



PRODUCTION AND QUALITY EVALUATION OF BISCUITS FROM WHEAT (*TRITICUM AESTIVUM*) SWEET POTATOES (*IPOMOEA BATATAS*) AND SOYBEAN (*GLYCINE MAX*) FLOURS

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Abstract: The purpose of this research work was to evaluate flours made from Wheat (*Triticum aestivum*), Sweet Potatoes (*Ipomoea batatas*) and Soybean (*Glycine max*), their blends and biscuits. Flours were produced from wheat, yellow fleshed sweet potato and soybean and blended into different ratios of 100:0:0 (WSS₁₀₀), 75:20:5 (WSS₇₅), 50:40:10 (WSS₅₀), 25:60:15 (WSS₂₅) and 0:80:20 (WSS₀). The flours were evaluated for proximate, functional and pasting properties while the biscuits were evaluated for proximate, Physical properties, and mineral properties using standard methods while sensory composition of the biscuit was determined using 20 semi-trained panelists. The results of the proximate composition of the flours showed that soybean had the highest protein (39.09%), fats (28.02%), crude fiber (5.01%), ash (2.19%) and energy content (491Kcal) while sweet potato had the highest carbohydrates (83.77%) and moisture content (8.91%). Partially substituting wheat flour with sweet potato and soybean flour had a significant increase in the functional properties of the flour blends except for swelling capacity (72.50% - 62.30%) and bulk density (10.01% - 7.6g/ml) which had a significant decrease. The pasting properties of the flour blends decreased significantly with substitution in all the parameters except for the peak time (5.21mins - 6.07mins) and pasting temperature (57.12 °C - 67.27°C) which increased significantly. For the biscuits, there was a significant increase in their physical properties except for thickness (10.0 - 8.0mm) which decreased significantly. There was significant increase in the proximate composition of the biscuits with substitution except for the carbohydrate (75.61- 63.24%). The mineral content of the biscuits also increased significantly with substitution except for iron (5.81 - 3.40mg/100g) and zinc (2.13 - 1.52mg/100g) which had a significant decrease ($p < 0.5$) with substitution. The biscuits from Sample WSS₅₀ (50% wheat flour, 40% sweet potato flour and 10% soybean flour) were preferred in terms of taste, flavour, colour and overall acceptability while sample WSS₂₅ (25% wheat flour, 60% sweet potato flour and 15% soybean flour) was preferred in terms of texture. Based on the findings of this research work, substituting wheat with sweet potatoes and soybeans in biscuit formulation and the likes will improve their nutritional quality, functional properties, physical and chemical properties, sensory and overall acceptability. This will also reduce the over dependence on wheat flour which is usually imported hence reducing the burden of importation which will lead to improved economy.

Keywords: Composite flour, *Ipomoea batatas*, *Glycine max*, peak viscosity, pasting temperature.

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I. Introduction

In developing countries like Nigeria under-nutrition persists, the burden of diet-related diseases exist (World Health Organization, 2021) and there is also increase in population growth and food consumption which have led to a global increase in food demand while fertile agricultural land is becoming scarcer. Because of this, food researchers have made conscientious efforts to develop healthy food products that are of great yield and nutritious to meet the consumer's demand (Galanakis, 2020). The continuously high levels of poverty and income inequality and the high cost of procuring healthy diets have continually kept rich and healthy diets out of reach of around 3 billion people worldwide. This situation can be alleviated by using composite functional foods from indigenous flours obtained from local materials reserved in each region of the world without recourse to importation.

Composite food technology is an excellent way of creating distinctively novel food products from the combinations of conventional and unconventional botanicals. These composite flour developments will accelerate the further exploitation of native food crops toward producing ready-to-eat, highly nutritious functional foods such as biscuits, bread, cakes, and pastries. Composite food technology is an excellent way of creating distinctively novel food products from the combinations of conventional and unconventional botanicals. These composite flour developments will accelerate the further exploitation of native food crops toward producing ready-to-eat, highly nutritious functional foods such as biscuits, bread, cakes, and pastries. Wheat flour the major ingredients in bakery products is very expensive and not readily available in many regions of the world especially in developing countries like Nigeria. This has led to high importation of the flour by these regions which have a negative impact in their economy (Zouari, 2016). There is a compelling need to develop an adequate substitute for wheat flour which should be readily available, affordable, and capable of replacing wheat in functionality and in nutritional quality. Therefore, substituting wheat flour with composite flour made from foods such as sweet potato, corn, rice, and soybean that are grown locally would improve the economy of the country.

Sweet potato is used in both human and animal nutrition due to its high nutritional content as a relatively inexpensive and easily-accessible natural source (Wang *et al.*, 2016). Sweet potato (*Ipomoea batatas* Lam) has been identified as a food security crop because it contains reasonable amounts of bioactive compounds such as β -carotene, ascorbic acid, polyphenols, dietary fibre as well as vitamins, minerals, and proteins (Motsa *et al.*, 2015). Sweet potato plays many vital roles in the world food system and has the criteria for meeting the nutritional needs, food requirements, reducing poverty, and increasing food security. Nigeria grows sweet potatoes in large quantities, but this crop is underutilized. The utilization of sweet potato flour for biscuit production will not only increase the utilization of the crop but also reduce the dependence on wheat flour which is imported into the country at a high cost (Fărcaș *et al.*, 2014).

Soybean (*Glycine max*) is an economically important oilseed crop with a high protein (40%), high oil content (20%), and of good nutritional quality (Tukamuhabwa and Maphosa, 2012). It is beneficial to human considering its low quantity of sodium, cholesterol and saturated fatty acids and high polyunsaturated fatty

acids, protein and dietary fiber content. Wheat based diets are poor regarding essential amino acid content especially lysine as the first limiting amino acid. Since human body is unable to build lysine, it is necessary to be taken via food and/or supplements (Mollakhalili *et al.*, 2019). Soybean meal contains a high level of protein in comparison to other plant protein sources. It has an excellent profile of essential amino acids and these amino acids are highly digestible. Soybean meal has the highest lysine digestibility of any on the commonly available protein sources. It also ranks high in methionine, cystine and threonine digestibility and has an excellent lysine to protein ratio. Soybean therefore has the potential to supplement wheat to meet with the nutritional needs of both humans and animals.

II. Materials and Methods

A: Material Procurement

Wheat flour, Sweet Potatoes tubers, Soybean seeds and all the ingredients used in the production for this work were procured from Ubani main market in Umuahia North LGA of Abia State. All reagents used for the study are of analytical grade.

B: Sample Preparation

Production of Sweet potato flour:

Sweet potato flour (Figure 1) was prepared as described by Singh *et al.* (2008). Sweet potatoes were sorted, peeled, washed, and cut into thin slices manually over running water. The slices were directly immersed in solution containing 1% potassium metabisulfite (KMS) for 30 min to prevent browning. Drying of sweet potato slices was done by spreading on a tray covered with aluminum foil and oven dried at 60°C for 12 hours. The dried slices were milled after cooling using a disc attrition mill and sieved through a 0.25 mm sieve.

Production of Soybean flour:

The method described by Igbabul and Sule (2013) was used in the preparation of the soybean flour (Figure 2). The soybean grains were cleaned manually by separating all foreign materials, such as dirt, husk, chaff, sticks, and other extraneous materials from the soybeans. The soybeans were washed in clean water and soaked for 9 hrs. The soaked soybeans were boiled for 30 minutes, after which it is washed, and the coats removed and separated from the beans in cold water. The beans were dried at 65°C for 9 hours, ground into flour with attrition mill and sieved through 0.25 mm sieve to obtain the soybean flour.



Figure 1: Sweet Potato Flour



Figure 2: Soybean Flour

C: Experimental Design

A completely randomized design (CRD) was employed in this work. Composite flours consisting of different proportions of wheat, sweet potato and soybean flours were prepared as shown in Table 3.1 while 100% wheat flour served as the control.

Table 3.1: Percentage composition of the flour blends (%)

Ingredients	WSS ₁₀₀	WSS ₇₅	WSS ₅₀	WSS ₂₅	WSS ₀
Wheat flour	100	75	50	25	0
Sweet Potato flour	0	20	40	60	80
Soya bean flour	0	5	10	15	20

D: Production of Biscuits:

For the biscuit production, the recipe used is as described by Oyewole *et al.* (1996). The ingredients were weighed accurately and the raw materials in powder form were mixed (800g of flour, 3g of salt, 8g of vanilla and 16g of yeast) and kept aside. The margarine (200g) and sugar (260g) were mixed using a manual cake mixer to get a creamy consistency. The egg (160g) was beaten and incorporated into the cream, and then, the mixing continues until a snow-white paste was obtained. The ingredients and raw materials in powdered form previously prepared (salt, flour, and yeast) were added to the cream and mixed together manually. Water (120g) was added until the dough was smooth. The dough was spread on the pastry board using the rolling pin and then cut into desired size of 4 mm for better cooking. The biscuits dough was baked at a temperature 150°C for 20 minutes until a golden brown colour was observed. The trays were then removed from the oven and cooled. The same method was used for all the samples.

E: Methods of Analysis

Proximate Analysis: The proximate compositions (protein, moisture content, crude fibre, fat, ash, carbohydrate) and energy content of the flour and biscuit samples were determined according to the methods of AOAC (2015).

Functional Property Determination: The functional properties of the flours, water absorption capacity, swelling index, water solubility index, bulk density and oil absorption capacity were determined according to the methods described in Onwuka (2018).

Pasting Property Determination: The pasting properties of the samples were assessed using a Rapid Visco-Analyzer (Model RVA series 4; Newport Scientific Pty Ltd., Warriewood, Australia) and the parameters measured were peak and trough viscosities, breakdown viscosity, final viscosity, setback viscosity, peak time and pasting temperature.

Physical properties: The biscuits were analyzed for diameter, thickness, weight and spread ratio, following the method described by Zoulias *et al.* (2000) with slight modification. The Diameter and thickness of each biscuit was measured using a vernier caliper, ensuring precise readings to the nearest 0.01 mm. The spread ratio was calculated by dividing the diameter by the thickness of each biscuit while the weight of each biscuit was determined using a Precisa 321 LS analytical balance, ensuring precise weight measurements to the nearest 0.001g.

Mineral Analysis:

Young Lin flame Atomic Absorption Spectrophotometer model 8010 was used for the determination of Ca and Mg, while K and Na was determined using Spectrum Lab 22 flame photometer by the method described by (Khan and Zeb, 2007)

Wet digestion

The digestion of samples for metal analysis was accomplished as described by (Van loon, 1996). One (1) gramme of the pulverized maize sample was weighed accurately into 250 ml conical flask. A 15 ml of HNO₃ was added to the flask followed by addition of 5 ml of conc. H₂SO₄. The mixture was shaken to mix and heated on a hot plate preset at 160°C until the brown fumes disappeared and white fume began to show. Ten (10) ml of H₂O₂ was carefully added and heating was continued to dryness. The digest was allowed to cool and 20 ml de-ionized water was added to dissolve the residue. This was filtered quantitatively into 100 ml volumetric flask. The residue in the conical flask was washed with 10ml de-ionized water into the filtrate. The filtrate was made up to the 100 ml mark and transferred to a plastic bottle, aspirated into the machine for the trace metal analysis.

F: Sensory Evaluation

The method of Iwe (2010) was employed in the determination of the sensory attributes of the biscuits. A 20-member semi-trained panellist conversant with the products was used to assess consumer acceptability of the blended extruded products. The extruded snacks were placed on white plates coded with alphabetic letters under normal lighting conditions at room temperature. Sensory attributes, including taste, texture, aroma, appearance and overall acceptability of the biscuits were evaluated using a nine-point Hedonic scale ranked from 1 (dislike extremely) to 9 (like extremely) while 5 was neither like nor dislike.

G: Statistical Analysis

All determinations were done in duplicates. The data generated was analyzed using Statistical Package for Social Sciences (SPSS version 16.0). Means and standard deviation were calculated, analysis of variance (ANOVA) was computed and level of significance was accepted at $p < 0.05$ (Onwuka, 2018).

III: Results and Discussion

A: Proximate Composition of the flours

The proximate composition of the flours is presented in Table 1.

Proximate composition results showed that protein content ranged from 2.49% (sweet potato flour) to 39.09% (soybean flour). There was significant ($p < 0.05$) difference in protein content of the flour samples. Fat content ranged from 0.49% (sweet potato flour) to 28.02% (soybean flour); fibre ranged from 0.58% (wheat flour) to 5.01% (soybean flour); moisture ranged from 7.50% (soybean flour) to 8.91% (sweet potato flour); ash content ranged from 0.95 to 2.19% while carbohydrate and energy values ranged from 18.19 to 83.77% and 334.42 to 491.14 (kcal) respectively. There were significant ($p < 0.05$) differences in all the proximate parameters and energy values except for moisture content which showed no significant ($p > 0.05$) difference among the samples. Soybean had the

highest protein content (39.09%), fat (28.02%), Crude fiber (5.01%), Ash (2.19%) and energy values (491.14%) while sweet potato had the highest carbohydrate (83.05%) and moisture content (8.91%). Omoniyi *et al.* (2016) reported proximate composition values of 7.28 to 8.19 % for moisture, 2.21 to 12.42 % for crude protein, 1.02 to 3.22 % for fat, 1.73 to 2.62 % for ash, 3.76 to 4.62 % for crude fibre and 69.38 to 84.22 % for carbohydrate contents for sweet potato-soybean flour blends and are within reported values obtained in this research.

Soybean has excellent nutritional value especially the high level of protein which will help alleviate protein deficiencies which is one

the major diet related diseases in developing countries. According to the European Food Information Council (2019), proteins are made up of amino acids which are the building blocks of protein. The body needs dietary protein to be able to supply these amino acids for the proper functioning of the body and for the development and maintenance of cells and tissues. Proteins are polymers of amino acids which are composed of hydrogen, oxygen, carbon, and nitrogen (Hou *et al.*, 2017). The content of the individual flours (7.50% to 8.91%) is below the maximum permissible mixture value for flours (Omoniyi *et al.*, 2016).

Table 1: Percentage proximate Composition and Energy value (kcal) of the Flour

Samples	Protein	Fat	Fiber	Moisture	Ash	Carbohydrate	Energy
Wheat flour	12.45 ^b ± 0.10	1.49 ^b ± 0.10	0.58 ^c ± 0.12	8.61 ^a ± 1.10	0.95 ^c ± 0.14	75.92 ^b ± 0.26	359.65 ^b ± 1.90
Sweet potato flour	2.49 ^c ± 0.20	0.49 ^c ± 0.19	2.89 ^b ± 0.19	8.91 ^a ± 1.01	1.54 ^b ± 0.05	83.77 ^a ± 0.17	334.42 ^c ± 1.27
Soybean flour	39.09 ^a ± 0.12	28.02 ^a ± 0.21	5.01 ^a ± 0.21	7.50 ^a ± 0.90	2.19 ^a ± 0.18	18.19 ^c ± 0.10	491.14 ^a ± 1.28

Values are mean ± SD of 3 replications. ^{a-c} means within a column bearing different superscripts are significantly different (p<0.05). WSS₁₀₀ = 100% Wheat; WSS₇₅ = 75% wheat flour, 20% sweet potato, 5% soya bean flour; WSS₅₀ = 50% wheat flour 40% sweet potato and 20 % soybean; WSS₂₅ = 25% wheat flour, 60% sweet potato flour and 15 % soybean flour while WSS₀ = 0% wheat flour, 80% potato flour and 20% soybean flour.

B: Functional Properties of Flour blends

The results of functional of flours blends are presented in Table 2.

The functional properties varied significantly in water absorption capacity, swelling capacity, water solubility index, bulk density, and Oil absorption capacity. Soybean flour had the highest water absorption capacity (78.50%), water solubility index (28.02%) and oil absorption capacity (478.34%), sweet potato flour had the highest swelling capacity (83.05%) while wheat had the highest bulk density (10.01%). For the flour blends, there was significant increase with substitution in water absorption capacity (70.93% WSS₁₀₀ - 86.02% WSS₀), Water Solubility Index (17.21% WSS₁₀₀ - 29.75% WSS₀) and Oil Absorption Capacity (358.20% WSS₁₀₀ - 375.21% WSS₀) while a decrease was observed for Swelling Capacity (72.50% - 65.20%) and bulk density (10.01% WSS₁₀₀ - 8.10% WSS₀). These findings were in line with the report of Elisa *et al.* (2015) in functional and rheological properties of composite flour from sweet potato, maize, soybean and xanthan gum. The functional properties of flours are influenced by the components of

the food material, especially the carbohydrates, proteins, fats and oils, moisture, fibre, ash, and other ingredients. These factors could have led to the increase in some of the functional properties with substitution as soybean is nutrient dense and hence the higher values of functional properties in the individual flours and the blends. The high bulk density value (7.60 to 10.01 %) recorded for the flour blends might likely aid its industrial applications (Oladebeye *et al.*, 2009) that suggested the suitability of high bulk density-sweet potato as drug binder and disintegrant in pharmaceuticals industries. The bulk density of the sample also describes the degree of compactness of the matrices, an important factor in mixing of ingredients. Water absorption capacity is an important pointer to whether the blends can be incorporated into aqueous foods products. WAC is the maximum amount of water that a food material can take up and retain under formulation condition which is related to the dryness and porosity of material (Oyelade *et al.*, 2002) as reported by Atobatele and Afolabi (2016). While Absorption of oil by baked food products improve the mouth-feel and retain flavour.

Table 2: Functional of the flours blends

Samples	WSS100 (100% Wheat)	WSS75 (75:20:5)	WSS50 (50:40:20)	WSS25 (25:60:15)	WSS0 (0:80:20)
Water Absorption Capacity (%)	70.93 ^d ± 0.91	75.05 ^c ± 9.12	78.91 ^b ± 4.3	80.75 ^b ± 7.12	86.02 ^a ± 4.23
Swelling Capacity (%)	72.50 ^a ± 2.1	70.5 ^b ± 1.0	69.3 ^b ± 2.0	65.2 ^c ± 1.3	62.30 ^d ± 2.0
Water Solubility Index (%)	17.21 ^c ± 7.10	25.01 ^c ± 1.34	22.40 ^d ± 5.90	29.75 ^b ± 1.20	33.12 ^a ± 1.20
Bulk Density (%)	10.01 ^a ± 0.2	9.20 ^b ± 0.1	8.50 ^c ± 0.2	8.10 ^c ± 0.1	7.60 ^d ± 0.2
Oil Absorption Capacity (%)	170.2 ^a ± 1.25	167.46 ^a ± 0.98	160.21 ^b ± 1.41	160.56 ^b ± 0.78	154.68 ^c ± 2.05

Values are mean ± SD of 3 replications. ^{a-c} means along the rows bearing different superscripts are significantly different (p<0.05). WSS₁₀₀ = 100% Wheat; WSS₇₅ = 75% wheat flour, 20% sweet potato, 5% soya bean flour; WSS₅₀ = 50% wheat flour 40% sweet potato and 20 % soybean; WSS₂₅ = 25% wheat flour, 60% sweet potato flour and 15 % soybean flour while WSS₀ = 0% wheat flour, 80% potato flour and 20% soybean flour

C. Pasting properties of flour blends

The pasting properties of the blends are presented in Table 3.

There was significant decrease ($p < 0.05$) in the pasting properties (372.44 to 300.66 RVU for peak viscosity; 170.23 to 154.68 RVU for trough viscosity; 201.88 to 144.21 RVU for breakdown viscosity; 417.16 to 332.57 RVU for final viscosity and 246.67 to 174.40 RVU for setback viscosity) of the flour samples with substitution with non-wheat flours in all the parameters except for peak time (5.21% WSS₁₀₀ - 6.07% WSS₀) and pasting temperature (57.12% WSS₁₀₀ - 67.27% WSS₀). This result could be as a result of lower swelling capacity of the composite flour compared to wheat. These findings were in line with the findings of *Julianti et al.* (2016) on rice, sweet potato, and potato who reported that increasing level of soybean flour reduced the peak and breakdown viscosities while set back and final viscosities increased with increasing soy flour level. Pasting properties of food describe the changes that take place in food when heat is applied in the presence of water and

these changes affect the texture and digestibility of the final product. It measures the ability of flour or starch to form a paste. The increase in peak time and pasting temperature is an indication that the composite flour will take a longer time to cook. The result of the pasting analysis of flour blends is an indication that at higher levels of substitution, the flour may not be suited for bakery products that require rising but more suited for products that requires low gel strength and elasticity such as biscuits. According to Linus-Chibuezeh *et al.* (2017) peak viscosity is often correlated with the final product quality, and also provides an indication of the viscous load likely to be encountered during mixing. Flours with high peak viscosity show that the associated forces between the starch molecules are relatively weak. The molecules are able to penetrate their starch granules much easier and the granules swell enormously leading to weakening of associated forces which in turn make them susceptible to breakdown leading to weak gel formation (Etudaiye *et al.*, 2009).

Table 3: Pasting properties of flour blends

Samples	WSS100 (100% Wheat)	WSS75 (75:20:5)	WSS50 (50:40:20)	WSS25 (25:60:15)	WSS0 (0:80:20)
Peak (RVU)	372.44 ^a ±1.43	366.13 ^b ±0.01	351.06 ^c ±0.08	333.56 ^d ±0.64	300.66 ^e ±0.78
Trough (RVU)	170.23 ^a ±1.25	167.46 ^a ±0.98	160.2 ^b ±1.41	160.56 ^b ±0.78	154.68 ^c ±2.05
Break down (RVU)	201.88 ^a ±0.01	199.84 ^a ±1.16	191.12 ^b ±1.11	173.0 ^c ±1.42	144.21 ^d ±0.57
Final Viscosity (RVU)	417.16 ^a ±1.45	393.17 ^{ab} ±2.59	370.34 ^{bc} ±22.60	36483 ^c ±4.94	332.57 ^d ±0.91
Set back Viscosity (RVU)	246.67 ^a ±0.16	224.31 ^b ±0.3	196.01 ^c ±0.16	208.18 ^d ±0.23	174.40 ^e ±1.82
Peak Time (Min)	5.21 ^e ±0.01	5.51 ^d ±0.01	5.66 ^c ±0.02	5.92 ^b ±0.01	6.07 ^a ±0.06
Pasting Temperature (C)	57.12 ^d ±1.10	62.53 ^c ±0.02	65.48 ^b ±0.04	67.00 ^a ±0.00	67.27 ^a ±0.23

Values are mean ± SD of 3 replications. ^{a-e} means along the rows bearing different superscripts are significantly different ($p < 0.05$). WSS₁₀₀ = 100% Wheat; WSS₇₅ = 75% wheat flour, 20% sweet potato, 5% soya bean flour; WSS₅₀ = 50% wheat flour 40% sweet potato and 20 % soybean; WSS₂₅ = 25% wheat flour, 60% sweet potato flour and 15 % soybean flour while WSS₀ = 0% wheat flour, 80% potato flour and 20% soybean flour.

D: Physical Properties of the Biscuits

Results of physical properties of the flour are presented in Table 4.

The weight of the cookies ranged from 10.50 to 12.91 g. The value obtained for weight of the cookies in this study is lower than 29.44 to 30.62g reported for cookies from flour blends of wheat, yam and soybean (Apotiola and Fashakin, 2013) but within the value of 14.33g to 16.13g reported by Uboor *et al.* (2022) for cookies from flour blends of wheat, cassava and pumpkin. However, Ndife *et al.* (2020) reported lower cookies weight of 6.93 g to 9.11 g from tropical cereal flours enriched with groundnut flour.

There were significant increase in physical properties except for thickness (10.0 WSS₁₀₀ - 8.0mmWSS₀) which decreased significantly ($p < 0.5$) with increasing flour substitution. This could

be due to the higher moisture retention, density and fiber content in these flours, which affected the dough's expansion during baking. The increase in diameter, weight and spread ratio suggests that these flours may contribute to a greater spread during baking. These findings are in line with the findings of Adeyemi *et al.* (2022) on incorporation of soybean flour in biscuits who observed an increase in weight and diameter, along with a decrease in thickness. This increase in spread ratio with higher proportions of sweet potato and soybean flour indicates that biscuits will spread more during baking, resulting in thinner and wider biscuits. It is also an indication that these flours will contribute to softer dough that spreads more during baking. These changes could be as a result of high protein content and different structural properties of soybean flour and sweet potato flour compared to wheat flour.

Table 4: Physical Property Compositions of the Biscuits Samples

Samples	Weight (g)	Diameter (mm)	Thickness (mm)	Spread Ratio (Diameter/Thickness)
WSS ₁₀₀	10.50 ^c ±0.2	49.0 ^c ± 1.0	10.0 ^a ± 0.5	5.0 ^c ± 0.1
WSS ₇₅	10.81 ^c ±0.3	51.0 ^c ± 1.2	9.6 ^a ± 0.4	5.4 ^c ± 0.2
WSS ₅₀	11.42 ^b ±0.4	54.5 ^b ± 1.5	8.7 ^b ± 0.3	6.0 ^b ± 0.3
WSS ₂₅	11.90 ^b ± 0.5	56.0 ^b ± 1.8	8.4 ^b ± 0.2	6.5 ^b ± 0.4
WSS ₀	12.91 ^a ± 0.6	59.0 ^a ± 2.0	8.0 ^c ± 0.1	7.2 ^a ± 0.5

Values are mean ± SD of 3 replications. ^{a-c} means within a column bearing different superscripts are significantly different ($p < 0.05$). WSS₁₀₀ = 100% Wheat; WSS₇₅ = 75% wheat flour, 20% sweet potato, 5% soya bean flour; WSS₅₀ = 50% wheat flour 40% sweet potato and 20 % soybean; WSS₂₅ = 25% wheat flour, 60% sweet potato flour and 15 % soybean flour while WSS₀ = 0% wheat flour, 80% potato flour and 20% soybean flour.

E: Proximate Composition and energy value of the Biscuits

The proximate composition result of the cookies is presented in Table 5.

There was significant increase in the proximate composition of the biscuits with substitution except for the carbohydrate (74.3 – 64.6%) which decreased with substitution. There was reduction in protein content of the cookies (11.09 to 14.03%) compared to protein content of the individual fours. This could be attributed to effect of processing especially heat that denatured and resulted to decrease and as well as effect of flour composition. Bolarinwa *et al.* (2016) reported slightly lower protein range of 7.28 – 11.78% for biscuit from blends of sorghum and soybean while Usman *et al.* (2015) reported protein range of 8.81– 12.70% for biscuit from blends of wheat and maize bran flour while Ndife *et al.* (2020) reported higher protein content of 8.21 - 28.05% for biscuits enriched with groundnut. Protein is an important macronutrient in human being and source of amino-acids for the synthesis of the body protein

Fat content of the biscuit ranged from 2.01 to 3.09%. There was significant difference ($p < 0.05$) in fat content of the samples. Higher fat content of 9.50 - 13.75% was reported by Ndife *et al.* (2020) for cereal biscuits enriched with groundnut and by other researchers (Usman *et al.*, 2015; Bolarinwa *et al.*, 2016; Hama-Ba *et al.*, 2018). Fat acts as flavour retainer and helps to improve sensory qualities of baked products. Fasasi (2009) reported that low fat content in a dry product will help in increasing shelf life of the product by decreasing the chances of rancidity and also contributed to low energy value in food product while high fat content product will have high energy value and promote lipid oxidation.

There was significant increase in crude fibre (1.59 to 6.50%) with increasing level of sweet potato and soybean flours. This increase is attributed to higher fibre content of potato tuber. Hama-Ba *et al.* (2015) reported lower fibre content of 0.84% for wheat biscuit, and 1.15% of biscuit from 70% wheat and 30% maize bran. Fibre

recorded in this study for biscuit is in range with the value of 2.77% reported by Bolarinmwa *et al.* (2018) for biscuit containing 90% sorghum and 10% soybean. Crude fibre facilitates peristalsis which helps to reduce many gastrointestinal diseases, serum cholesterol, risk of coronary heart diseases, colon and breast cancer and hypertension (Adeyeye and Aye, 2005).

Moisture content of the biscuits ranged from 8.61 to 10.25% with increasing substitution level of wheat flour. The moisture content of the biscuits was generally low which might be due to the processing method and ingredients used. Usman *et al.* (2015) reported higher moisture range of 10.15 – 10.85 and 5.54 – 6.10% for gluten free biscuit and wheat and maize bran biscuit fortified with carrot extract respectively. Hama-ba *et al.* (2018) reported moisture content of 6.38% for biscuit from millet flour. The lower moisture content exhibited by the biscuit samples is an indication that the products are shelf stable. High moisture content has been associated with short shelf life of baked products, as they encourage microbial proliferation that lead to spoilage (Ezeama, 2007) as reported by Ndife *et al.* (2020).

Increasing ash content (1.09 to 2.905) and energy value (368.65 to 478.34 kcal) were also recorded with increasing substitution level. The ash content of food material could be used as an index of mineral constituents of the food because ash is the inorganic residue remaining after the water and organic matter have been removed by heating in the presence of an oxidizing agent (Sanni *et al.*, 2008). The proximate composition of biscuit samples is a fundamental aspect in assessing their nutritional quality and suitability for consumption. These parameters provide a comprehensive understanding of the nutritional profile of the biscuits, which is essential for both consumers and manufacturers. The increase in the proximate composition of the biscuit is as a result of the high nutritional value of soybean and sweet potato flour. This implies that the substitution of the wheat flour with sweet potato flour and soybean flour in biscuits production lead to improved nutritional quality of the biscuits.

Table 5: Proximate Composition (%) and Energy value (kcal/g) of the Biscuits Samples

Samples	Protein	Fat	Fiber	Moisture	Ash	Carbohydrate	Energy
WSS ₁₀₀	11.09 ^d ± 0.20	2.01 ^e ± 0.01	1.59 ^e ±0.1	8.61 ^b ± 0.1	1.09 ^d ± 0.2	75.61 ^a ± 0.13	368.65 ^c ±1.90
WSS ₇₅	12.01 ^d ± 0.21	2.16 ^d ±0.01	1.91 ^d ±0.2	8.69 ^b ± 0.9	1.21 ^c ± 0.4	74.02 ^b ± 0.9	372.42 ^c ±1.27
WSS ₅₀	12.68 ^c ± 0.29	2.37 ^c ± 0.10	2.91 ^c ±0.1	8.79 ^b ± 0.3	1.33 ^c ± 0.1	71.92 ^c ± 0.01	448.34 ^b ±1.28
WSS ₂₅	13.15 ^b ± 0.40	2.63 ^b ± 0.10	4.30 ^b ±0.1	9.53 ^a ±0.01	2.01 ^b ± 1.1	68.38 ^d ±0.05	461.34 ^b ±1.28
WSS ₀	14.02 ^a ± 0.31	3.09 ^a ± 0.20	6.50 ^a ± 0.7	10.25 ^a ± 0.2	2.90 ^a ± 0.1	63.24 ^e ±0.06	478.34 ^a ±1.28

Values are mean ± SD of 3 replications. ^{a-e} means within a column bearing different superscripts are significantly different ($p < 0.05$). WSS₁₀₀ = 100% Wheat; WSS₇₅ = 75% wheat flour, 20% sweet potato, 5% soya bean flour; WSS₅₀ = 50% wheat flour 40% sweet potato and 20 % soybean; WSS₂₅ = 25% wheat flour, 60% sweet potato flour and 15 % soybean flour while WSS₀ = 0% wheat flour, 80% potato flour and 20% soybean flour.

F: Mineral Composition of the Biscuits

Result of mineral composition of the biscuit is presented Table 6.

The mineral content of the biscuits also increased significantly with substitution except for iron (5.81- 3.40mg/100g) and zinc (2.13 – 1.52mg/100g) which had a significant decrease ($p < 0.5$) with substitution. Minerals are essential elements in our diet for long and healthy life; some macro- and microelements are found in the structure of teeth (Ca, P and F) and bones (Ca, Mg, Mn, P, B and F) and in the control of blood pressure (Ca and K), and some act as catalysts for metabolic reactions (Zn, Cu, Se, Mg, Mn). Minerals play vital role as a structural part of many enzymes (Cu, Fe, Mn, Mg, Se and Zn) and are involved in the immune (Ca, Mg, Cu, Se and Zn) and brain (Cr and Mn) systems (Gharibzadeh and Jafari, 2017). This increase could be as a result of the high ash content of soybean (2.19%) and sweet potato (1.54%) as compared to wheat (0.95%). This indicates that the mineral content of the biscuits were greatly improved with substitution of sweet potatoes and soybean flour.

Table 6: Mineral compositions of the biscuits

Parameters mg/100g	WSS ₁₀₀	WSS ₇₅	WSS ₅₀	WSS ₂₅	WSS ₀
Potassium	183.0 ^e ± 1.00	301.0 ^d ±1.00	441.0 ^c ±1.00	531.0 ^b ±1.00	591.0 ^a ±1.0
Magnesium	33.0 ^e ± 0.4	37.5 ^d ±0.5	40.0 ^c ±0.5	46.0 ^b ±0.5	52.0 ^a ±0.5
Calcium	31.0 ^e ± 0.4	45.0 ^d ± 0.5	60.0 ^c ± 0.5	65.0 ^b ±0.5	76.0 ^a ±0.5
Iron	5.81 ^a ± 0.19	4.03 ^b ± 0.10	3.58 ^c ± 0.01	3.50 ^c ± 0.32	3.40 ^d ± 0.01
Zinc	2.13 ^a ± 0.01	1.90 ^b ±0.01	1.70 ^c ± 0.01	1.67 ^c ± 0.01	1.52 ^d ± 0.02
Manganese	0.91 ^e ±0.04	0.92 ^d ± 0.13	0.949 ^c ± 0.02	0.961 ^b ± 0.21	0.98 ^a ±0.20
Copper	0.304 ^d ±0.10	0.31 ^d ± 0.20	0.31 ^c ±0.34	0.34 ^b ±0.31	0.36 ^a ± 0.23
Sodium	251.0 ^a ± 1.00	229.0 ^b ± 1.00	130.0 ^c ± 1.00	105.0 ^d ± 1.00	90.0 ^e ± 1.00

Values are mean ± SD of 3 replications. ^{a-e} means within a column bearing different superscripts are significantly different ($p < 0.05$). WSS₁₀₀ = 100% Wheat; WSS₇₅ = 75% wheat flour, 20% sweet potato, 5% soya bean flour; WSS₅₀ = 50% wheat flour 40% sweet potato and 20 % soybean; WSS₂₅ = 25% wheat flour, 60% sweet potato flour and 15 % soybean flour while WSS₀ = 0% wheat flour, 80% potato flour and 20% soybean flour.

F: Sensory Evaluation of the Biscuits:

The result of sensory evaluation of the biscuit is presented in Table 7.

The biscuit from sample WSS₅₀ (50% wheat flour, 40% sweet potato flour and 10% soybean flour) was mostly preferred in terms of taste, flavour, colour and overall acceptability while sample WSS₂₅ (25% wheat flour, 60% sweet potato flour and 15% soybean flour) was preferred in terms of texture. This implies that acceptable biscuits can be produced from substituting wheat flour with sweet potato and soybean flour and that 50% incorporation of these flours will be very acceptable. General acceptability of the samples showed that the biscuits were acceptable to the panellists irrespective of the flour and processing method. However, all the biscuits were accepted with regards to general acceptability and differed significantly ($p < 0.05$) with respect to general acceptability. General acceptability is an overall assessment of the sensory characteristics of samples (Iwe *et al.*, 2017). Oluwole (2009) also reported that general/overall acceptability is the combination of all the other sensory parameters and if a product records acceptable quality levels in most of the other parameters, it is expected that such product will have a good overall acceptability.

Table 7: Sensory evaluation of the biscuits

Samples	Taste	Texture	Aroma	Appearance	Overall Acceptability
WSS ₁₀₀	7.50 ^c ±1.30	7.75 ^b ±1.10	7.42 ^c ±1.10	5.90 ^c ±1.29 ^c	7.50 ^b ±1.20
WSS ₇₅	6.02 ^d ±0.91	5.83 ^d ±1.40	6.69 ^d ±1.00	6.29 ^b ±2.50	6.65 ^d ±1.10
WSS ₅₀	8.01 ^a ±1.20	7.74 ^b ±0.01	7.85 ^a ±1.90	7.40 ^a ±2.10	8.21 ^a ±0.78
WSS ₂₅	7.90 ^b ±7.21	7.81 ^a ±0.79	7.56 ^b ±0.90	6.7 ^b ±1.20	7.60 ^b ±1.00
WSS ₀	6.91 ^c ±1.50	7.01 ^c ±1.50	6.90 ^d ±1.00	6.20 ^{bc} ±1.30	7.01 ^c ±1.70

Values are mean ± SD of 3 replications. ^{a-c} means within a column bearing different superscripts are significantly different (p<0.05). WSS₁₀₀ = 100% Wheat; WSS₇₅ = 75% wheat flour, 20% sweet potato, 5% soya bean flour; WSS₅₀ = 50% wheat flour 40% sweet potato and 20 % soybean; WSS₂₅ = 25% wheat flour, 60% sweet potato flour and 15 % soybean flour while WSS₀ = 0% wheat flour, 80% potato flour and 20% soybean flour.

Conclusion

From the findings of this research work, composite flour from wheat flour, sweet potato flour and soybean flour revealed an improvement in the nutrient, functional and pasting properties of the composite flours. From all the findings in this study, sweet potato flour and soybean flour have great potential as a substitute for wheat flour in the baking and confectionary industries and will be a great asset for developing countries like Nigeria. Recommendation is therefore made, for promotion and utilization of wheat-sweet potato-soybean flour for the baking and confectionary industry especially in developing countries where malnutrition persists.

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