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Production and Quality Evaluation of Pasta from Aerial Yam and Soybean Flours Blend Using Single-Screw Extruder

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Abstract
Pasta produced from aerial yam and soybean flours blend using single-screw extruder was evaluated for some quality characteristics, namely; anti-nutritional factors, sensory properties, proximate composition and functional properties. Standard laboratory analytical methods were adopted in the quality evaluation of the pasta. Results of the analyses for anti-nutritional factors show that the pasta contained 2.63mg/100g tannin, 59.61mg/100g oxalate, 17.48mg/100g phytate, 1.42mg/100g hydrogen cyanide, and 1.03% alkaloids. Sensory evaluation shows that the scores were: 5.72 for texture, 5.66 for taste, 6.11 for appearance, 6.30 for aroma, and 5.51 for overall acceptability. Proximate compositions were: 3.19% moisture content, 3.57% fibre content, 5.07% ash content, 35.89% protein content, 23.86% lipid content, and 30.11% carbohydrates content, while energy value was 478.88kcal. Functional properties were: 0.6969g/cm^3 bulk density, 2.60g/g water absorption capacity, and 1.72g/g oil absorption capacity. The results of quality evaluation of the pasta obtained can attest to the fact that it is possible to obtain expanded products from aerial yam and soybean flours blend, using extrusion processing technology, that possess desirable functional and sensory properties and minimal levels of anti-nutrients/toxicity, with nutritional benefits.

Keywords: *Quality evaluation, Pasta, Sensory properties, Aerial yam flour, Extrusion processing*

1.0 INTRODUCTION

Aerial yam (*Discorea bulbifera*) is a vigorous climber plant native of West Africa (Hamon *et al.*, 1995), cultivated for their bulbils which are consumed once cooked like potatoes in water with oil or roasted with local sauce (a combination of palm oil and other local spices). About 50-60 species of yam (*Dioscorea* spp.) are found in Nigeria but only 5 or 6 species are important as food (Ogbuagu, 2008). Unfortunately, some of these food crops have been under-exploited for their food values, for example, *Dioscorea bulbifera* (Ogbuagu, 2008). *Dioscorea bulbifera* is native to Africa and Asia and is commonly known as “air potato” (Ahmed *et al.*, 2009). Aerial yam is available in two varieties, the edible and non-edible. The edible varieties are cultivated and widely distributed in West Africa, West Indies, South Pacific, and South East Asia (FAO, 1985). *Dioscorea bulbifera* is among the most important tuber crops in West Africa. It is included in the roots and tubers which are widely distributed throughout the tropics with only a few in the temperate regions of the world (FAO, 1999). Together with cereals, they constitute the main source of energy in the tropics. This yam specie produced aerial starchy bulbils.

Soybean (*Glycine max*) is mainly cultivated for its seeds, used commercially as human food and livestock feed, and for the extraction of oil. Soy foods are becoming some of the fastest-growing categories in the food industry, with products ranging from traditional soy foods to protein ingredients, and from dairy and meat alternatives to various types of Western and traditional foods enriched with soybean flour and or its fractions (Iwe, 2003).

Soybean is nutritious, and has a unique chemical composition on an average-dry-matter basis; it contains about 40% protein and 20% oil and ranks highest in terms of protein content among all the legumes (Iwe, 2003).The protein and oil components in soybean are high not only in quantity, but also in quality. Soy oil contains a high proportion of unsaturated fatty acids, such as linolenic and linoleic acids; hence it is healthful oil. In addition, soybean contains many minor substances known as photochemical, which have been shown to offer unique health benefits. Soy foods have a high protein content and high protein utilization, leading to the highest amount of protein gained (Iwe, 2003).Industrially, soy protein products had been used as late as the 1960s as nutritional and functional food ingredients in some food categories available to the consumer. The earliest known of such products in Nigeria is the *soy-ogi*, developed at the Federal Institute of Industrial Research (FIIRO) Oshodi (Iwe, 2003).Substituting wheat flour with soybean up to 25% will go a long way to increase noodles variety, make them affordable to many and boost their nutritional content (Omeire *et al.*, 2014).

Aerial yam is yet to gain recognition and popularity globally, as a food crop. Processing it into stable blend, and subsequent extrusion processing to producing different products, will increase the visibility of the crop in food trade, thereby bringing to limelight its potential food uses to the food industry. Blending of aerial yam and soybean, and or extrusion cooking of the blend, has not been adequately studied for its potential application in food products formulation (Umoh and Iwe, 2022).

In addition, the application of known methods of food processing, like extrusion cooking, in the utilization of aerial yam (*Dioscorea bulbifera*) would mean introducing new food processing technology and food products, thereby offering variety to consumers.

This study is aimed at evaluating the quality attributes (anti-nutritional factors, sensory properties, proximate composition and functional properties) of pasta produced from aerial yam and soybean flours blend, using single-screw extruder.

2.0 MATERIALS AND METHODS

2.1 Procurement of Aerial yam bulbs and Soybean seeds

The aerial yam bulbs and the soybean seeds used in this study were purchased in an urban market in Uyo, Akwa Ibom State, Nigeria.

2.1.1 Preparation of Aerial yam flour

Aerial yam flour was prepared according to the method described by Umoh *et al*. (2021).The aerial yam bulbs were cleaned and sorted to remove unwanted materials, before peeling with knife, washed with clean water and sliced to 10 mm thickness using kitchen knife. The slices (chips) were then dried, using a laboratory oven at a temperature of 60 ℃ for 12 h. The dried slices (chips) were then milled using MF120 Hammer mill made in Italy, and sieved with laboratory sieve of 600µm aperture size. The flour obtained was packaged in a polyethene bag for subsequent use.

2.1.2 Preparation of Soybean flour

Soybean flour was prepared according to the method described by Umoh *et al*. (2021). Seeds were screened to remove foreign materials, splits, and damaged beans. This was followed by washing and roll boiling at 100 ℃ for 30 minutes. It was then oven -dried at a temperature of 70 ℃ for 12h, and milled in a disc attrition mill. The milled full-fat soybean was sieved using a 100-mesh standard sieve. The flour obtained was then stored in air- tight polyethene bag at room temperature for further use.

2.2 Production of pasta

The aerial yam and soybean flours blend was prepared in the ratio of 1:3, that is, 25% aerial yam flour and 75% soybean flour, and then rehydrated to 31% feed moisture content. The pastas were produced using a laboratory scale single-screw extruder, utilizing 105 ^{o}C barrel temperature and 115 rpm screw speed. The pastas were collected as they exit from the die, oven-dried and packaged for subsequent laboratory analyses.

2.3 Determination of Anti-nutritional factors

The following anti-nutritional factors were determined:

2.3.1 Tannin content determination

The Folin-Dennis spectrophotometric method as described by Umoh *et al.* (2021) was used in the determination of tannin. One gram (1g) of the sample was dispersed in 10ml distilled water, agitated and allowed to stand for 30 minutes at room temperature (23 ^{o}C), then centrifuged. Two and half millilitres (2.5 ml) of the supernatant, 2.5 ml of tannic acid solution were dispersed into a 50ml flask respectively. One millilitre (1 ml) of Folin Dennis reagent was added to each flask, followed by 2.5ml of saturated Na_2CO_3 solution. The mixture was then diluted to 50ml mark, and incubated for 90 minutes at room temperature. The absorbance was measured at 250nm in a BENWAY Model 6000 electronic spectrophotometer. The tannin content was calculated using equation 2.1.

$$\text{Tannin (\%)} = \frac{An}{As} \times C \times \frac{100}{W} \times \frac{Vf}{Va} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad 2.1$$

Where:

An = Absorbance of test sample
As = Absorbance of standard solution
C = concentration of standard solution
W = weight of Sample

V_f = total volume of extract
Va = volume of extract analyzed

2.3.2 Oxalates content determination

Determination of Oxalate which involves three major steps (digestion, oxalate precipitation and permanganate titration) was carried out according to the method described by Umoh *et al.* (2021).

Digestion:
Two and half grams (2.5g) of the sample was mixed with 95ml distilled water and 5ml 6N HCl in a 250ml beaker. The mixture was heated at 50°C for 2h using water bath, filtered and diluted to 125ml with distilled water.

Oxalate precipitation:
Four (4) drops of methyl red indicator was added to 50ml of the filtrate in a 100ml beaker, evaporated to 25ml volume, and filtered. The filtrate was treated with 5ml concentrated. NH_4OH, heated again to 90°C, and 10ml 5% $CaCl_2$ solution added with constant stirring. It was then cooled and left overnight at 5°C, centrifuged at 2500rpm for 5 minutes, supernatant decanted and the precipitate obtained, washed with 10ml 20% (v/v) H_2SO_4 solution and total volume diluted to 125ml distilled water.

Permanganate titration:
Aliquots of 125ml of the solution was heated to 90°C, titrated against 0.05N $KMnO_4$ solution to a faint pink colour, and the calcium oxalate content calculated thus: 10ml of 0.05N $KMnO_4$ = 2.2 mg oxalate.

2.3.3 Phytates content determination

This was determined according to the method of Mecance and Widdowson as described by Umoh *et al.* (2021). Two and half grams (2.5 g) of the sample was extracted with 50 ml 3% TCA for 30 minutes, centrifuged and transferred into a 40 ml conical flask. Four millilitres (4 ml) of $FeCl_3$ solution was added, heated in a boiling water bath for 45 minutes, centrifuged and carefully decanted. The precipitate was washed with 20 ml 3% TCA, heated and centrifuged. Then dispersed in a few ml of water and 3ml of 1.5 M NaOH added with mixing. The volume was brought to 30 ml with water, heated for 30 minutes, centrifuged and carefully decanted.

The precipitate was washed again with hot water, re-centrifuged and decanted. Then dissolved with hot 40 ml 3.2M HNO_3, and transferred into a 100 ml standard flask, cooled to room temperature and diluted to volume with distilled water. The iron (Fe) of the solution was determined, with an assumed 4:6 iron-phosphorus molecular ratio.

Calculation:

$\text{Determined Fe in the sample} = \text{Xmg}$
$\text{Convert Xmg to mmole X} = \text{5mmole} = 55.85(\text{mol Fe})$
$\text{Therefore, phosphorus, P} = {}^{6}/_{4} \times \text{X} = \text{4mmole of P}$
$\text{Phytic acid, P.A} = 660.80 \times \text{Y} = \text{Zmmole P.A}$

Where: 660.80 is the molar weight of P.A, Y is 6 × molecula mass of P
∴ mg P.A= Z × 660.80, i.e,
Phytic acid (mg/100g) = Zmmole × molecular weight of P. A

2.3.4 Hydrogen cyanide determination

This was determined using the alkaline picrate method- by spectrophotometer as described by Umoh *et al*. (2021). Five grams (5 g) of the sample was made into paste. The paste was then dissolved in 50 ml distilled water in a conical flask and corked. The extraction process was allowed to stay overnight, then filtered. The filtrate was then used for cyanide determination. To 1ml of the filtrate in a corked test tube, 4 ml of alkaline picrate was added and incubated for 5 minutes in a water bath. After a reddish brown colour development, absorbance was read in the spectrophotometer at 490 nm.
The absorbance of the blank containing 1ml distilled water and 4 ml alkaline picrate solution was also read. The cyanide content was then extrapolated from the cyanide standard curve, and expressed as *mgHCN equivalent/100g* of sample.

2.3.5 Alkaloids determination

The gravimetric method of Harbone, as described by Umoh *et al*. (2021), was used in the determination of alkaloids content in the flour sample. Five grams (5 g) of the sample was weighed into a 100 ml beaker; 50 ml of 10% acetic acid solution in ethanol will be added and stirred.

This was allowed to stand for 4 hours, filtered and the filtrate evaporated to ¼ of its original volume, and concentrated NH_4OH will be added drop wise to precipitate the alkaloids. The precipitate was filtered off using a weighed filter paper (W_1) and washed with 1% NH_4OH solution. The precipitate in the filter paper was oven dried at 60 ºC for 30 minutes and weighed (W_2). The weight of alkaloid was determined by weight difference expressed as a percentage of the sample weight analyzed, using equation 2.2.

$$\text{Alkaloid (\%)} = \frac{W_2 - W_1}{W} \times \frac{100}{1} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad 2.2$$

Where:
w = weight of sample
w_1 = weight of empty filter paper
w_2 = weight of filter paper + precipitate.

2.4 Evaluation of Sensory properties

Sensory properties of the pasta produced from aerial yam and soybean flours blend were determined using a 9 point Hedonic scale ranging from 1 (extremely dislike), 5 (neither like nor dislike) to 9 (extremely liked), as described by Umoh and Iwe (2022). A ten-man semi trained panel evaluated the sample, and accordingly, scored for texture, taste, appearance, aroma and overall acceptability of the pasta.

2.5 Determination of Proximate composition

Proximate compositions of the pasta were determined according to the method of AOAC (2014), as follows:

2.5.1 Moisture content determination

The weight of a washed and oven dried beaker was taken after cooling in a desiccator (a). Two grams (2g) of the flour blend sample was introduced into the weighed beaker and the weight of the beaker plus sample was taken (b). The beaker with its content was dried in an oven at 105 ℃ for 4h after which was quickly transferred into a desiccator to cool, then reweighed. This procedure was repeated till a constant weight was obtained (c). The moisture content was calculated using equation 2.3.

$$\text{Calculation:Moisture Content } (\%) = \frac{\text{loss in weight due to drying}}{\text{weight of sample taken}}$$

$$= \frac{b-c}{b-a} \times 100 \text{ ....equation 2.3}$$

2.5.2. Fiber content determination

Two grams (2 g) of the sample was defatted with petroleum ether for 2 h. It was boiled for 30 minutes with 200 ml of H_2SO_4 solution, filtered through linen on a fluted funnel and washed with boiling water until the washings were no longer acidic. The residue was transferred to a beaker and boiled for another 30 minutes with 200 ml of NaOH solution, filtered and the final residue washed with boiling water several times until was base (NaOH) free.The residue was finally washed twice with methanol, quantitatively transferred into a pre-weighed crucible, and oven dried at 105 ℃ (Io). It was incinerated in a furnace at 550 ℃, cooled in a dessicator and weighed (Ia). The loss in weight after incineration was also taken. The fiber content was calculated using equation 2.4.

Calculation:

$$\text{Crude fiber } (\%)= \frac{I_{a-I_o}}{\text{weight of original sample taken}} \text{ X } 100 \text{ ....equation 2.4}$$

2.5.3 Ash content determination

A crucible with lid was ignited in a muffle furnace, Model SXL-1200, at 105 ℃ for 1h. It was then transferred to a dessicator to cool and weighed (a). Two grams (2g) of the flour blend sample was put into the pre-weighed crucible and its content (flour sample) was taken (b). The crucible and its content was charred using Bunsen flame in a fume cupboard, until smoking ceased. It was then transferred to a muffle furnace, at 550 ℃ for 2h until a white ash resulted. The crucible was taken out, cooled, covered and placed in a dessicator and weighed (c). The ash content was calculated using equation 2.5.

Calculation:

$$\text{Ash } (\%) = \frac{\text{weight of Ash}}{\text{weight of sample}} \text{ X } 100$$

$$= \frac{b-C}{b-a} \times 100 \text{ ……………………………..equation 2.5}$$

2.5.4 Protein content determination

Crude protein was determined by Kjeldahl method. One gram (1g) of the flour sample was accurately weighed into a standard 250 ml Kjeldahl flask containing 1.5 g $CuSO_4$ and 1.5 g Na_2SO_4 as catalyst and 5 ml conc. H_2SO_4.

The kjeldahl flask (digestion) was placed on a heating mantle and was heated gently to prevent frothing, for some hours until a clear bluish solution was obtained. The digested solution was allowed to cool and was quantitatively transferred to 100 ml standard flask, made up to the mark with distilled water. Twenty millilitres (20 ml) portion of the digest was pipetted into a semi micro kjeldahl distillation apparatus and treated with equal volume of 40% NaOH solution. The ammonia evolved was steam distilled into 100 ml conical flask containing 10 ml solution of saturated boric acid to which 2 drops of Tashirus indicator (double indicator) had been added.

The tip of the condenser was immersed into the boric acid – double indicator solution and then the distillation continued until about 2/3 of the original volume was obtained. The tip of the condenser was then rinsed with a few millilitres of distilled water in the distillate which was then titrated with 0.1M HCl solution until a purple-pink end-point was observed. A blank determination was also carried out in the similar manner as described above except for the omission of the sample. The crude protein was obtained by multiplying the % Nitrogen content by a factor, 6.25.

Crude protein = % Nitrogen X factor. The protein content was calculated using equation 2.6.

Calculation:

$$\frac{(\text{Sample titre} - \text{blank titre})0.1\times0.014}{\text{Weight of sample}} \times \frac{100}{20} \times \frac{100}{1} \times 6.25 \text{ ………… equation 2.6}$$

2.5.5 Lipids content determination

Two grams (2 g) of the flour sample was weighed into extraction thimble, which had already been washed, oven dried and lightly plugged with cotton wool. One hundred and fifty millilitres (150 ml) of petroleum ether with boiling point between $35\ to\ 60℃$, was poured into a 500 ml capacity round bottom flask. The soxhlet extractor was fitted into the round bottom flask which was seated on a heating mantle. The soxhlet apparatus was assembled and allowed to reflux for about 4 h. The extract was poured into a dried pre-weighed beaker (W_1) and the thimble rinsed with a little quantity of the ether back to the beaker. The beaker was heated on a steam bath to drive off the excess solvent, cooled in a desiccators and weighed (W_2). The crude fat content was calculated using equation 2.7.

$$\frac{\text{Weight gain in flask}}{\text{Weight of sample}} \times \frac{100}{1}$$

$$\text{Crude fat (\%)} = \frac{W_2 - W_1}{\text{Weight of sample}} \times \frac{100}{1} \text{ ………………………………….. equation 2.7}$$

2.5.6 Carbohydrate Content determination

Determination of carbohydrate content of the sample was carried out by subtracting the total estimations (in %) made of nitrogen (protein), fat, ash and crude fibre contents from 100%. The resultant value gave the percentage carbohydrate content by difference, using equation 2.8

$$\text{Carbohydrate (\%)} = 100 - (a + b + c + d) \qquad 2.8$$

where, a = percentage protein content
b = percentage lipid content
c = percentage ash content
d = percentage fibre content

2.5.7 Energy (caloric) value determination

This was obtained using the Atwater factor method. The values of the crude protein, fat, and carbohydrate obtained were multiplied by 4, 9, 4 respectively, and the sum of the products was taken as the caloric or energy value, (in kcal) of the sample, using equation 2.9.

$$\text{Energy value (kcal)} = (x \times 4) + (y \times 9) + (z \times 4) \qquad 2.9$$

where, x = protein content
y = lipid content
z = carbohydrate content

2.6 Determination of Functional properties

2.6.1 Bulk density determination

The flour sample was filled in a 10 ml dried measuring cylinder and the bottom of the cylinder tapped several times on the laboratory table until there was no further diminution of the sample level after filling to 10 ml mark (Onwuka, 2018). Bulk density was then calculated using equation 2.10

Calculation:

$$\text{Bulk density (g/cm}^3) = \frac{\text{weight of sample (g)}}{\text{volume of sample (cm}^3)} \text{ .... equation 2.10}$$

2.6.2 Water absorption determination

This was determined according to the methods described by Onwuka (2018).Ten millilitres (10ml) of distilled water was mixed with one gram (1 g) of sample in a mixer and homogenized for 30 seconds and allowed to stand at room temperature for 30 minutes and centrifuged at 5000 rpm for 30 minutes. The volume of the supernatant (free water) in a graduated cylinder was noted. The amount of water absorbed (total minus free) was multiplied by its density for conversion to grams. Density of water was assumed to be 1 g/ml.

$$\text{Water absorption capacity (g/g)} = \frac{V_1 - V_2}{W} \times \text{density of water}$$

Where:

V_1 = initial volume of water (10 ml)
V_2 = final volume after centrifugation
W = weight of sample (1 g)

2.6.3 Oil Absorption capacity

This was determined according to the methods described by Onwuka (2018).Exactly one gram (1g) of flour blend sample was mixed with 10 ml of vegetable oil. The oil and the sample were mixed and homogenized for 30 seconds and allowed to stand for 30 minutes at room temperature and then centrifuged at 5000 rpm for 30 minutes. The volume of free oil (supernatant) was noted directly from the graduated centrifuge tube. The amount of oil absorbed (total minus free) was then multiplied by its density for conversion to grams.

Density of oil was taken to be 0.88 g/ ml for bleached palm oil.

$$\text{Oil absorption capacity (g/g)} = \frac{V_1 - v_2}{w} \times \text{density of oil}$$

Where:

V_1 = Initial volume of oil
V_2 = Final volume after centrifugation
w = Weight of sample.

3.0 RESULTS AND DISCUSSIONS

3.1 Anti-nutritional factors

The results of the anti-nutritional factors in the pasta produced from aerial yam and soybean flours blend are presented in Table 3.1.

Table 3.1: Anti-nutritional factors in pasta produced from Aerial yam and Soybean flours blend

S/N	Anti-nutritional factors	Composition
1	Tannin (mg/100g)	2.63±0.0025
2	Oxalates (mg/100g)	59.56±1.245
3	Phytate (mg/100g)	17.48±0.018
4	Hydrogen cyanide (mg/100g)	1.42±0.003
5	Alkaloids (%)	1.03±0.005

Values are means ± standard deviation of triplicate determination

3.1.1 Tannin content

Tannin content of the pasta produced from aerial yam and soybean flours blend was 2.63 mg/100g of sample (Table 3.1). This value is quite low compared to 5.144 to 21.68 mg/100g of sample for processed false yam tuber flour (Umoh, 2013); 35.50 to 130.17mg/100g for sorghum-based extruded product supplemented with defatted soy meal flour (Tadesse *et al*., 2019), but slightly higher than 0.03 to 0.04% for extruded meals of quality protein maize, soybean concentrate and cassava starch (Omosebi *et al*., 2018); 0.1942 to 0.4643 % tannic acid for extruded sorghum-soya blends (Arun kumar *et al*., 2018); 0.28 to 0.81mg GA/g – dry matter, for soybean hull (Tabibloghmany*et al*., 2020).

Tannins exhibit anti-nutritional properties by impairing the digestion of various nutrients and preventing them from being absorbed by the body. Tannin can also bind and shrink proteins, which may result in digestive enzymes inactivation and protein digestibility reduction caused by protein substrate and ionizable iron interaction (Popova and Mihaylova, 2019; Ogunkoya *et al*., 2006).

3.1.2 Oxalates content

The results of the anti-nutritional factors in the extruded aerial yam and soybean flours blend shows that oxalate content recorded 59.56 mg/100g of sample (Table 3.1). This value is lower, when compared with 167.200 to 256.900 mg/100g of sample for processed false yam tuber flour (Umoh, 2013); and 102.71 mg/100g of sample for extruded aerial yam and soybean flours blend (Umoh *et al.*, 2021). Oxalic acid can form soluble (potassium and sodium) or insoluble (calcium, magnesium and iron) salts or esters called oxalates, that are commonly found in plants or synthesized in the body.

In sensitive people, even small amount of oxalate can result in burning in the eyes, ears, mouth and throat; large amount may cause abdominal pain, muscle weakness, nausea and diarrhoea (Popova and Mihaylova, 2019).

3.1.3 Phytates content

The result of the phytates content of the extruded aerial yam and soybean flours blend was 17.48 mg/100g of sample (Table 3.1). This value is within the range of 12.48 to 32.86 mg/100g of sample for extruded aerial yam and soybean flours mixture, earlier reported by Umoh *et al.* (2021), but much lower than 177.53 to 311.83mg/100g for extruded sorghum-soya blends (Arun kumar *et al*., 2018); and 247.32 to 485.69mg/100g for sorghum-based extruded product supplemented with defatted soy meal flour (Tadesse *et al*., 2019b).

Phytates occur in several vegetable products. Seeds, grains, nuts and legumes store phosphorus as phytic acid in husks in the form of phytin or phytate salt. Their presence may affect bioavailability of minerals, solubility, functionality and digestibility of proteins and carbohydrates (Popova and Mihaylova, 2019).

3.1.4 Hydrogen cyanide (HCN) content

The pasta produced from aerial yam and soybean flours blend recorded a hydrogen cyanide content of 1.42 mg/100g of sample (Table 3.1). This value is slightly higher than 0.11 to 0.13mg/100g for extruded maize-soybean protein concentrate, earlier reported by Omosebi *et al*. (2018), but falls within the range of 0.79 to 5.11mg/100g for extruded aerial yam-soybean flours mixture (Umoh *et al.*, 2021). However, the HCN content recorded was lower than the recommended safe level of 10mg HCN/kg, db (FAO/WHO, 1991; Bandna, 2012). This suggests that pastas produced from aerial yam and soybean flours blend could be safe from the toxicity effect of hydrogen cyanide. So, it is important to ensure that minimal levels are present in food for human consumption, as consumption of foods containing cyanogens could results in acute or chronic toxicity.

3.1.5 Alkaloids content

Alkaloids content of the pasta produced from aerial yam and soybean flours blend was 1.03% (Table 3.1). This value falls within the range of 0.79 to 2.19% for extruded aerial yam-soybean flours mixture (Umoh *et al*., 2021); and 1.36 to 3.12 mg/100g for processed false yam tuber flour (Umoh, 2013). Some of the toxicological manifestations of potato glycol-alkaloids include gastro-intestinal upset and neurological disorders, especially in doses in excess of 20mg/100g sample.

3.2 Sensory properties

The results of the sensory properties of pasta produced from aerial yam and soybean flours blend are presented in Table 3.2.

Table 3.2: Sensory properties of pasta produced from aerial yam and soybean flours blend

S/N	Sensory property	Score
1	Texture	5.72±0.021
2	Taste	5.66±0.003
3	Appearance	6.11±0.003
4	Aroma	6.30±0.034
5	Overall acceptability	5.51±0.011

Values are means ± standard deviation of triplicate determination

3.2.1 Texture

The recorded score for texture was 5.72 (Table 3.2), which is within the range of 4.38 and 6.02 for pasta from blends of aerial yam-soybean flours, earlier reported by Umoh and Iwe (2022). However, the recorded score for texture is higher than 1.96 to 4.64 for sorghum-based extruded product supplemented with defatted soy meal flour, as earlier reported by Tadesse *et al*. (2019a), but lower than 7.22 to 8.44 earlier recorded for pulse-based snacks (Alemayehu *et al*., 2019). The high score recorded for texture shows that the pasta produced from aerial yam and soybean flours blend had a good texture.

3.2.2 Taste

For taste, the recorded score was 5.66 (Table 3.2). This score falls within 5.3 to 7.6 for root and tuber composite flour noodles (Akonor *et al*., 2017); 5.44 to 6.58 for selected Aerial yam cultivar and African Breadfruit extruded snacks (Olatoye and Arueya, 2021); and 4.68 to 6.78 for pasta from blends of aerial yam and soybean flours (Umoh and Iwe, 2022). The high score recorded for taste indicates that the pasta had a good taste.

3.2.3 Appearance

The recorded score for appearance of the pasta was 6.11 (Table 3.2). This value is within the range of 4.58 to 6.97 for pasta from blends of aerial yam-soybean flour (Umoh and Iwe, 2022); 2.96 to 6.68 for sorghum-based extruded product supplemented with defatted soy meal flour earlier reported by Tadesse *et al*. (2019a), but lower than 6.89 to 8.22 for pulse-based snacks (Alemayehu *et al*., 2019). The high score for appearance suggests that the appearance of the pasta produced from aerial yam and soybean flours blend was moderately liked.

3.2.4 Aroma

The aroma recorded a score of 6.30 (Table 3.2). This score falls within 4.88 to 6.80 for sorghum-based extruded product supplemented with defatted soy meal flour earlier reported by Tadesse *et al*. (2019a); 5.3 to 7.4 for root and tuber composite flour noodles (Akonor *et al*., 2017); and 4.45 to 7.00 for pasta from blends of aerial-soybean flours (Umoh and Iwe, 2022).

3.2.5 Overall acceptability

The overall acceptability of the pasta produced from aerial yam and soybean flours blend recorded a score of 5.51 (Table 3.2). The recorded score is within the range of 4.20 to 7.10 for pasta from blends of aerial yam-soybean flours, earlier reported by Umoh and Iwe (2022); 4.00 to 6.44 for sorghum-based extrudate supplemented with defatted soy meal flour (Tadesse *et al*. 2019a); 5.20 to 7.50 for rice flour-pineapple waste pulp powder-red grain- powder extrudates (Kothakota *et al*., 2013), but lower than 7.22 to 8.33 for pulse-based snacks (Alemayehu *et al*., 2019); 5.94 to 7.02 for selected Aerial yam cultivar and African Breadfruit extruded snacks (Olatoye and Arueya, 2021). The high score recorded indicates that the pasta produced from aerial yam and soybean flours blend was well accepted generally by the panelists.

3.3 Proximate composition and Energy value

The results of the proximate composition and energy value of pasta produced from aerial yam and soybean flours blend are presented in Table 3.3.

Table 3.3: Proximate composition and Energy value of pasta produced from Aerial yam and Soybean flours blend

S/N	Parameter	Composition
1	Moisture content (%)	3.19±0.004
2	Fibre content (%)	3.57±0.002
3	Ash content (%)	5.07±0.003
4	Protein content (%)	35.89±0.071
5	Lipids content (%)	23.86±0.005
6	Carbohydrate (%)	30.11±0.062
7	Energy value (kcal)	478.88±0.891

Values are means ± standard deviation of triplicate determination

3.3.1 Moisture content

The result of the moisture content of pasta produced from aerial yam and soybean flours is presented in Table 3.3. The pasta recorded a moisture content of 3.19%, which is within the range (3.10 to 7.02%) for extruded aerial yam-soybean flour blends earlier reported by Umoh and Iwe (2022), but lower than 8.15 to 8.66% for sorghum-based extruded product supplemented with defatted soy meal flour (Tadesse *et al*., 2019a); and 5.97 to 6.59% for selected aerial yam cultivar and African Breadfruit extruded snacks (Olatoye and Arueya, 2021). The observed low value for moisture content indicates that the pasta can store for a long time without spoilage due to microbial activities.

3.3.2 Fibre content

Fibre content of the pasta was 3.57% (Table 3.3). This value is within the range of 2.70 to 4.67% for extruded aerial yam-soybean flours blend, reported earlier by Umoh and Iwe (2022), but higher than 0.83 and 1.58% for sorghum-based extruded product supplemented with defatted soy meal flour (Tadesse *et al*., 2019a); 0.78 to 0.99% for selected Aerial yam cultivar and African Breadfruit extruded snacks (Olatoye and Arueya, 2021). The high fibre content is an indication that pastas produced from aerial yam and soybean flours blend is a potential rich source of dietary fibre, which is necessary in the movement of food bowel and helps in the prevention of obesity, diabetes, cancer of the colon and other diseases of the gastro-intestinal tract of man (Dresden, 2021).

3.3.3 Ash content

Ash content of the pasta was 5.07% (Table 3.3), which is higher than 1.45 to 2.56% for sorghum-based extruded product supplemented with defatted soy meal flour (Tadesse *et al*., 2019a); 1.88 to 2.91% for root and tuber composite flour noodles (Akonor *et al*., 2017); 1.33 to 2.69% for selected Aerial yam cultivar and African Breadfruit extruded snacks (Olatoye and Arueya, 2021); and 1.67 to 3.00% for high quality cassava-Tiger nut extruded snacks (Kareem *et al*., 2015). This is an indication that pastas produced from aerial yam and soybean flours blend is a potentially rich source of minerals.

3.3.4 Protein content

Results of the proximate analysis of the pasta indicate that protein content was 35.89% (Table 3.3). This value is within the range of 24.57 to 36.79% earlier reported for extruded aerial yam and soybean flours blend (Umoh and Iwe, 2022), but higher than 12.20 to 20.85% for sorghum-based extruded product supplemented with defatted soy meal flour (Tadesse *et al*., 2019a); 10.90 to 14.26% for root and tuber composite flour noodles (Akonor *et al*., 2017); and 8.80 to 13.59% for selected Aerial yam cultivar and African Breadfruit extruded snacks (Olatoye and Arueya, 2021).The high protein content in the pasta may be attributed to the higher proportion of soybean flour (75%), compared to the proportion of aerial yam flour (25%) in the flour blend; Soybean has been reported to contain appreciable high percentage of protein. It can therefore be inferred that pasta produced from aerial yam and soybean flours blend is a potential rich source of protein required by humans for proper growth and development.

3.3.5 Lipid content

The pasta recorded a lipid content of 23.86% (Table 3.3). This value falls within the range of 11.39 and 35.35% for aerial yam and soybean flours blends, earlier reported by Umoh and Iwe (2022), but higher than 3.06 to 3.96% for sorghum-based extruded product supplemented with defatted soy meal flour (Tadesse *et al*., 2019a); 6.40 to 9.07% for selected Aerial yam cultivar and African Breadfruit extruded snacks (Olatoye and Arueya, 2021); and 0.42 to 22.28% for high quality cassava-Tiger nut extruded snacks (Kareem *et al*., 2015). The high fat content in the pasta may be attributed to the full-fat soybean flour used as a component of the blend.

3.3.6 Carbohydrates content

The result of the carbohydrates content of the pasta produced from aerial yam and soybean flours blend was 30.11% ((Table 3.3). This value is rather low when compared with 54.47 to 82.96% for high quality cassava-Tiger nut extruded snacks (Kareem *et al*., 2015); 62.60 to 74.20% for sorghum-based extruded product supplemented with defatted soy meal flour (Tadesse *et al*., 2019a); and 69.55 to 76.58% for selected Aerial yam cultivar and African Breadfruit extruded snacks (Olatoye and Arueya, 2021). The low carbohydrates content of the pasta produced from aerial yam and soybean flours blend may be attributed to the fact that soybean which accounted for 75% of the flour blend, is not so rich in carbohydrates. Also, an appreciable percentage of carbohydrate has been destruct as a result of extrusion cooking.

3.3.7 Energy value

Energy value of the pasta produced from aerial yam and soybean flours blend was 478.88 kcal (Table 3.3). This value is within the range, 398.84 to 529.17 kcal for extruded aerial yam and soybean flours blend (Umoh and Iwe, 2022). The high energy (caloric) value is an indication that pastas produced from aerial yam and soybean flours blend may be very useful in providing, or supplementing the daily energy requirement of the human body.

3.4 Functional properties

The results of the functional properties of pasta produced from aerial yam and soybean flours blend are presented in Table 3.4.

Table 3.4: Functional properties of pasta produced from aerial yam and soybean flours blend

S/N	Functional property	Composition
1	Bulk density (g/cm^3)	0.6969±0.004
2	Water absorption capacity (g/g)	2.60±0.003
3	Oil absorption capacity (g/g)	1.72±0.028

Values are means ± standard deviation of triplicate determination

3.4.1 Bulk density

Bulk density of the pasta was 0.6969 g/cm^3 (Table 3.4). This observed value is higher than 0.24 to 0.36 g/cm^3 for sorghum-based extruded product supplemented with soy meal flour (Tadesse *et al*., 2019b); 0.0202 to 0.3503g/cm^3 for extruded rice flour-pineapple waste pulp powder-red gram powder (Kothakota *et al*., 2013); 0.19 to 0.31g/cm^3 for fish-maize based extruded snacks (Nkubana *et al*., 2020); 0.114to 0.2176g/cm^3 for ready-to-eat pulse-based snacks (Alemayehu *et al*.,2019), but lower than 0.832 to 0.988g/cm^3 for meat analogue from mucuna bean seed flour (Omohimi *et al*., 2014).

Bulk density is an index of extent of puffing, and is directly related to the texture of the final product of expanded starch-based extrudate. It is also determined by the combination of growth and subsequent shrinkage or collapse of water vapour bubbles in the extrudates, and by the effect of die swelling due to the elastic property of the melted matrix (Tadesse *et al*., 2019b). Light density means soft structure which is desirable in such type of product.

3.4.2 Water absorption capacity

The result of water absorption capacity of pasta produced from aerial yam and soybean flours blend was 2.60 g/g (Table 3.4). The recorded value is within the range of 2.5 to 3.56g/g for cassava/soybean extrudates (Olusegun *et al*., 2016), higher than 1.667 to 2.320 g/g for meat analogue from mucuna bean seed flour (Omohimi *et al*., 2014), but lower than 3.918 to 5.997g/g for pineapple waste pulp-rice flour-red gram powder based extrudates (Kothakota *et al*., 2013); 4.92 to 6.07g/g for fish-maize based extruded snacks (Nkubana *et al*., 2020), and 3.922 to 6.017g/g for ready-to-eat pulse-based snacks (Alemayehu *et al*., 2019).

Water absorption capacity gives an insight into the extent of gelatinization of starch in the feed ingredients generally by measuring the amount of water absorbed by starch granules after swelling in excess of water originally present in the product (Olusegun *et al*., 2016). Water absorption index depends on the availability of hydrophilic groups which bind water molecules and the gel-forming capacity of the macromolecules involved.

3.4.3 Oil absorption capacity

Results of the functional properties of pasta produced from aerial yam and soybean flours blend show that oil absorption capacity of the pasta was 1.72 g/g (Table 3.4). This value is within the range of 1.12 to 2.88 g/g for extruded aerial yam and soybean flours mixture, earlier reported by Umoh and Iwe (2023); and 1.761 to 2.389 g/g for meat analogue from mucuna bean seed flour (Omohimi *et al*., 2014). Oil absorption capacity can be used as an index of the hydrophobicity of an extruded product (Tabibloghmany *et al*., 2020).

4.0 CONCLUSION

The findings from this study is a confirmation of previous researches, of the possibility of developing new food products from aerial yam and its composites by the application of extrusion processing technology.

The results obtained for the anti-nutritional factors, sensory properties, proximate composition and functional properties and of the pasta can attest to the fact that it is possible to obtain expanded products from aerial yam and soybean flours blend by extrusion processing technology, that possess desirable functional and sensory attributes and minimal levels of anti-nutrients/toxicity, with nutritional advantages.

REFERENCES

Ahmed, Z., Chishti, M. Z., Johri, R. K., Bhagat, A., Gupta, K. K. and Ram, G. (2009). Antihyperglycemic and Antidyslipidemic activity of aqueous extract of *Dioscorea bulbifera* tubers. *Dioscorea Croatica*, pp 38–39.

Akonor, P. T., Tortoe, C., Buckman, E. S. and Hagan, L. (2017). Proximate composition and Sensory evaluation of Root and Tuber composite flour noodles. *Cogent Food and Agriculture* 3:1-6.

Alemayehu, H., Addmassu, E., and Henry, C. (2019). Effects of Extrusion process parameters on the quality properties of Ready-to-eat Pulse-based snacks. *Cogent Food and Agriculture.* 5:22-29.

Arun kumar, T. V., Indra, M., Pramod, A., Samuel, D. V. K., Jha, S. K., Sahoo, P. K., Sinha, J. P., and Abhijit, K. (2018). Effect of Extrusion technique on Antinutritional factors of Sorghum-soya Blends. *Indian Journal of Agricultural Sciences.*88(3): 420-428.

Bandna, C. (2012). Effect of processing on the Cyanide content of Cassava products in fiji. *Journal of Microbiology, Biotechnology and Food Sciences,* 2: 947- 958.

Dresden, D., http://www.medicalnewstoday.com/article.Accessed, March 25, 2021.

FAO. (1985). Production year book. Food and Agriculture Organisation of United Nations Rome, Italy. p. 39.

FAO. (1999). Food and Agriculture Organization of the United Nations .Production Yearbook Vol. 53., Rome, Italy.

FAO/WHO. (1991). Joint FAO/WHO Food Standard programme. Codex Alimentarius Commission XII. (Suppl. 4). Italy, Rome: FAO.

Hamon, P., Dumont R., Zoundjihékpon, J., Tio-Touré, B. and Hamon, S. (1995). Les Ignames Sauvages d'Afrique de l'Ouest/ Wild Yam in Africa. Morphological Characteristics. Ed. Orstom,collection Didactiques. 1995; 84.

Iwe, M. O. (2003). *The Science and Technology of Soybean: Chemistry, Nutrition, Processing, Utilization*. Rojoint Communication Services Ltd, Enugu, Nigeria. Pp 1-6.

Kareem, S. T., Adebowale, A. A., Sobukola, O. P., Adebisi, M. A., Obadina, O. A., Kajihausa, O. E., Adegunwa, M. O., Sanni, L. O. and Keith, T. (2015). Some quality attributes of high quality Cassava-tigernut composite flour and its Extruded snacks. *Journal of Culinary Science and Technology,* 13:242-262.

Kothakota, A., Jindal, N., and Thimmaiah, B. (2013). A study on Evaluation and Characterization of Extruded product by using various by-products. *African Journal of Food Science,* 7(12): 485–497.

Nkubana, A., Dusabumuremyi, J. C. and Yadufashije, C. (2020).Optimization of Extrusion conditions for development of Fish-maize based Extruded snacks by Response Surface Methodology. *Afr.J.Bio.Sc.* 2 (2): 88-99.

Ogbuagu, M. N. (2008). Nutritive and Anti-nutritive Composition of the wild (in-edible) Species of *Dioscorea bulbifera* (potato yam) and *Dioscorea dumentorum* (Bitter yam). *Journal of food Technology*, 6 (5): 224-226.

Olatoye, K.K. and Arueya, G.L. (2021). Chemical and Sensory characteristics of Extruded snacks from selected Aerial yam (*Dioscorea bulbifera*) cultivar and African Breadfruit (*Treculia Africana*) Seed. *Journal of Culinary Science and Technology.*19: 1-17.

Olusegun, A. A., Stephen, A. A., Folashade, B. I. and Oladejo, D. (2016). Effect of Extrusion conditions on Cassava/Soybean Extrudates. *MOJ Food Process Technol.*3(1):237-245.

Omeire, G. C., Umeji, O. F. and Obasi, N. E. (2014). Acceptability of Noodles produced from Blends of Wheat, Acha and Soybean Composite Flours. *Nigerian Food Journal* 32(1): 31-37.

Omohimi, C.I., Sobokola, O.P., Sarafaden, K.O. and Sanni, L.O. (2014). Effect of Thermo-extrusion Process Parameters on Selected Quality Attributes of Meat Analogue from Mucuna Bean Seed Flour. *Nigerian Food Journal* 32(1): 21-30.

Onwuka G. I. (2018). *Food Analysis and Instrumentation (Theory and practice*). Naphtali Prints, Somolu, Lagos, Nigeria. pp 1-100.

Popova, A. and Mihaylova, D. (2019). Anti-nutrients in Plant-based Foods: A Review. *The Open Biotechnology Journal*, 13: 68-76.

Tabibloghmany, F. S., Tehrani, M. M. and Koocheki, A. (2020). Optimization of the Extrusion process through Response Surface Methodology for improvement in Functional and Nutritional properties of Soybean hull. *J. Food Sci. Technol.*1-11.

Tadesse, S. A., Bultosa, G. and Abera, S. (2019a). Chemical and Sensory quality of Sorghum-based Extruded Product supplemented with Defatted Soy meal Flour. *Cogent Food and Agriculture*, 5(1): 1-19.

Tadesse, S. A., Bultosa, G. and Abera, S. (2019b). Functional and Physical properties of Sorghum-based Extruded Product supplemented with Soy meal Flour. *Cogent Food and Agriculture 5:*1-21.

Umoh, E. O. (2013) Anti-nutritional Factors of False Yam (*Icacina trichantha)* Flour. *Internet Journal of Food Safety*. Vol. 15, 2013. pp. 78-82. FoodHACCP.com Publishing.

Umoh, E. O. (2020). Evaluation of Proximate composition, Functional properties and Anti-nutritional factors of Aerial yam-soybean Flour. *International Journal of Food Science and Nutrition*, 5(1): 70-74.

Umoh, E. O, Iwe, M. O. and Ojimelukwu, P. C. (2021). Optimization of Extrusion process parameters for the Anti-nutritional composition of Aerial Yam (*Dioscorea bulbifera*)-Soybean (*Glycine max*) flour Blends using Response surface Methodology. *International Journal of Food Science and Nutrition*, 6 (6): 62-69.

Umoh, E. O. and Iwe, M. O. (2022). Effects of Extrusion Processing on the Proximate composition of Aerial yam (*Dioscorea bulbifera*)-Soybean (*Glycine max*) flour Blends using Response Surface Methodology. *Journal of Food Research*, 11 (1): 38-52.

Umoh, E. O and Iwe, M. O. (2022). Sensory Evaluation of Pasta from Blends of Aerial Yam (*Dioscorea bulbifera*) and Soybean (*Glycine max*) Flour using Response Surface Analysis. *Nigerian Food Journal, NIFOJ*, 40(1): 74-91.

Umoh, E. O. and Iwe, M. O. (2023). Influence of Extrusion process conditions on Bulk Density, Water absorption capacity and Oil absorption capacity of Extruded Aerial Yam-Soybean Flour Mixture. *African Journal of Food Science*, 17(6): 111-121.