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Brief Research Report

Utilization of Cassava/Soybean Composite Flour in Biscuit Making

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Abstract: Cassava and soybean flour were used to produce biscuits in different ratios in an attempt to substitute or replace wheat. Composite flour, made from a combination of cassava and soybean flour, was processed into biscuits using varying proportions. The ratios ranged from 10% to 50% soybean flour and 90% to 50% cassava flour. The proximate evaluation revealed that including 20% soybean flour in the cassava flour, making up 80% of the mixture, resulted in a significant level of protein and other nutrients that closely compared to those found in 100% wheat flour. The protein and fat content increased significantly as the proportion of soy flour increased, leading to a corresponding decrease in the carbohydrate content of the analyzed biscuit samples. This study demonstrates that a blend of 80% cassava flour and 20% soy flour produced biscuits with good nutritional quality. The sensory evaluation and overall acceptance of the product showed no significant difference between the 80:20 blend and the control (100% wheat).

Keywords: Biscuit, Cassava Flour, Composite Flour, Proximate Evaluation, Soybean Flour

1. Introduction

Biscuits are an important food product that is steadily increasing in consumption in Nigeria, especially among infants and children. Biscuits are made from a dough and baked to a very low moisture content, resulting in a crispy texture. They are convenient and ready-to-eat, containing important digestive principles (Kulkarni, 1997). Bread and biscuits are the main baked foods produced in most countries. While the quality of bread and biscuits is similar, biscuits are considered to have more value than bread. Biscuit consumption is increasing even in rural areas, thanks to its popularity as a snack, longer shelf life, and good taste that appeals to a wide range of people (Oyewole et al., 1996). Wheat flour is the main ingredient used in biscuit production, primarily because of its gluten protein, which is not found in other cereal flours (Kent, 1998). The ingredients for biscuit production include flour, shortening (hydrogenated fat), sugar, and water. Optional ingredients can include milk, salt, and baking powder (a mixture of sodium bicarbonate and sodium biophosphate). The production process involves making the dough, rolling it out, cutting it, baking it, and cooking it (Okaka, 1997).

Before the importation of wheat in Nigeria, biscuits were made solely from wheat flour, which was relatively expensive due to the lack of wheat cultivation in the country's tropical climate (Edema et al., 2005). To address this, efforts have been made to promote the use of composite flour, which combines locally ground crops and high protein seeds to replace a portion of wheat flour in biscuit production. This helps decrease the demand for imported wheat and produce enriched biscuits at a more affordable price (Giami et al., 2004). Enriching or fortifying biscuits and other baking products with protein sources like oil seeds and legumes has gained attention, as these proteins are rich in lysine, an essential amino acid lacking in most cereals (Ihekoronye & Ngoddy, 1985).

Baked products, such as biscuits, should remain the most affordable among processed ready-to-eat foods or snacks. Therefore, it is economically advantageous to process and use locally grown crops, such as cassava root, to meet the demand for baked goods instead of relying solely on wheat. The consumption of cereal-based foods like biscuits requires the development of wheat flour substitutes (Bokanga, 1995; Eggleston et al., 1993; Kim & De Ruiter, 1968; Morton, 1988), and studies have shown that 100% substitution of wheat flour with cassava flour for biscuit production is possible (Oyewole et al., 1996). Substituting 100% soybean flour for wheat flour in biscuit production has also been reported (Okoye et al., 2008). However, physicochemical analysis of biscuits made from 100% cassava showed low acceptability and lower protein and fat content compared to wheat flour.

The protein in cassava tubers is rich in arginine but low in methionine, lysine, tryptophan, phenylalanine, and tyrosine. Therefore, cassava protein is not only low in quantity but also poor in quality (Ihekoronye & Ngoddy, 1985). However, cassava can be combined with nutritious food materials to enhance its nutritional value. The challenge in the food industry today is to develop affordable foods that are both nutritionally superior and acceptable to consumers (IITA, 1990). Protein malnutrition is a major public health problem in some parts of Nigeria, especially among infants who make up a significant portion of biscuit consumers.

Soybean (Glycine max), a grain legume, is a cheap and rich source of plant protein that can improve the diets of millions of people, particularly the poor and low-income earners in developing countries. Soybean protein is nutritionally similar to animal protein and plays an important role in enriching cereal-based baked goods (Fukushima, 2001). Soybean is also a rich source of vitamins and minerals and has a relatively low crude fiber content (Oyenuga, 1968). This research aims to combine the nutritional composition of cassava and soybean flour to produce biscuits with good nutritional quality and evaluate the acceptability of the product.

1.1. Statement of Problem

The majority of biscuits produced by the population are made from wheat flour, which is not commercially cultivated in Nigeria and is relatively expensive. This has led to an increase in the price of bakery products, especially biscuits. The substitution of cassava and soybean flour in the production of bakery products will encourage the cultivation of indigenous crops and the diverse utilization of these crops, providing job opportunities for agriculturists.

1.2. Purpose of the Study

The primary objective of this work is to develop biscuits using blends of cassava flour and soybean flour that have good quality and are acceptable. Other objective include conducting a proximate evaluation of the cassava soy biscuits to determine the level of substitution that can compete with wheat nutritionally.

1.3. Hypothesis

The following hypothesis guided the study:

(a) A blend of cassava flour and soy flour will produce biscuits with good nutritional quality.

(b) The sensory evaluation and overall acceptance of the product will demonstrate no significant difference between the blend and the control (wheat).

2. Materials and Methods

2.1. Materials

The main ingredient used in biscuit manufacturing is flour. Other materials used include cassava tuber and soybean seeds. Additional baking materials include fat, sugar, salt, baking powder, and water. The equipment used includes a weighing balance, mixer, rolling board and rolling pin, bowl, oven, heat sealer, cutter, scales, and thermometer clock.

2.2. Study Procedure

Cassava was processed according to the method described by the Federal Institute of Industrial Research Oshodi (FIIRO). Freshly harvested cassava tubers were cleaned to remove contamination and soil particles. The tubers were then sorted, graded, and peeled. After peeling, they were thoroughly washed. The peeled tubers were finely grated and soaked for several days to soften the tissues. They were then dried in the oven, milled, and sieved. The final product was packaged in a cellophane bag.

Soybean was processed using the method described by Ihekoronye and Ngoddy (1985). The soybean was thoroughly cleaned under air aspiration to remove dust, sand, stones, and other soil particles. It was then soaked in water for 8 hours and drained. The hulls were separated under air flow to remove lighter hulls. The dehulled soybeans were then conditioned in a cooker at a temperature of 100°C for 30 minutes. After that, the beans were milled and finely sieved to produce soybean flour, which contains about 47-59% protein.

2.3. Flour Blend

Six different flour blends were produced, varying the proportions of cassava flour and soya bean flour. The blends produced from the given samples were as follows: 90% cassava flour and 10%

soya bean flour, 80% cassava flour and 20% soya bean flour, 70% cassava flour and 30% soya bean flour, 60% cassava flour and 40% soya bean flour, and 50% cassava flour and 50% soya bean flour. The other sample used 100% wheat flour, which served as the control sample. The ratios of the mixtures are shown in Table 1.

Table 1: Biscuit recipe for each blend sample

Ingredient	Quantity
Margarine	200g
Sugar	100g
Salt	2g
Baking powder	16g
Water	needed

2.4. Baking Process

Each flour blend was mixed thoroughly with the other ingredients using a mixer. Next, the shortening was rubbed in, followed by the gradual addition of water while mixing until the dough reached the desired consistency. The dough was then kneaded by hand and cut into various shapes using a cutter. The cut-out dough pieces were placed on an oiled stainless steel tray and baked in an oven at 1850°C for 15-20 minutes. After baking, the freshly baked biscuits were allowed to cool before being packaged using a heat sealer. The quality of each blending sample used is shown in Table 2. According to the table, as the ratio of cassava flour increased, the mean flour also increased from 250g. Also, as the ratio of soya bean flour decreased, the mean flour decreased from 225g to 0g.

Table 2: Quantity for each blend sample used

Material	Ratio [%]	Quantity [G]
Wheat	100	450G:45g
C.F:SB F	90:10	360G:90g
C.F:SB F	80:20	350G:90g
C.F:SB F	70:30	315G:135g
C.F:SB F	60:40	270G:180G
C.F:SB F	50:50	225g:225g

2.5. Proximate Analysis

Proximate analysis of grounded biscuit samples was carried out using the standard procedure of the Association of Official Analytical Chemists (2023) for moisture content and ash determination. The carbohydrate content was calculated using the difference method (Aletan & Kwazo, 2019). Recent studies have shown that it is very important to conduct proximate analysis on product samples in order to determine their nutritional value, composition, and quality (e.g., Abdullahi et al., 2022; Amonyeze et al., 2022; Arukwe et al., 2022; Nwakanma et al., 2022). This process helps us to ascertain whether a product meets consumer expectations and relevant standards.

2.6. Determination of moisture content

2.6.1. Method: Oven dry at 105^0c as stated by Onwuka (2005).

2.6.2. Apparatus: Crucibles, weighing balance, spatula, desiccators and oven

2.6.3. Procedure: The crucibles were thoroughly washed and dried in the oven. After that, they were placed in the desiccators to cool. The weight of each crucible was measured first (W1), and then again (W2). Next, the crucible and its contents were dried in the moisture oven at a constant temperature of 1050°C, and weighed again (W3). The samples were then placed inside the desiccators to cool, and the weight of the dried samples plus the dish was measured.

2.6.4. Calculation

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

2.7. Determination of Ash

2.7.1. Method: Muffle furnace at 500^0c as described by Association of Official Analytical Chemists (2023).

2.7.2. Apparatus: Silica dish muffle furnace, desiccators

2.7.3. Procedure: The silica dish was cleaned thoroughly, dried, ignited for some time, and cooled in desiccators. The silica dish was then weighed [w2], and 2g was accurately introduced into the dish and weighed [w2]. It was then transferred into a muffle furnace at 500°C until a gray color of ash was obtained. The dish and the ash were then cooled in desiccators and weighed.

2.7.4. Calculation

$$\%\text{ASH} = \frac{\text{weight of ash x } 100\%}{\text{Weight of sample}} = \frac{\text{W3-W1X } 100\%}{\text{W2-W1}}$$

2.8. Determination of Fat Content

2.8.1. Apparatus: Filter paper, boiling flask, weighing balance

2.8.2. Method: The soxhlet extraction method as described by Onwuka (2005)

2.8.3. Procedure: A 250ml boiling flask was washed and dried in the oven for approximately 30 minutes. It was then transferred onto a filter paper, stapled, and labeled. The thimble was partially inserted into the extractor, and the weighed sample was carefully transferred into it. The boiling flask was filled with around 300ml of N-Hexane. Next, the extraction thimble was tightly plugged with cotton wool. The Soxhlet apparatus was assembled and allowed to reflux for about 6 hours. The thimble was carefully removed, and the collected N-Hexane was drained into a container for later use. The flask was then almost free of petroleum ether, removed, and dried at a temperature of 1050 to 1100 for 1 hour. The flask was transferred from the oven to a desiccator to cool, and then weighed.

2.8.4. Calculation

$$\%\text{FAT} \quad \frac{\text{weight of fat x } 100}{\text{weight of sample}}$$

2.9. *Determination of Nitrogen and Protein*

2.9.1. Apparatus: Kjeldahl flask, pipette, fume cupboard, burette, baker.

2.9.2. Method: Kjeldahl method described by Onwuka (2005).

2.9.3. Re-agent: Sodium hydroxide, boric acid, methyl red, sodium sulphate and copper.

2.9.4. Procedure: 2g of sample, 2g of anhydrous sodium sulphate, and 1g of copper sulphate were weighed and transferred into the Kjeldahl flask. Then, 10ml of concentrated sulphuric acid was added to the mixture in the flask. The flask was gently heated in a fume cupboard and occasionally swirled after the initial vigorous reaction subsided. The heat was increased and digestion continued until a clear liquid was obtained. The flask was swirled periodically to remove any charred particles from the sides. Once cooled, the contents of the flask were diluted with approximately 200ml of distilled water. Next, the distillation apparatus was assembled, consisting of a 500ml capacity flask with a stopper carrying a dropping funnel and a straight delivery tube. 20g of boric acid was measured into a 100ml conical flask, and a few drops of screened methyl red indicator were added. The conical flask was placed under the delivery tube so that the end dipped just below the level of the boric acid. Then, 10ml of the digestion solution was added to the apparatus through the filler funnel aperture, followed by rinsing with distilled water and then 10ml of sodium hydroxide, with some rinsing in the funnel. The apparatus was gently shaken to ensure thorough mixing of the contents. It was then vigorously boiled until 50ml distilled over. The receiver was removed along with the delivery tube, and the tap on the dropping funnel was opened while heating was stopped. The delivery tube was rinsed into the receiver, and the resulting solution was titrated using sulphuric acid until a dull color was achieved.

2.9.5. Calculation

% nitrogen = $Vs - \frac{Vs \times Nacid \times 0.0141 \times 100}{W}$

Where W = weight of sample in grams

Vs = volume [ml] of aside required to titrate sample

N = Normality of acid [0.01N]

Vb = volume of blank [without sample, only re-agent]

2.10. Determination of Crude Fibre

2.10.1. Re-agents: Sulphuric acid, ethylated spirit

2.10.2. Apparatus: Conical flask, spatula, fluted funnel, filter paper, desiccators

2.10.3. Method: The method is as described by Onwuka (2005).

2.10.4. Procedure: Defat approximately 2g of sample by combining it with 200ml of sulphuric acid in a conical flask. Boil and reflux the mixture for 30 minutes, then remove the flask from the heat source and cool it under tap water. Next, filter the mixture through filter paper on a fluted funnel. Wash the residue six times with hot water and ethylated spirit. Remove the residue using a spatula and transfer it to a muffle furnace heated to 600°C. After cooling the residue in a desiccator, weigh it.

2.10.5. Calculation

Loss in weight after incineration x 100%

Source: Onwuka (2005)

2.11. Determination of Carbohydrate

Carbohydrate [%] 100- [ash + protein + fat + moisture]

2.12. Sensory Evaluation

Sensory evaluation was carried out to determine the acceptability of the baked biscuit in terms of color, texture, and taste. The sample was presented to eight panel members who were familiar with the product. I visited each panelist at their home and provided them with a 9-point hedonic scale to determine their level of acceptability. They completed the scale in the absence of other panelists. The preference scores were based on a hedonic test that used a scale ranging from "Like extremely" (9) to "Dislike extremely" (1).

3. Results and Discussion

3.1. **Hypothesis 1:** A blend of cassava flour and soy flour will produce biscuits with good nutritional quality.

Table 3. Proximate Composition of Cassava – Soy Biscuit

Samples %	MC %	Protein %	Fat %	Ash %	Fiber %	CHO %
100 WHEAT	9.53± 0.32^{b}	10.88± 0.99^{e}	6.40± 0.07^{f}	0.97± 0.62^{a}	1.79± 0.01^{b}	70.44± 0.33^{a}
90:10 (cf:sf)	9.68± 0.46^{b}	7.73± 0.03^{f}	10.73± 0.04^{e}	1.0± 0.01^{a}	1.58± 0.03^{c}	69.30± 0.50^{a}
80:20 (cf:sf)	11.15± 0.14^{ab}	13.21± 0.06^{d}	11.50± 0.21^{d}	1.0± 0.01^{a}	1.64± 0.02^{6}	60.25± 0.11^{b}
70:30(cf:sf)	11.88± 0.88^{a}	16.62± 0.14^{c}	12.20 ± 0.14^{c}	0.97± 0.04^{a}	0.46± 0.01^{e}	57.88± 1.20^{a}
60:40(cf:sf)	10.68± 0.11^{ab}	18.50± 0.06^{b}	13.63± 0.04$_{b}$	0.96± 0.04^{a}	2.28± 0.11^{e}	53.89± 0.16
50:50(cf:sf)	6.35± 1.77	21.48± 0.16^{a}	14.30± 0.1^{4}	1.0± 0.14^{a}	0.74± 0.02^{d}	56.15± 1.72^{c}

90:10 CF:sf-90% cassava flour and 10%soyflour

80:20 CF:sf-80% cassava flour and 20%soyflour

70:30 CF:sf-70% cassava flour and 30%soyflour

60:40 CF:sf-60% cassava flour and 40%soyflour

50:50 CF:sf-50% cassava flour and 50%soyflour

- Means of duplicate samples.
- Means in the same column and followed by the same letters are not significantly from other (p> 0.05).
- Mean ± S.D

3.2. **Hypothesis 2:** The sensory evaluation and overall acceptance of the product will demonstrate no significant difference between the blend and the control (wheat).

Table 4: Sensory Evaluation of the Biscuit Samples

Samples %	Colour %	Texture %	Taste %	Acceptability
100 wheat	7.17± 0.98^{a}	6.50± 0.84^{a}	8.00± 1.26^{a}	7.00± 1.09^{a}
90:10 (cf:sf)	3.00± 1.78^{c}	3.83± 1.94^{b}	4.50± 2.34^{b}	4.83± 1.17^{b}
80:20 (cf:sf)	6.17± 1.17^{ab}	6.67± 1.51^{a}	7.33± 1.37^{a}	7.67± 0.82^{a}
70:30(cf:sf)	4.83± 1.83^{bc}	5.33± 2.33^{ab}	5.83± 2.48^{ab}	5.50± 1.38^{b}
60:40(cf:sf)	6.00± 1.55^{ab}	3.17± 2.04^{b}	4.00± 1.90^{b}	4.33± 1.03^{b}
50:50(cf:sf)	3.33± 1.96^{c}	4.50± 2.07^{ab}	4.00± 1.78^{b}	4.17± 1.33^{b}

Mean ± SD; Mean is the same column with the same letters not significantly different from each other (p>0.05).

The proximate composition table 3 shows that a nutritious biscuit can be made from a blend of cassava and soy flour. Cassava is known to be rich in carbohydrates, while soybean is a good source of high-quality protein, fat, and minerals. The biscuit made with 50% soy flour substitution had the highest crude protein content at 21.48%, which was greater than the control biscuit made with 100% wheat. The biscuit made with 90% cassava showed a carbohydrate content of about 69.30%, which was not significantly different from the 100% wheat biscuit. We observed that protein and fat levels increased as the proportion of soy flour increased, while carbohydrate content increased with an increase in the proportion of cassava. This study shows that blending soy flour into cassava flour up to 20% (13.21%) can result in higher protein quality compared to the control (100% wheat flour) at about 10.88%. This is due to the significant quality and quantity of protein present in soybean seeds, as indicated in the literature review (Ihekoronye & Ngoddy, 1985). Supplementing cassava flour with soybean can greatly improve the protein nutritional quality of bakery products, which is especially important in developing countries, particularly in rural areas where high-protein foods are less affordable. This observation was also supported by an increase in protein content with an increase in soybean supplementation in maize flour during the production of *agidi*, a fermented cereal product. Olatidoye et al. (2011) also showed an increase in the protein level of cassava flour produced with the inclusion and increase in the proportions of soybean. As the proportion of soy flour increased, a decrease in carbohydrate level was observed, ranging from 69.30% to 56.15% with an increase in soy flour ratio from 10% to 50%. The table results showed no significant difference in carbohydrate content between 100% wheat flour and 90% cassava flour. The inclusion of soybean in cassava flour does not affect the carbohydrate quality of the product, as the 50% cassava inclusion still had a carbohydrate content of about 56.15%. The highest fat content of 14.30% was recorded with 50% soy inclusion. Olatidoye et al. (2011) and Olaoye et al. (2006) reported that soybean contains a considerable amount of fat and minerals, and they also found an increase in fat and protein content with an increase in the proportion of soy flour supplementation in bread made from composite flour of wheat, plantain, and soybean.

Table 4 presents the results from the sensory evaluation of biscuits made from blends of cassava and soybean flour at different proportions. There was no significant difference in the color, taste, texture, and acceptability between the biscuit made with 100% wheat flour (control) and the one made with 80:20% cassava soy flour. However, the biscuit made with 90:10% cassava soy flour showed a significant difference in taste, texture, color, and acceptability, and can be considered unacceptable based on comments from the sensory panel during the assessment. The biscuit made with 70:30% cassava soy flour showed a significant difference in acceptability and color. The products made with 60:40% and 50:50% cassava soy flour showed a significant difference in color, texture, taste, and acceptability ($p<0.05$). Based on the proximate and sensory evaluation, this study shows that a blend of cassava and soy flour at an 80:20% ratio can be generally acceptable, especially when other baking ingredients are added to enhance the attractiveness and marketability of the biscuit.

4. Conclusion

The findings indicate that good biscuits can be produced from a blend of cassava and soybean flour. The inclusion of soybean flour at a 20% ratio into cassava flour can increase the protein content to match that of wheat flour. Biscuits with favorable sensory attributes can be made by substituting 80% cassava flour with 20% soy flour. This is economically significant for developing countries like Nigeria, as it promotes the cultivation and processing of local crops. This study encourages the use of locally available tuber and leguminous crops in bakery production, reducing the need for wheat imports. Nigeria is the largest producer of soybeans for food in West Africa. Incorporating soybeans into food processing not only improves nutritional quality but also prevents post-harvest losses by utilizing soybean seeds more effectively. Tuber cultivation offers promising economic advantages and should be encouraged to provide job opportunities for young agriculture graduates. Cassava has a high yield and minimal waste, as the leaves and peel can be processed into animal feed. It is also a valuable source of starch, and the liquid waste from cassava can be used to produce biogas. Lastly, adding soybean flour to biscuits and other bakery products enhances their nutritional value, which can help address protein malnutrition, especially among children in rural areas who rely on starchy foods like yams and cassava. Further research is needed to explore the effects of different ratios of cassava and soybean flour on the quality attributes of biscuits.

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Conflict of Interest

The author declare no conflict of interest.

Author Contributions

The study's conceptualization, methodology, writing, data collection, analysis and revision were solely performed by UDK.

Data Availability Statement

The dataset used for this study is available on request. For further inquiries can consult the authors.

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