.76^{f}±0.01	78.74^{a}±0.17	370.16^{a}±0.64
B	90 : 10	7.86^{e}±0.01	7.76^{e}±0.01	4.36^{e}±0.01	2.87^{e}±0.01	3.11^{e}±0.00	74.07^{b}±0.01	366.48^{b}±0.06
C	80 : 20	7.92^{d}±0.01	10.79^{d}±0.01	4.58^{d}±0.01	3.12^{d}±0.01	3.44^{d}±0.01	70.17^{c}±0.01	364.99^{c}±0.04
D	70 : 30	8.11^{c}±0.01	14.21^{c}±0.01	4.74^{c}±0.01	3.56^{c}±0.01	3.76^{c}±0.01	65.63^{d}±0.01	361.94^{d}±0.01
E	60 : 40	8.21^{b}±0.01	17.35^{b}±0.01	4.92^{b}±0.01	3.89^{b}±0.01	3.97^{b}±0.01	61.68^{e}±0.03	360.36^{e}±0.05
F	50 : 50	8.36^{a}±0.01	21.14^{a}±0.01	5.09^{a}±0.01	4.16^{a}±0.01	4.06^{a}±0.01	57.21^{f}±0.00	359.15^{f}±0.15

A – 100% instant yam flour, B – Soy–poundo yam blend made with 90% yam flour and 10% soybean flour, C – Soy- Soy–poundo yam blend made with 80% yam flour and 20% soybean flour, D – Soy– Soy–poundo yam blend made with 70% yam flour and 30% soybean flour, E- Soy–poundo yam blend made with 60% yam flour and 40% soybean flour, F – Soy–poundo yam blend made with 50% yam flour and 50% soybean flour.
Values are mean ± standard deviation of triplicate determinations. Means in the same column with different superscripts are significantly different ($p<0.05$).
IYF – Instant yam flour, BSF – Boiled soybean flour

Table 2. Mineral composition (mg/100g) of soy-poundo yam composite blends

Samples	% Substitution IYF BSF	Potassium	Magnesium	Manganese	Iron	Zinc	Copper
A	100 : 00	78.34^{F}±0.01	2.46^{f}±0.01	20.48^{f}±0.57	1.56^{f}±0.01	1.78^{f}±0.01	2.88^{f}±0.01
B	90 : 10	86.57^{e}±0.01	5.67^{e}±0.01	48.12^{e}±0.01	1.74^{e}±0.01	1.99^{e}±0.01	2.94^{e}±0.01
C	80 : 20	98.46^{d}±0.01	8.87^{d}±0.01	69.21^{d}±0.69	1.93^{d}±0.01	2.10^{d}±0.01	3.11^{d}±0.01
D	70 : 30	108.35^{c}±0.01	11.02^{c}±0.01	88.69^{c}±0.64	2.07^{c}±0.01	2.24^{c}±0.01	3.24^{c}±0.01
E	60 : 40	138.38^{b}±0.56	14.26^{b}±0.01	104.79^{b}±0.64	2.16^{b}±0.01	2.41^{b}±0.01	3.46^{b}±0.01
F	50 : 50	164.11^{a}±0.70	17.44^{a}±0.01	125.53^{a}±0.67	2.23^{a}±0.01	2.63^{a}±0.01	3.64^{a}±0.01

A – 100% instant yam flour, B – Soy–poundo yam composite blend made with 90% yam flour and 10% soybean flour, C – Soy-poundo yam composite blend made with 80% yam flour and 20% soybean flour, D – Soy–poundo yam composite blend made with 70% yam flour and 30% soybean flour, E- Soy-poundo yam composite blend made with 60% yam flour and 40% soybean flour, F – Soy-poundo yam composite blend made with 50% yam flour and 50% soybean flour.
Values are mean ± standard deviation of triplicate determinations. Means in the same column with different superscripts are significantly different ($p<0.05$).
IYF – Instant yam flour, BSF – Boiled soybean flour

Table 3. Vitamin composition (mg/100g) of soy-poundo yam composite blends

Samples	% Substitution IYF :BSF	Vitamin A	Pyridoxine	Ascorbic Acid	Thiamine	Vitamin E	Niacin
A	100 : 00	12.00^{f}±0.00	2.28^{e}±0.01	16.21^{f}±0.01	56.07^{f}±77.69	3.34^{f}±77.69	2.29^{f}±0.01
B	90 : 10	12.06^{e}±0.01	2.32^{e}±0.01	16.29^{e}±0.01	62.19^{e}±0.01	3.41^{e}±0.01	2.47^{e}±0.01
C	80 : 20	12.17^{d}±0.01	2.37^{d}±0.01	16.44^{d}±0.01	66.18^{d}±0.01	3.60^{d}±0.02	2.67^{d}±0.01
D	70 : 30	12.27^{c}±0.03	2.43^{c}±0.01	16.60^{c}±0.02	68.14^{c}±0.01	3.78^{c}±0.02	2.84^{c}±0.01
E	60 : 40	12.44^{b}±0.02	2.50^{b}±0.01	16.83^{b}±0.01	72.21^{b}±0.01	3.91^{b}0.02	3.06^{b}±0.01
F	50 : 50	12.70^{a}±0.01	2.59^{a}±0.32	17.07^{a}±0.01	74.46^{a}±0.01	4.10^{a}±0.01	3.22^{a}±0.01

A – 100% instant yam flour, B – Soy–poundo yam composite blend made with 90% yam flour and 10% soybean flour, C – Soy-poundo yam composite blend made with 80% yam flour and 20% soybean flour, D – Soy–poundo yam composite blend made with 70% yam flour and 30% soybean flour, E- Soy-poundo yam composite blend made with 60% yam flour and 40% soybean flour, F – Soy-poundo yam composite blend made with 50% yam flour and 50% soybean flour.

Values are mean ± standard deviation of triplicate determinations. Means in the same column with different superscripts are significantly different ($p<0.05$).

IYF – Instant yam flour, BSF – Boiled soybean flour

Table 4. Sensory properties of soy-poundo yam doughs prepared from soy-poundo yam flours

Samples	% Substitution IYF : BSF	Colour	Taste	Texture	Aroma	Overall Acceptability
A	100 : 00	8.55^{a}±0.68	8.55^{a}±0.069	8.55^{a}±0.060	8.20^{a}±1.44	8.60^{a}±0.59
B	90 : 10	8.10^{b}±0.64	7.60^{b}±1.14	7.85^{b}±0.99	7.30^{b}±1.08	7.80^{b}±0.89
C	80 : 20	7.10^{c}±1.03	6.70^{c}±1.22	7.00^{c}±1.12	6.70^{c}±1.34	6.25^{c}±1.29
D	70 : 30	6.10^{d}±1.02	6.20^{d}±1.06	5.95^{d}±1.32	5.60^{d}±1.31	5.90^{d}±1.29
E	60 : 40	5.85^{e}±0.71	5.50^{e}±1.36	5.25^{e}±0.76	5.10^{e}±1.12	5.50^{e}±1.24
F	50 : 50	5.65^{f}±0.88	5.40^{f}±0.68	5.15^{f}±1.04	5.35^{f}±1.63	5.10^{f}±0.80

A – 100% instant yam flour, B – Soy–poundo yam composite blend made with 90% yam flour and 10% soybean flour, C – Soy-poundo yam composite blend made with 80% yam flour and 20% soybean flour, D – Soy–poundo yam composite blend made with 70% yam flour and 30% soybean flour, E- Soy-poundo yam composite blend made with 60% yam flour and 40% soybean flour, F – Soy-poundo yam composite blend made with 50% yam flour and 50% soybean flour.

Values are mean ± standard deviation of twenty (20) semi-trained judges. Means in the same column with different superscripts are significantly different ($p<0.05$).

IYF – Instant yam flour, BSF – Boiled soybean flour poundo yam dough) was rated highest in all the parameters evaluated by the judges. This could be due to the unique quality of the product in terms of colour, taste, texture and aroma. However, the samples substituted with 10% soybean flour was equally rated high by the panelists compared to the other test samples. The increase in substitution of soybean flour resulted in decrease in acceptability of soy-poundo yam dough sample substituted with soybean flour at different graded levels as indicated by the relatively low values for the soy-poundo yam dough sample substituted with 50% soybean flour. The low acceptability could be due to the beany flavour of the soybean flour used for its formulation as well as the poor texture exhibited by the sample. The colour and the texture of the poundo yam dough samples produced from the substituted samples were also affected by the addition of soybean flour compared to the control (100% poundo yam dough). The change in colour observed in the substituted samples could be attributed to increased substitution and Maillard browning caused by the reaction between the amino acids of the proteins and the reducing sugars produced as a result of the breakdown of the starch granules upon reconstitution of the samples with boiling water. The rate of Maillard browning reaction in foods has been reported to be hastened with change in temperature, time and presence of water [41]. Panelists described the poundo yam dough prepared from the blend substituted with 10% soybean flour as having appreciable and better colour, taste, aroma and texture compared to the other test samples. However, the substitution of yam flour with soybean flour in the preparation of soy-poundo yam dough samples generally produced good and organoleptically acceptable products upon reconstitution with boiling water.

4. CONCLUSION

The study showed that the enrichment of yam flour with various proportions of soybean flour in the preparation of soy-poundo yam flours significantly enhanced the proximate composition, micronutrients content and sensory properties of soy-poundo yam flours. The results showed that the increase in the addition of soybean flour resulted to corresponding increase in protein, fat, ash, crude fibre, potassium, magnesium, manganese, iron, copper, zinc, vitamins A and E, ascorbic acid, thiamine, pyridoxine and niacin contents of the soy-poundo yam composite blends with slight decrease in their carbohydrate and energy contents. The sensory properties of the samples equally revealed that the poundo yam dough prepared from 100% instant yam flour (control) was the most acceptable organoleptically and also differed significantly ($p < 0.05$) in colour, taste, aroma and texture from those made from the substituted samples. Although the poundo yam dough made from the control sample was most acceptable, the soy-poundo yam dough samples prepared from the composite blends were equally acceptable because they were also rated high by the judges.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Malomo O, Ogunmoyela OA. Adekoyeni B OO, Jimoh O, Oluwajoba SO, Sabanwa MO. Rheological and functional properties of soy-poundo yam flour. International Journal of Food Science and Nutrition Engineering. 2012;2(6):101-107.
2. Okoye JI, Ihiasota NU, Egbujie AE. Quality evaluation of garri produced from cassava mash and soybean flour. Asian Food Science Journal; 2022;21(9):109-1*18.*
3. Achi OK. Quality attributes of fermented yam flour supplemented with processed soy flour. Plant Foods for Human Nutrition; 2001;54(2):151–158.
4. Iwuoha CL. Comparative evaluation of physicochemical qualities of flours from steam-processed yam tubers. Food Chemistry. 2004;85:541-551.
5. Jimoh KO, Olatidoye OP. Evaluation of physicochemical and rheological characteristics of soybean fortified yam flour. Journal of Applied Biosciences; 2009;13:703-706.
6. Akanbi CT, Oladeji BS. Pasting performance of composite flour from yam, cocoyam, breadfruit and plantain blends. Proceedings of the 32nd Annual Conference of Nigerian Institute of Food Science and Technology. 2008:312-313.
7. Ekwu FC, Ozo NO, Ikegwu OJ. Quality of fufu from white yam varieties (*Dioscorea spp*). Nigerian Food Journal; 2005;23:107-113.
8. Babajide JM, Henshaw FO, Oyewole OB. Effect of yam varieties on the pasting properties and sensory properties of

traditional dry yam and its product. Journal of Food Quality. 2007;31(3):295 – 305.

9. Akinwande BA, Abiodun OA, Adeyemi IA, Akanbi CT. Effect of steaming methods and time on the physical and chemical properties of flour from yam tubers. Nigerian Food Journal; 2008;26(2):97-105.
10. Abiodun AO, Akinoso R. Effect of the harvesting periods on the chemical and pasting properties of trifoliate yam flour. Food Chemistry; 2014;142:159 –165.
11. Iwe MO. The Science and Technology of Soybean. Chemistry, Nutrition, Processing and Utilization. 1st edn. Rejoint Communication Services Ltd, Enugu, Nigeria. 2003;11–70.
12. William S, Akiko A. History of whole dry soybeans used as beans or ground, mashed or flaked. Journal of Food Science. 2013;12:212- 254.
13. Bolarinwa IF, Olaniyan SA, Adebayo LO, Ademole AA. Malted sorghum-soybean composite flour: preparation chemical and physico-chemical properties. Journal of Food Processing Technology. 2015;6(8): *1-7*.
14. Song TT. Economic and health benefits of soybean seeds. Journal of Food Science and Agriculture. 2000;8:38–40.
15. Ndife JI, Abdulraheem LO, Zakari UM. Evaluation of the nutritional and sensory quality of functional bread produced from whole wheat and Soybean flour blends. Africa Journal of Food Science. 2011;5(2): 66-72.
16. FIIRO. Instant poundo yam flour production technology. American Journal of Food Science; 2005;2(3):60-80.
17. AOAC. Official Methods of Analysis Association of Official Analytical Chemists. Washington, DC, USA. 2010;18:614-521.
18. Okaka JC. Teach Yourself Sensory Evaluation and Experimentation. Ocjanco Academic Publishers, Enugu, Nigeria. 2010;68- 69.
19. Oluwamukomi MO, Adeyemi AO. Physicochemical, pasting and sensory properties of “poundo” yam enriched with defatted soybean flour. Journal of Applied Tropical Agriculture; 2015;20(1): 89-95.
20. Okaka JC, Akobundu ENT, Okaka ANC. Food and Human Nutrition. An Integrated Approach. Ocjanco Academic Publishers, Enugu, Nigeria. 2006;102-144.
21. Gyoung D, Mebrahtu RD.Protein, fibre, and lipid contents of vegetable protein. Journal of the American Dietetic Association. 2003;98(9):44 – 49.
22. Gbenga DA, Emmanuel OA, Daniel BL, Margaret MM. Nutritional composition of yam flour fortified with soy-pomace. International Journal of Research and Scientific Innovation; 2019;6:22–60.
23. Okafor GO. Fundamentals of Food and Nutrition. His Glory Academic Publishers, Enugu, Nigeria. 2011;69 – 88.
24. Fabiyi EF. Soy processing, utilization and benefits. Pakistan Journal of Nutrition; 2006;5(5):453 – 457.
25. Trindad PT, Mallinlin AC, Valdez DH, Loyola AS, Askali-Mercado FC, Castillo JC, Encabo RR, Musa OB, Maglaya AS, Chua MT. Dietary fibre from coconut flour: a functional food. Innovative Food Science and Emerging Technologies; 2006;*7*:309-317.
26. Lattimer JM, Haub MD. Effect of dietary fibre and its components on metabolism of healthy nutrients. Critical Reviews in Biochemistry and Molecular Biology. 2010; 2:1226- 1289.
27. Nwamarah JU, Uwaegbute AC. Chemical and organoleptic evaluation of soybean-yam recipes as possible snacks and food for children. Journal of Biological Research; 2006;4(1):18 – 22.
28. Jackson SL, Cogswell ME, Zhao L, Terry AL, Wang CY, Wright J. Associations between urinary sodium and potassium excretion and blood pressure among adults in the United States. National Health and Nutrition Examination Survey. 2018; 173:237 – 246.
29. Maestric DM, Kumar V, Gai Z. History and seed composition of soybean cultivars evaluated in different regions. Journal of Food Science and Agriculture. 2002;77: 494–524.
30. Larsson SC, Wolk A. Magnesium intake and risk of type 2- diabetes: A meta-analysis. International Journal of Medicine. 2006;262:208 – 214.
31. Liu KS. Chemistry and nutritional value of soybean components. Journal of Nutritional Biochemistry. 2006;25–113.
32. Wesslsing Resmic R. Iron and mechanisms of emotional behaviour. Journal of Nutritional Biochemistry. 2014; 25(11):1101-1107.

33. Folake OS, Bolank OO, Titilope A. Nutrient and antinutrient contents of soy-enriched tapioca. Food and Nutrition Bulletin. 2012; 33:784-789.
34. Whittaker P. Iron and zinc interactions in humans. American Journal of Clinical Nutrition; 2001;68:442 – 446.
35. Bonham M, O'Connor JM, Hannigan BM, Strain, JJ. The immune system as a physiological indicator for marginal copper status. British Journal of Nutrition; 2002;87 (5)393– 403.
36. Beleke A, Beleke E. Proximate and mineral composition of Ethiopian yam (*Dioscorea specie*). Journal of Food and Nutrition. 2018;6:12-17.
37. Jacob RA, Sotoundeh G. Vitamin, function and status in chronic disease. Nutrition in Clinical Care. 2002;5:66– 74.
38. Alinnor IJ, Akalezi CO. Proximate and mineral composition of *Dioscorea rotundata* (white yam) and *Colocasia esculenta* (white cocoyam). Pakistan Journal of Nutrition. *2010;9(10):998–1001.*
39. Bruno RS, Mah E. Vitamin as a natural antioxidant. Journal of Biomedical Sciences. 2014;5(3):482 – 499.
40. Butt MS, Batool R. Nutritional and functional properties of some promising legume protein isolates. Pakistan Journal of Nutrition. 2010;9(4):374-379.
41. Olaoye OA, Ade-Omowaye BIO. *Composite Flours and Breads*; *Potential of Local Crops in Developing Countries.* In: Preedy, V.R., Watson, R.R. and Patel, V.B. (edn), flours and breads and their fortification in health and disease prevention. Academic Press, Elsaevier, London. 2011; 189 – 193.

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