



## Production and evaluation of biscuits from flour blends of soybean and wheat

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### Abstract

Samples of biscuits were made using six distinct wheat and soybean flour mixtures. W1SB stood for 100% wheat, W2SB for 95% wheat and 5% soybean, W3SB for 90% wheat and 10% soybean, W4SB for 85% wheat and 15% soybean, W5SB for 80% wheat and 20% soybean, and W6SB for 75% wheat and 25% soybean. The proximate and mineral compositions of the biscuit samples, along with their organoleptic qualities, were assessed using standard procedures. The approximate percentages of the following components were found in the biscuit samples: moisture (7.87–8.52), ash (2.21–4.18), crude fiber (0.37–1.13), crude protein (9.92–13.53), fat (12.82–13.50), and carbohydrates (59.74–66.06). Mineral concentrations (mg/100g) included potassium (5.93–11.67), sodium (10.83–12.36), calcium (0.84–2.97), magnesium (0.72–0.92), and phosphorus (10.60–13.33). Additionally, biscuits made with 0% and 5% soybean flour substitution had high acceptance levels. The nutritional value and organoleptic qualities of the biscuit samples were significantly ( $p < 0.05$ ) enhanced when soybean flour was substituted for wheat flour.

**Keywords:** Biscuits, Blends, Flour, Mineral, Organoleptic, Proximate, Soybean, Wheat.

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### Contribution of this paper to the literature

This study is original in establishing optimal soybean substitution levels for biscuits using locally sourced Nigerian materials while jointly evaluating proximate, mineral, and sensory qualities. It demonstrates improved nutrition with acceptable taste, providing new baseline data for composite flour adoption, small-scale baking, and reduced reliance on imported wheat.

## 1. Introduction

A biscuit is a baked, shaped food product made from wheat flour that is now a common snack item in most parts of the world. Biscuits are unleavened, firm, flat dessert treats that are often shaped like circles in most nations [1]. The definition of a biscuit is a tiny, unleavened, crisp cake, according to Agu, et al. [2]. According to Edema, et al. [3] biscuits are made from a combination of flour and water, but they can also include oil, sugar, milk, eggs, emulsifier, and other ingredients. The dough is then tested for a while before being put through rollers to create a sheet. A significant part of snacks are biscuits [4]. Convenient snack foods that have been dried to a very low moisture level, biscuits are popular with both adults and children. These nutritious treats are made from unappetizing dough that is heated in an oven to provide enticing results. They are prepared to consume low-cost food items that contain essential nutritional and digestive principles [5].

Depending on how they are made, biscuits fall into three main categories: sweet dough, crackers, and spongy foods. The two types of biscuit dough are hard and soft. The soft dough cookies, which include short cakes, shortbread, and melted biscuits, are high in fat and sugar. *Maries* and morning coffee are part of the dough. Cream crackers, soda crackers, savory, water, digestive, and short dough biscuits are further varieties of biscuits [6]. Typically, sugar, chocolate, frosting, jam, ginger, or cinnamon are used to make some of these biscuits. Nonetheless, given the main ingredients, a decent source of fiber, vitamins and minerals, anti-inflammatory substances, and a healthy quantity of calories, biscuits may offer some health advantages. Ginger biscuits, which are rich in antioxidants, can also lessen nausea and vomiting.

*Triticum* spp., or wheat grain, belongs to the *Poaceae* family. The bran (outer layer), germ, and endosperm make up the structure of wheat. Wheat's nutritional composition includes dietary fiber (0.5%), protein (25%), and fat (8–13%), as well as mineral content (7.2%). Cereal, pasta, noodles, leavened, flat, and steamed breads, biscuits, cakes, breakfast, flour, and fermentation to produce beer and other alcoholic drinks are all made from wheat grains. Due to its higher gluten concentration [7] compared to other cereals and its ability to improve baking quality [8], wheat remains the preferred flour for baked goods.

The leguminous plant known as the soybean (*Glycine max*) is commonly cultivated for its edible bean, which has several applications [9]. All of the important amino acids [10], phytosterols, B vitamins, and minerals (calcium, iron, and phosphorus) are solely found in this plant source. Millions of people's diets can be improved by using soybeans, one of the most abundant and affordable sources of plant protein [9]. The seeds of soybeans are said to have the highest nutritional content of any plant food consumed worldwide, and they are a great source of protein (35–40%).

A blend of various ratios of non-wheat flours made from cereals, legumes, roots, and tubers, with or without the addition of wheat flour, is known as composite flour [11]. Because it stimulates the use of locally grown crops and decreases the importation of wheat flour, composite flour is seen as beneficial in developing nations. According to Ayo and Gaffa [12], a growing market for confections has led to a rise in replacing indigenous raw ingredients for wheat flour. Nigeria's climate and soil conditions have prevented it from producing wheat in commercial quantities.

As a result, almost all of the wheat flour used in snacks and other goods comes from overseas. Nonetheless, attempts are underway to use non-wheat flours in place of some of the wheat flour. This could boost the use of native foods grown in Nigeria and lower the price of baked goods [13]. The potential for using underused crops and the benefit of lowering the enormous sums of money spent on importing wheat flour make composite flour technology significant [14]. The functional, proximate, and rheological characteristics of blends used in confectionery manufacture are impacted when cassava starch flour is added as a composite in breadfruit [15].

Combining flours from different sources, such as soybean and wheat, presents a special opportunity to create noodle products with increased nutritional value [16].

This study's primary goal is to assess the qualitative attributes of biscuits made from wheat and soybean composite flours. It is anticipated that this work's use of soybean as a composite in biscuit manufacture will lessen our over-reliance on imported wheat. By raising their revenue, it will either directly or indirectly improve the standard of living for soybean farmers.

## 2. Materials and Methods

### 2.1. Source of Materials

Federal University of Agriculture, Umuahia, Umudike, provided the soybeans. Wheat flour was obtained from Valleumbra Flour Mill Aba, while other supplies like granulated sugar, baking powder, fat, and vanilla flavor were bought from Ariaria Market Aba.

### 2.2. Preparation of Samples

#### 2.2.1. Preparation of the Soybean Flour

The production of soybean flour is depicted in Figure 1. In essence, two kilograms of soybeans were cleaned and sorted using warm water, then parboiled for forty minutes before being allowed to cool. To facilitate the dehulling of the seed coverings, the parboiled soybeans were rinsed with cold water. After being dehulled, the soybeans were fried and oven-dried for 48 hours at 60 degrees Celsius before being ground into flour with an electric blender.

#### 2.2.2. Preparation of Wheat Flour

Using a mix of air currents and sieves, the whole wheat grain was completely cleaned and washed to eliminate contaminants (other grains, branches, boulders, etc.). The whole wheat grains were debranned to remove the

outermost layer of bran as a safety measure against contaminants connected to the bran. Once the wheat had been cleaned and debranned, it was mixed to preserve its consistent seasonal quality. To make grinding the grain easier, water was added until the moisture level was between 12% and 14%. To reduce their size, the kernels were run through a number of roller mills; the smaller fractions from the various grinding processes were then mixed. To get rid of bigger particles, the flour was sieved using a muslin cloth. Until they were ready to be used, the flour was stored in a plastic bag (Figure 1).

### 2.2.3. Production of Biscuit Samples

Figure 2 and Table 1 display the recipe and process utilized to create the composite biscuit. Six flour blends were produced after the weight of the ingredients was determined using a weighing scale. To get the ideal dough, 25 milliliters of water were added after the fat and sugar had been mixed until frothy. The dough was then forcefully kneaded for 30 minutes using a dough mixer. To achieve the desired thickness, the dough was placed on a level rolling surface and lightly kneaded for 5 mm. A hand biscuit cutter was used to cut it into the desired shapes. After the dough was cut, it was placed on oiled trays and cooked for 20 minutes at 200 degrees Celsius. After 15 minutes of cooling, the hot, baked cookies were wrapped in cellophane [17].

### 2.3. Proximate Analysis of Flour Samples

Food macromolecules are quantitatively analyzed in proximate analysis. Proximate contents will be determined using the procedure outlined in AOAC [18].

#### 2.3.1. Determination of Ash Content

In triplicate, one gram of the material was placed in the crucible, lit over a Bunsen burner, and then ashed for two hours at 600°C in a muffle furnace. In a desiccator, the crucible was cooled before being weighed. According to the percentage ash content was computed as follows:

$$\% \text{ Ash content} = \frac{\text{Weight of Ash}}{\text{Weight of sample}} \times 100$$

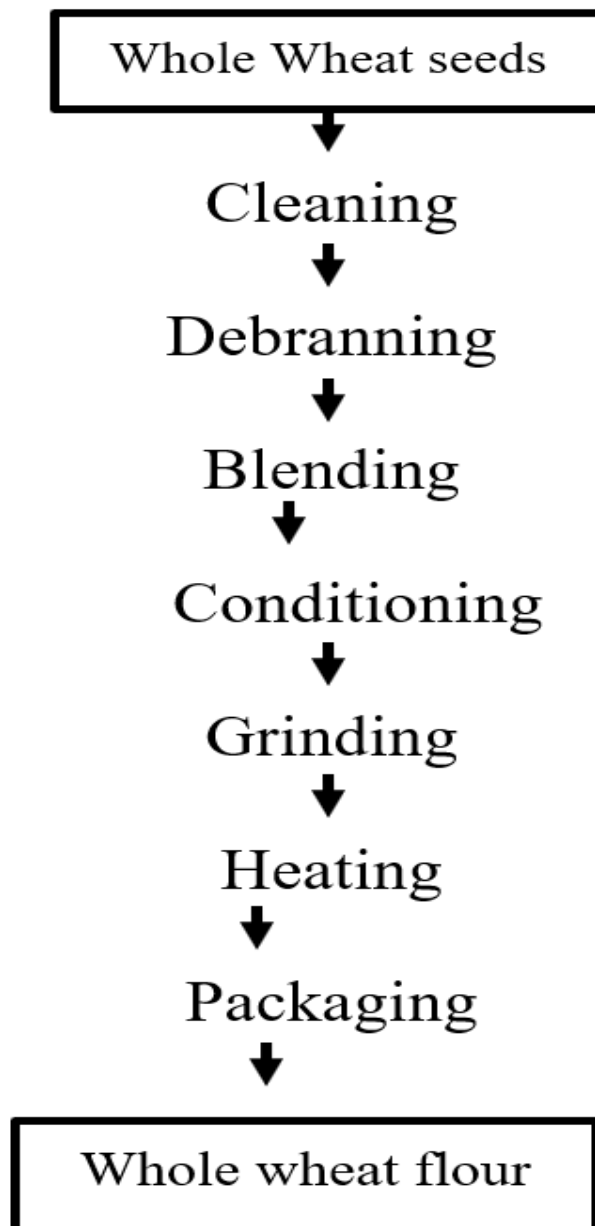


Figure 1. Flow diagram of whole wheat flour production.

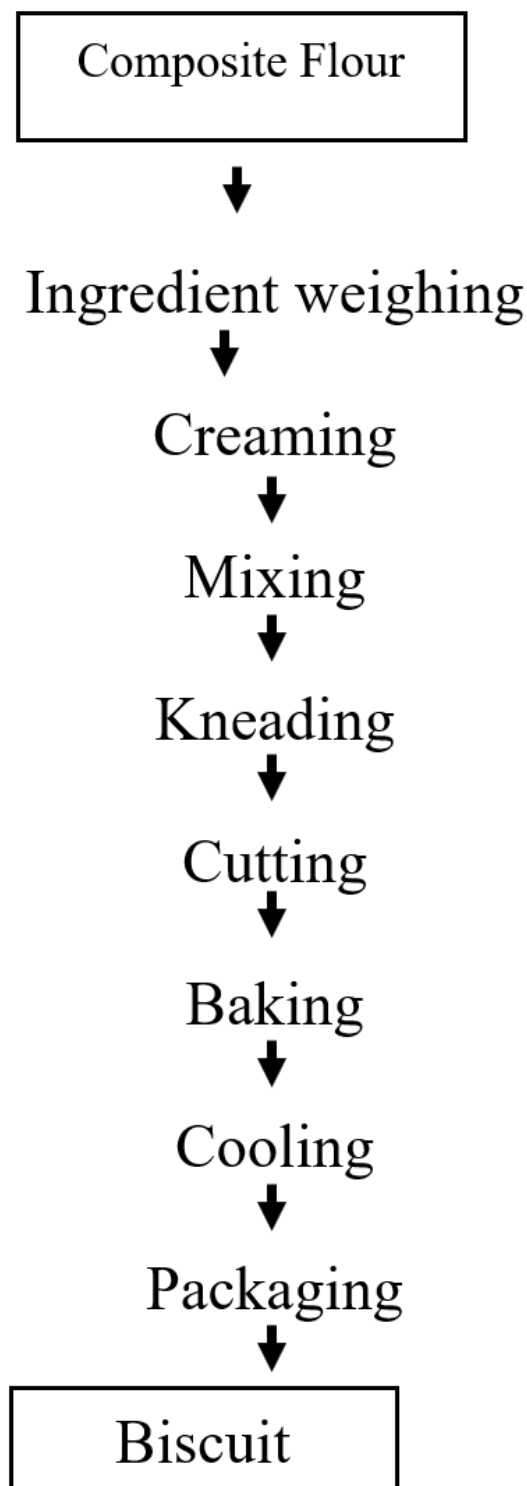


Figure 2. Flow chart for biscuit production.

Table 1. Recipe for biscuit samples at six different levels of wheat with soybean flour substitution.

Ingredients	W1SB	W2SB	W3SB	W4SB	W5SB	W6SB
Wheat flour(g)	100	95	90	85	80	75
Soybean flour (g)	0	5	10	15	20	25
Sugar (g)	25	25	25	25	25	25
Fat (g)	30	30	30	30	30	30
Flavor Vanilla (g)	3	3	3	3	3	3
Water (m)	25	25	25	25	25	25
Baking powder	3.5	3.5	3.5	3.5	3.5	3.5

**Note:** W1SB = 100 % wheat flour.  
 W2SB = 95 % wheat flour.  
 W3SB = 90 % wheat flour.  
 W4SB = 85 % wheat flour.  
 W5SB = 80 % wheat flour.  
 W6SB = 75 % wheat flour.

### 2.3.2. Determination of Crude Fat Content

The Soxhlet extraction method was used to determine the crude fat content. After being cleaned, a 250 ml Soxhlet flask was dried for 30 minutes at 105°C in an oven, cooled in a desiccator, and weighed. A clean extraction thimble was filled with ten grams of the sample. Cotton wool was used to cover the thimble. After assembling the Soxhlet equipment and setting it on a heating mantle, the fat extraction process took three hours. After the fat was extracted, the device was dismantled, and the solvent was extracted and collected. For half an hour, the crude fat remaining in the flask was dried in an oven set at 100°C. After cooling to room temperature in a desiccator, the flask was weighed. The crude fat % was computed.

$$\% \text{ Crude fat} = \frac{\text{Weight of fat}}{\text{Weight of sample}} \times 100$$

### 2.3.3. Determination of Crude Protein Content

The nitrogen concentration, as established by the micro-Kjeldahl technique, was multiplied by a conversion factor to calculate the percentage protein content [18]. A clean micro-Kjeldahl digesting flask was filled with 1 g of the material after it had been securely wrapped in ashless filter paper. The material was mixed with 20 milliliters of strong sulfuric acid. As a catalyst, a tiny amount of copper sulfate was also added. After that, the flask was set on a digesting mantle and heated gradually until the frothing stopped. A clear solution was eventually achieved by heating it more thoroughly and shaking it occasionally. After cooling, the digest was transferred into the Kjeldahl distilling flask along with 100 milliliters of distilled water devoid of ammonia and some anti-bumping granules. After setting up the distillation apparatus, the solution in the flask was distilled into a 10-milliliter solution of 4% boric acid that contained three drops of a mixed indicator (bromo-cresol green and methyl red). After collecting 50 milliliters of the distillate, it was titrated against solutions of 0.02 N H<sub>2</sub>SO<sub>4</sub>. A blank sample was used for the distillation procedure. A color shift to the endpoint indicated the titration's finish point. The crude protein percentage was computed as follows:

$$\% \text{ Crude protein} = \frac{(V_E - V_b) \times N_a \times 0.0014 \times 6.25 \times V_d}{V_{AL} \times M_s}$$

Where:

V<sub>E</sub> = Titre value for the sample distillate.

V<sub>b</sub> = Titre value for the blank distillate.

V<sub>AL</sub> = Aliquot of the distillate taken for titration.

V<sub>d</sub> = Distillate volume obtained.

M<sub>s</sub> = Mass of test sample.

N<sub>a</sub> = Normality of acid used (H<sub>2</sub>SO<sub>4</sub>).

0.0014 = Conversion constant for % nitrogen.

6.25 = Conversion constant from % nitrogen to protein.

### 2.3.4. Determination of Moisture Content

The samples' percentage moisture content was determined using the two-stage air-oven method. An air oven weighed two grams of the composite flour samples into two dry aluminum crucibles (W<sub>1</sub> and W<sub>2</sub>) of known weights. The samples were heated and dried at 130 °C for one hour. The crucibles were dried, cooled to room temperature, and weighed again (W<sub>3</sub>). The procedure was repeated until a consistent weight was achieved. The moisture content percentage was computed as follows:

$$\% \text{ Moisture content} = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

Where;

W<sub>1</sub> = Weight of crucible.

W<sub>2</sub> = Weight of sample + crucible before drying.

W<sub>3</sub> = Weight of sample + crucible after drying.

### 2.3.5. Total Carbohydrate

Using difference the samples' total carbohydrate content was computed as follows: 100% minus (a + b + c + d + e) is the total carbohydrate.

Where

a = % moisture content.

b = % ash content.

c = % crude protein.

d = % crude fat.

e = % crude fiber.

### 2.4. Determination of the Mineral Composition of the Composite Flours

The samples were burned for six hours at 550°C in a muffle furnace, and the ashes were dissolved in strong hydrochloric acid (Merck). Atomic absorption spectrophotometry (Perkin-Elmer Model 3300) was used to measure calcium. Flame photometry was used to measure potassium (Micronal B260). In accordance with AOAC, the analyses were conducted [18]. Each triplicate's three readings yielded the data, which were then expressed in g/100 g. Analytical grade reagents were all employed in the analysis.

### 2.5. Sensory Evaluation

Four hours after manufacture, a sensory evaluation of the biscuits made from the composite flours was conducted using the nine-point hedonic scale quality analysis [19]. Eighty voluntary adult panelists from Ogbonnaya Onu Polytechnic personnel and students in Aba, Abia State, Nigeria, participated in the assessment. The following is a ranking of the descriptive terms that were used.

Like extremely	-	9
Like very much	-	8
Like moderately	-	7
Like slightly	-	6
Neither like nor dislike	-	5
Dislike slightly	-	4
Dislike moderately	-	3
Dislike very much	-	2
Dislike extremely	-	1

## 2.6. Statistical Analysis

The acquired triple data was statistically analyzed using SPSS software version 23. Following the calculation of mean values and One-Way ANOVA, Fisher's Least Significant Difference was used to determine the separation of the means at ( $p \leq 0.05$ ) [20].

## 3. Results and Discussion

### 3.1. Proximate Composition of Biscuits from Wheat-Soybean Flour

Table 2 shows the approximate composition of biscuits made with blends of wheat and soybean flour.

**Table 2.** Proximate Composition of Wheat-Soybean Biscuit.

Sample (WF: SBF)	Crude protein	FAT	Crude fiber	ASH	Moisture content	CHO
W1SB (100:0)	9.92 <sup>c</sup> ±0.88	12.82 <sup>c</sup> ±0.13	0.37 <sup>d</sup> ±0.01	2.21 <sup>c</sup> ±0.03	8.62 <sup>a</sup> ±0.04	66.06 <sup>a</sup> ±0.74
W2SB (95:5)	10.97 <sup>c</sup> ±0.54	13.12 <sup>b</sup> ±0.07	0.43 <sup>c</sup> ±0.04	2.47 <sup>bc</sup> ±0.01	8.61 <sup>a</sup> ±0.13	64.40 <sup>ab</sup> ±0.31
W3SB (90:10)	11.43 <sup>b</sup> ±0.20	13.17 <sup>b</sup> ±0.01	0.51 <sup>c</sup> ±0.04	3.10 <sup>bc</sup> ±0.2	8.56 <sup>ab</sup> ±0.09	63.23 <sup>bc</sup> ±0.15
W4SB (85:15)	12.11 <sup>bc</sup> ±0.25	13.41 <sup>a</sup> ±0.03	0.51 <sup>c</sup> ±0.02	3.23 <sup>bc</sup> ±0.1	8.40 <sup>b</sup> ±0.05	62.35 <sup>cd</sup> ±0.30
W5SB (80:20)	12.95 <sup>ab</sup> ±0.00	13.47 <sup>a</sup> ±0.02	0.64 <sup>b</sup> ±0.02	3.55 <sup>ab</sup> ±0.01	8.18 <sup>bc</sup> ±0.04	61.22 <sup>d</sup> ±0.05
W6SB (75:25)	13.53 <sup>a</sup> ±0.20	13.50 <sup>a</sup> ±0.13	1.13 <sup>a</sup> ±0.08	4.18 <sup>a</sup> ±1.00	7.87 <sup>d</sup> ±0.06	59.74 <sup>e</sup> ±0.92
LSD	1.32	0.23	0.13	1.16	0.22	1.47

**Note:** Values are means of triplicate analysis and standard deviation. Means on the same column with the same superscript are not significantly different ( $p > 0.05$ ).

W1SB= 100% wheat + 0% soybean flour.

W2SB= 95% wheat flour + 5% soybean flour.

W3SB= 90% wheat flour + 10% soybean flour.

W4SB= 85% wheat flour + 15% soybean flour.

W5SB= 80% cassava flour + 20% soybean flour.

W6SB= 75% wheat flour + 25% soybean flour.

#### 3.1.1. Crude Protein Content

The flour samples' crude protein results varied between 9.92 % and 13.53 %. The biscuits' crude protein content increased significantly ( $p < 0.05$ ), with the exception of the 5 % level of soybean flour substitution. With 100% wheat and 0% soybean, sample W1SB had a low protein level of 9.92%. Samples W3SB, W4SB, W5SB, and W6SB had protein contents of 11.43%, 12.11%, 12.95%, and 13.53%, respectively, while sample W2SB had a protein level of 10.97%.

Because of its large proportion of soybean flour, sample W6SB had the highest protein level. This suggests that the protein content of the flour for baking was enhanced by replacing wheat flour with soybean flour. This is consistent with Ubbor and Akobundu [21]'s assertion that adding legume flours to wheat-based composite flour could increase its protein content. This further demonstrates that the protein requirements of consumers of baked goods created with these flour blends would be satisfied by these composite flours [21]. This substantial ( $p < 0.05$ ) variation in the protein content of the three flours may be caused by the handling, food type, processing techniques, and environment.

#### 3.1.2. Fat Content

The flour samples' fat content varied from 12.82 % to 13.50 %, and they were statistically significant at the probability level of  $p < 0.05$ . Sample W6SB had the greatest fat content (13.50 %), while sample W1SB had the lowest (12.82 %). The outcome demonstrates that while wheat flour has a modest fat content, the addition of soybean flour raised the biscuit's fat content. Fat plays a crucial role in product formulation to enhance the product's rheology and smoothness. The low-fat content of wheat flour suggests that, depending on the product type, fat must be added to the formulation if wheat flour is to be utilized as the primary component to enhance the final product's texture and overall quality. The flour samples' fat content varied between 12.82 % and 13.50 %, and they were statistically significant at the probability level of  $p < 0.05$ . Sample W1SB had the lowest fat content (12.82 %), while sample W6SB had the highest fat content (13.50 %). The outcome demonstrates that while wheat flour has a low-fat content, adding soybean flour raises the biscuit's fat content. In product formulation, fat is crucial for enhancing the product's rheology and smoothness. The low-fat content of wheat flour suggests that, depending on the product type, fat must be added to the formulation if wheat flour is to be used as the primary ingredient to enhance the final product's texture and overall quality.

#### 3.1.3. Crude Fiber Content

The flour samples' crude fiber contents varied from 0.37 to 1.13 percent. Sample W6SB (1.13%) had a considerably ( $p < 0.05$ ) higher fiber content than the other samples. Consequently, when the biscuit's wheat flour proportion dropped. As demonstrated by samples W2SB, W3SB, W4SB, W5SB, and W6SB, which had fiber contents of 0.43 %, 0.51 %, 0.51 %, 0.64 %, and 1.13 %, respectively, their crude fiber content increased significantly ( $p < 0.05$ ). Additionally, crude fiber reduces the absorption of glucose and lowers blood sugar levels. Due to the low energy and low-fat flour formulation, it is important to mention that crude fiber induces satiety and helps with weight management. On the other hand, crude fiber composition is used to assess the quality of indigestible cellulose, pentose, lignin, and other dietary components. Crude fiber provides the digestive tract with the volume needed for peristaltic action, despite its low nutritional value [22]. According to Chugh, et al. [23] eating foods high in dietary fiber reduces the incidence of colon cancer, hemorrhoids, diabetes mellitus, heart disease, constipation, and appendicitis.

#### 3.1.4. Ash Content

The flour samples had ash contents ranging from 2.21 percent to 4.14 percent. As seen in samples W2SB, W3SB, W4SB, W5SB, and W6SB, which have ash levels of 2.21 %, 2.83 %, 3.10 %, 3.55 %, and 4.14 %, respectively, the result indicates that the ash content of the flour samples increased significantly ( $p < 0.05$ ) in biscuits with larger ratios of soybean flours. Ash is a mineral found in food that helps break down other organic substances like fat and carbohydrates. The highest ash percentage (4.14%) was found in sample W6SB, suggesting it will enhance the product's mineral content when used as composite flour in baking. A few of these minerals, which contribute to a food's ash level, help break down other organic substances like fat and carbohydrates [24]. The low ash levels, however, can be caused by the solubilization and leaching of nutrients into processing water.

#### 3.1.5. Moisture Content

The flour samples' moisture contents varied from 7.87 % to 8.62%, and all of them were statistically significant ( $p < 0.05$ ) at the probability level. The addition of soybean flour reduced the biscuit's moisture content, as demonstrated by samples W2SB, W3SB, W4SB, W5SB, and W6SB, which had moisture contents of 8.61%, 8.56%, 8.40%, 8.18%, and 7.87%, respectively. This can be because adding soybean flour lowers the high-water absorption capacity of wheat flour. A high moisture content in flour may indicate a limited shelf life since moisture can lead to microbial spoilage. Biscuits' low moisture content ensures that they are frequently free from microbiological deterioration and have a long shelf life if they are protected from absorbing moisture from damp places or the atmosphere, Noah [25]. Dada, et al. [26] reported that the moisture content of composite flour biscuit samples ranged from 1.75 to 2.93 percent. The low moisture readings could be due to the baking temperature [26].

#### 3.1.6. Carbohydrate Content

The flour samples had carbohydrate contents ranging from 66.06% to 59.74%. The results showed that sample W1SB had the highest carbohydrate content (66.06%), and sample W6SB had the lowest (59.74%). Since starch is the primary carbohydrate in wheat, this finding was expected. The lower carbohydrate levels in the biscuit samples could be due to the browning of the crust, which causes some sugars to be lost during baking. The study's findings align with those of Ubbor, et al. [27] who reported carbohydrate contents in biscuits made from flour mixes of wheat, tiger nut, and orange-fleshed sweet potato ranging from 59.74% to 66.06%. The carbohydrate content of biscuits decreased gradually with increasing soybean flour, likely because soybean flour has a lower carbohydrate content, reducing the overall carbohydrate level. This is consistent with research by Olu, et al. [28] which also found that adding soybean flour to wheat flour reduces its carbohydrate content.

### 3.2. Mineral Content of Biscuits from Wheat-Soy Composite Flour

#### 3.2.1. Potassium

The majority of potassium is inside cells. It controls the cell's internal osmotic pressure. It plays a role in the activation of several glycolytic and respiratory enzymes as well as the transfer of cell membranes. It is believed that 782 mg is the minimal daily need. Maintaining low sodium levels can help lower blood pressure because potassium stimulates the kidneys to eliminate excess sodium from the body. Because potassium acts as a blood buffer, it prevents the loss of calcium and phosphorus, two elements that strengthen bones, from the kidneys and bones [29-31]. The biscuit samples' potassium level varied from 5.93 to 11.67 mg/100 g. The results demonstrated that adding soybean flour increased the samples' potassium content. One well-known source of potassium is soybeans. This could explain why the potassium concentration increased as soybean flour replaced wheat flour more frequently. Because it mixes with iron and aids in the assimilation of proteins in the human body, potassium is essential to the system. Increased potassium consumption has been demonstrated to significantly impact blood pressure and the likelihood of developing cardiovascular disorders in the future [32]. It is well known that potassium salts control the body's acid-base equilibrium [33]. More potassium was found than other mineral elements, indicating that cocoyam might be a suitable dietary potassium source. According to a previous study, a high potassium intake in the diet protects against osteoporosis, hypertension, stroke, heart problems, renal damage, hypercalciuria, and kidney stones [34].

#### 3.2.2. Sodium

The primary electrolyte found outside of cells, sodium, aids in controlling blood pressure and bodily water balance [29]. It keeps the extracellular fluid's osmotic pressure constant and is mostly found as an extracellular component. Amylase is one of the enzymes that it activates. Absorption of sodium occurs quickly; it begins 3–6 minutes after ingestion and is finished in 3 hours. The typical daily need for adults is between 1.3 and 1.6 g (or 3.3 and 4.0 g of NaCl). Serious illnesses can arise from consuming too much salt or too little (low blood pressure). Only excessive salt consumption is significant from a nutritional perspective since it can cause hypertension [30]. Because sodium can absorb moisture from the blood and prevent blood from flowing to other areas of the body, higher sodium diets have been shown to have larger effects on blood pressure and the risk of later cardiovascular disorders [32]. The biscuit samples had a salt level of 10.83–12.36 mg/100g. The samples' salt concentration increased as more soybean flour was added, according to the results. Although soybeans don't contain a lot of salt, they do have a somewhat greater sodium level than wheat. This could explain why the biscuit samples' salt content slightly rises as more soybean flour is substituted for wheat flour. The system needs a low sodium level because it might not be able to sustain an increase in heart rate or the ensuing hypertension [35].

#### 3.2.3. Calcium

The biscuit samples had a calcium level ranging from 0.84 to 1.97 mg/100g. The results showed that the samples' calcium content increased when soybean flour was added. It has long been recognized that soybeans are a great source of calcium. This could explain why the calcium level rises as more soybean flour is substituted for wheat flour. Because it is involved in the structure of the muscular system and regulates vital functions like blood clotting, brain cell activity, muscle contraction (locomotor system, heartbeat), and cell growth, calcium is an essential nutrient. It also plays a crucial role in bone formation and strengthening.

The recommended daily intake of calcium is as follows: birth to 6 months (0.4 g), 6 to 12 months (0.6 g), 1 to 5 years (0.8 g), 6 to 10 years (0.8–1.2 g), 11 to 24 years and pregnant women (1.2 to 1.5 g), 25 to 65 years (1.0 g), and above 65 years (1.5 g) [29-31]. The body's acid-base balance is controlled by calcium salts [33]. Eating meals high in calcium strengthens the immune system, which in turn helps the body absorb, use, and digest nutrients. Calcium was the third most prevalent mineral in both cocoyam cultivars, with amounts of 110.2 mg/100g for *X. sagittifolium* and 68.7 mg/100g for *C. esculenta*, according to Ndabikunze, et al. [36]. Although the calcium values found in this study are below the daily requirement (1000 mg/day for adults aged 19 to 50 and 1200 mg/day for adults aged 51 and over) [31], they could be increased by either consuming more cocoyam or combining it with other foods high in calcium. Osteomalacia in adults and rickets in youngsters are caused by a significant calcium shortage.

### 3.2.4. Magnesium

The biscuit samples had a magnesium level between 0.62 and 0.92 mg/100g. It was found that adding soybean flour increased the samples' magnesium level. Magnesium can be found in soybeans. This may be the reason why the magnesium concentration rose as more soybean flour was substituted for wheat flour. For human cells, whether in children or adults, to function at their best, magnesium is essential to the body. Magnesium is a component and activator of numerous enzymes, especially those involved in the transformation of phosphate compounds that are high in energy. It also stabilizes nucleic acids, intracellular membranes, and plasma membranes. It is necessary for the metabolism of lipids, proteins, and carbohydrates. Supplementing with magnesium may help reduce blood pressure slightly. Additionally, eating more magnesium in your diet may help lower your chance of developing type 2 diabetes. The daily intake in a typical diet is between 300 and 500 mg [29-31]. Skeletal growth and development, blood pressure regulation, serum lipid profile improvement, and stroke prevention all depend on magnesium [37].

### 3.2.5. Phosphorus

In cells, phosphorus has a variety of functions [38]. People can obtain enough phosphorus from their diet thanks to the phosphorus content in samples. The fortifying substance found in bones and teeth, hydroxyapatite, is created when phosphorus and calcium combine. Phospholipids, which give cell membranes their structure, include phosphorus. Phosphorus aids in the body's ability to store energy produced by the metabolism of fats, proteins, and carbs for later use, which the body can utilize as needed. Adults require 700–1000 mg of phosphorus daily [29, 39]. The phosphorus level in biscuit samples ranged from 10.60 to 13.33 mg/100g (Table 3). The results demonstrated that adding soybean flour increased the samples' phosphorus concentration. Phosphorus is abundant in soybeans, which could explain the rise in phosphorus concentration when more soybean flour replaces wheat flour. Like magnesium, phosphorus is essential for activating enzymes that regulate lipid, carbohydrate, and electrolyte metabolism [40].

### 3.3. Sensory Characteristics of Biscuit Samples Produced from Wheat-Soybean Composite Flour

Using a nine-point hedonic scale, 25 panelists evaluated the biscuit samples' sensory attributes, including color, mouthfeel, taste, scent, and overall acceptability. Table 3 displays the average attribute scores for each sample. According to the statistical analysis of the sensory scores, the samples' colors differed significantly ( $p < 0.05$ ), but their aromas, mouthfeels, tastes, and general acceptance did not differ significantly ( $p < 0.05$ ).

**Table 3.** Mineral Content of Wheat-Soy Composite Flour Biscuit Sample.

Samples (WF: SBF)	Potassium (mg/100g)	Sodium (mg/100g)	Calcium (mg/100g)	Magnesium (mg/100g)	Phosphorus (mg/100g)
W1SB (100:0)	5.93 <sup>b</sup> ±0.12	10.83 <sup>b</sup> ±2.02	0.84 <sup>b</sup> ±0.31	0.75 <sup>a</sup> ±0.35	10.64 <sup>b</sup> ±0.46
W2SB (95:5)	6.07 <sup>b</sup> ±0.12	11.67 <sup>a</sup> ±0.58	0.91 <sup>b</sup> ±0.39	0.62 <sup>a</sup> ±0.15	10.60 <sup>b</sup> ±0.53
W3SB (90:10)	7.17 <sup>b</sup> ±1.04	11.67 <sup>a</sup> ±0.58	1.43 <sup>a</sup> ±0.32	0.72 <sup>a</sup> ±0.17	10.67 <sup>b</sup> ±0.58
W4SB (85:15)	9.33 <sup>a</sup> ±1.53	11.99 <sup>a</sup> ±2.31	1.92 <sup>a</sup> ±0.63	0.85 <sup>a</sup> ±0.93	11.13 <sup>b</sup> ±0.06
W5SB (80:20)	11.35 <sup>a</sup> ±2.08	12.20 <sup>ab</sup> ±1.15	2.38 <sup>a</sup> ±0.61	0.79 <sup>a</sup> ±0.41	13.33 <sup>a</sup> ±1.15
W6SB (75:25)	11.67 <sup>a</sup> ±0.61	12.36 <sup>a</sup> ±1.52	2.97 <sup>a</sup> ±1.18	0.92 <sup>a</sup> ±0.82	11.83 <sup>a</sup> ±0.55
LSD	3.42	2.32	1.75	3.51	1.96

**Note:** Values are means of triplicate analysis and standard deviation. Means on the same column with the same superscript are not significantly different ( $p > 0.05$ ).

W1SB= 100% wheat + 0% soybean flour.

W2SB= 95% wheat flour + 5% soybean flour.

W3SB= 90% wheat flour + 10% soybean flour.

W4SB= 85% wheat flour + 15% soybean flour.

W5SB= 80% cassava flour + 20% soybean flour.

W6SB= 75% wheat flour + 25% soybean flour.

#### 3.3.1. Appearance

The biscuit samples received sensory evaluations ranging from 6.40 to 7.32 for appearance. The results of the statistical analysis showed that sample W3SB differed significantly from the other samples ( $p < 0.05$ ). Sample W6SB had the lowest score (6.40), whereas sample W1SB had the highest value (7.32). The lighter appearance of sample W2SB (wheat/soybean flour 95:5) was preferred by the panelists. The Maillard reaction, caused by reducing sugars, proteins, and amino acids, may induce browning in the biscuit sample, while intense heat during processing may lead to caramelization [41].

#### 3.3.2. Aroma

One of the sensory characteristics that determines whether a product is liked or disliked is its aroma. The biscuit samples were scored on an olfactory scale from 6.52 to 7.08, with sample W1SB scoring the highest at 7.08 and sample W5SB the lowest at 6.52. The panelists enjoyed sample W1SB's aroma the most, followed by sample W2SB (6.76). Among all samples, W5SB was the least preferred. The beany taste of legume flours may be the cause of the low scent score in the combination flour biscuits.

### 3.3.3. Texture

Similar to the aroma of the samples, the mean scores for texture ranged from 6.16 to 7.60. In terms of texture, sample W1SB was the most favored with the highest score (7.60), while sample W6SB was the least favored with the lowest score (6.16). The texture of samples W2SB and W4SB received the same score (6.84). Due to its low protein level, composite flour produces baked products that are excessively dense or heavy.

### 3.3.4. Taste

The biscuit samples' tastes were rated between 5.72 and 7.08. Sample W1SB had the highest score (7.08), indicating that its taste was the most preferred of all the samples. Sample W3SB was the least favored since it received the lowest score (5.72), indicating that the panelists were undecided. Given the strong correlation between scent and taste, the flavor score essentially followed the same pattern as the aroma score [42].

### 3.3.5. Overall Acceptability

The biscuit samples' total acceptance scores ranged from 6.44 to 7.92. Despite score variation, Table 4 results show no statistically significant difference ( $p > 0.05$ ) between the composite flour samples. Although sample W1SB was rated higher ( $P > 0.05$ ), samples W2SB and W1SB received the best overall acceptability scores of 6.92 and 7.92, respectively. Consumer acceptance of the product relates to overall acceptability [42].

**Table 4: Sensory Qualities of Biscuit Samples Produced from Wheat-Soybean Composite Flour.**

Sample	Appearance	Aroma	Texture	Taste	Overall acceptability
W1SB	7.32±0.21 <sup>a</sup>	7.08 <sup>a</sup>	7.60 <sup>a</sup>	7.08 <sup>a</sup>	7.92 <sup>a</sup>
W2SB	7.16 <sup>a</sup>	6.76 <sup>a</sup>	6.84 <sup>a</sup>	6.76 <sup>a</sup>	6.92 <sup>b</sup>
W3SB	7.08 <sup>a</sup>	6.68 <sup>a</sup>	6.72 <sup>b</sup>	5.72 <sup>b</sup>	6.56 <sup>b</sup>
W4SB	6.88 <sup>a</sup>	6.68 <sup>a</sup>	6.84 <sup>a</sup>	6.76 <sup>a</sup>	6.60 <sup>b</sup>
W5SB	6.48 <sup>a</sup>	6.52 <sup>a</sup>	6.60 <sup>b</sup>	6.16 <sup>a</sup>	6.68 <sup>b</sup>
W6SB	6.40 <sup>a</sup>	6.56 <sup>a</sup>	6.16 <sup>b</sup>	6.20 <sup>a</sup>	6.44 <sup>b</sup>
LSD	0.99	0.82	0.86	0.99	0.89

**Note:** Means in the same column with the same superscript letters on the same column are not significantly different ( $P > 0.05$ ).

W1SB= 100% wheat + 0% soybean flour.

W2SB= 95% wheat flour + 5% soybean flour.

W3SB= 90% wheat flour + 10% soybean flour.

W4SB= 85% wheat flour + 15% soybean flour.

W5SB= 80% cassava flour + 20% soybean flour.

W6SB= 75% wheat flour + 25% soybean flour.

## 4. Conclusion and Recommendations

### 4.1. Conclusion

The findings of this study indicate that using soybean flour instead of wheat flour enhanced the biscuit's protein, ash, and fat contents, among other nutrients. This demonstrates that adding soybean flour to wheat-based goods can improve their nutritional content. Consequently, the population can avoid protein-energy deficiency by adopting or using composite flour in baking. The organoleptic characteristics of biscuits made with 0% and 5% soybean flour substitution were also shown to have excellent overall acceptability.

### 4.2. Recommendation

It is thus advised to use wheat-soybean composite flour when making biscuits since it contributes to the product's fortification and enrichment. To improve the nutritional composition and availability for the growing population, soybean flour should be added to other tuber or cereal-based flours for producing foods. Through seminars, publications (such as journals, newspapers, and bulletins), radio and television broadcasts, etc., the discovered compatibility of soy flour in composite with wheat flour for biscuit production should be shared with biscuit manufacturing facilities. Lastly, as this study's scope did not include the shelf life of biscuits made with wheat/soybean composite flour, I also suggest that more research be done in this area.

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