Nutritional Evaluation of Cookies Prepared from High-Quality Cassava Flour Fortified with Soy Flour and Coconut Milk for Household Food Security

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ABSTRACT

Background: *Cookies contribute significantly to dietary diversity and nutrition. In Nigeria, where food insecurity and undernutrition remain prevalent, developing nutrient-dense snacks using locally available resources is crucial. Combining cassava with soybeans and coconut milk aims to enhance nutritional profiles and address food security challenges in Nigeria.*

Objective: *To assess the nutritional composition and sensory attributes of cookies made from cassava flour enriched with soy flour and coconut milk.*

Methods: *Cassava flour was blended with soy flour and coconut milk in varying ratios. Ingredients were mixed, baked into cookies, and analyzed in the laboratory. Proximate composition, vitamin content, mineral content, and sensory characteristics were analyzed using standard methods as described by AOAC. Sensory evaluation was conducted using a 9-point hedonic scale with 50 semi-trained panelists. Data were subjected to Analysis of Variance (ANOVA) using SPSS Version 25.*

Results: *Snacks with higher proportions of soybean and coconut milk showed increased levels of protein, fat, and minerals. SVY 3 (50% cassava, 30% soybean, 20% coconut milk) exhibited the highest protein (17.16%) and fat (13.66%) content, significantly surpassing other formulations. SVY 3 also demonstrated significantly higher levels of Vitamins and minerals compared to other formulations. Sensory evaluation indicated that SVY 3 received significantly higher ratings for appearance, aroma, taste, and overall acceptability.*

Conclusion: *SVY 3 emerged as the optimal formulation due to its superior nutritional richness and sensory appeal. Cassava-based cookies enriched with soy flour and coconut milk offer a promising approach to augment protein and nutrient intake, potentially addressing food security challenges.*

Keywords: Cassava flour, Soy flour, Coconut milk, Nutritional composition, Sensory evaluation

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INTRODUCTION

Cookies can contribute to nutrition, primarily through energy provision (calories) from carbohydrates and fats. Reformulation efforts focus on enhancing their health profile by incorporating whole grains, reducing added sugars, and fortifying with fiber, protein, or micronutrients to support dietary guidelines and address energy needs (1). However, their role remains largely within discretionary calories, and overconsumption of commercial varieties high in sugar, saturated fat, and refined flour is linked to negative health outcomes (2). High-quality cassava flour (HQCF) is a finely milled, unfermented product made from fresh cassava roots through a controlled process of peeling, washing, drying, and milling. This modern method ensures a neutral flavour, light colour, and low moisture content, distinguishing it from traditional cassava flour, which often has a sour, fermented taste and inconsistent quality due to less standardized sun-drying and fermentation (3). HQCF's blandness and purity make it a versatile wheat flour substitute in baked goods and food industries, aligning with food safety standards and expanding its commercial application (4).

Cassava (*Manihot esculenta Crantz*), a tropical crop with a high level of carbohydrates, most varieties exhibit high starch content, which makes it prominent among polysaccharide-bearing crops (5). The economic influence of cassava research and extension in Malawi and Zambia from 1990 to 2008 was estimated after the introduction of varieties tolerant to diseases and drought. Farmers did not embrace them, mainly because they were not satisfied with their sensory attributes compared with the preferred local types. However, over time, researchers have introduced several varieties with higher yields and improved sensory and industrial traits (6).

Soybean (*Glycine max* L.) is a legume that grows in tropical, subtropical, and temperate climates. It is particularly known for its high protein content and is a staple in several developing countries, especially in Southern Africa, where it is popularly grown (7; 8). It has become a cash crop which smallholder farmers now rely on for income, partly due to an expansion of the poultry and animal feed industry (9), and also its increasing preventive therapeutic role in combating diseases (10; 11).

Coconut milk is the liquid obtained by manual or mechanical extraction from the endosperm of the coconut. It is widely used in traditional food dishes in Malaysia, Indonesia, Thailand, and the Philippines (12). Dairy milk and coconut milk can serve as substitutes for one another, depending on the purpose of substitution (13). On the contrary, there is also an increase in research on product developments whereby coconut milk is used to substitute dairy milk (cow milk) in dairy products such as cheese (14), yogurt (15), chocolate (16), and frozen dessert (17). This is because dairy milk originates from animals, whereas coconut milk originates from a plant source, which is perceived to be healthier. In addition, coconut milk would be a better option for vegetarians. Moreover, some people are allergic or have lactose intolerance to dairy milk, which limits their dairy products (18). Thus, coconut milk is said to be one of the most suitable replacements for dairy milk. This study assessed the nutritional composition and sensory attributes of cookies made from high-quality cassava flour enriched with soy flour and coconut milk.

MATERIALS AND METHODS

Materials

All food materials used in the study were purchased from the local market in Iluju market, Ogbomoso, Oyo State, Nigeria. The food materials used include cassava, soybeans, and coconut. The food materials were authenticated at the Department of Crop Production and Soil Science, Ladoke Akintola University of Technology, Ogbomoso, Nigeria. All chemicals used were of analytical grade and obtained from Sigma-Aldrich, London, UK.

Production of soybean flour

The soybean flour was obtained according to the described methods by Elisabeth (19). The raw seeds were sorted and cleaned, roasted in an oven for 20 min at 180°C, dehulled, and milled using a Binatone kitchen blender (model BLG 402, Zhongshan, Haishang), and the resultant flour sieved to obtain a uniform size of 400 µm.

Production of cassava flour

The cassava flour was obtained according to the method described by Ajewole (20) with little modification. Freshly harvested roots were washed, peeled, rewashed, and soaked in water for about 15 min to reduce the cyanogen. The roots were then sliced to a 2-3 mm thickness using a manual slicer, pressed using a manual hydraulic press to reduce the moisture and release the cyanogen into the liquid. The pressed cassava slices were sun-dried for 4-6 hours, followed by oven-drying at 55°C for 24 hours. The dried cassava slices were milled using a Binatone kitchen blender (model BLG 402, Zhongshan, Haishang) and the resultant flour sieved to obtain a uniform size of 400 µm.

Production of coconut milk

The coconut milk was obtained according to the method described by Ajewole (21). Briefly, the obtained coconuts were dehusked and cracked open with a knife. The brown surface of the coconuts was peeled in order to give white coconut meat. The paired coconut was washed and cleaned with water in order to remove specks of dirt and impurities attached to the coconut meat. The clean coconut meat was blended with an Akai electric blender from Tokyo, Japan, at 55°C. A cheese cloth was used to squeeze out the milk from the blended coconut, and it was filtered in order to remove any form of sediments. The extracted coconut milk was then filled into a plastic bottle.

Table 1: Composite flour formulations

Sample	HQCF %	Soybean Flour %	Coconut Milk %	Total %
SVY 1	70	20	10	100
SVY2	60	20	20	100
SVY 3	50	30	20	100
SVY 4 (Control)	100	-	-	100

Production of snacks (Cookies)

Cookies were produced according to the method described by Ikechukwu (22). The ingredients (cassava flour, soybean flour, and coconut milk) were measured into a bowl. Using the rubbing method, fat, milk, and salt were added and rubbed for 30 minutes. In a separate bowl, egg and water were mixed and added to the flour-based mixture and kneaded, and made into dough. The dough was rolled and flattened into a uniform thickness of about 3.5mm before being cut into shapes using a hand-cutter. The cutout dough was baked at 150°C for 30 minutes in the oven. After baking, the cookies were cooled to room temperature, packed in low-density polyethylene (LDPE) bags, and sealed in a transparent plastic container.

Proximate composition analysis

Proximate compositions of the snacks were determined as described by AOAC (23). This encompassed assessing moisture content, ash, crude fiber, crude fat, and crude protein levels

Carbohydrate content was determined by difference as follows:

$$Carbohydrate\ (\%) = 100 - (\%Moisture + \%Fat + \%Ash + \%Crude\ fibre + \%Crude\ protein)$$

Mineral analysis

The snacks (cookies) were analyzed for their Iron, Copper, Sodium, Calcium, and Zinc content according to their respective methods as modified and previously described by (27).

Evaluation of sensory attributes

The cookies were coded and presented to 50 semi-trained panellists for evaluation of their appearance, texture, taste, aroma, and mouth feel using a Hedonic scale of 1 to 9, where 1 = dislike extremely and 9 = like extremely as described by (24).

Statistical analysis

All determinations were carried out in triplicate. Data were subjected to analysis of variance (ANOVA) using SPSS (version 21, Chicago, United States of America), while means were separated using the Duncan Multiple Range Test (DMRT) at a 5% level of significance ($p < 0.05$).

RESULTS

Proximate composition of snacks from cassava flour, soybean flour, and coconut milk

The result of the proximate composition of snacks produced from cassava flour, soybean flour, and coconut milk is shown in Table 2. SVY 3 had the lowest moisture (9.72%), suggesting better shelf stability and lower microbial spoilage risk. The control sample (SVY 4) had the highest moisture (13.78%), indicating shorter shelf life. Ash content was highest in the control (3.84%) and lowest in SVY 3 (2.28%). Ash gives an estimate of total mineral content, but the trend here may reflect differences in ingredient purity or concentration rather than mineral density. Fibre content decreased with higher soy and coconut milk addition. SVY 4 (7.38%) had the highest, while SVY 3 had the lowest (3.65%). Fortification may dilute fibre concentration compared to plain cassava formulations. Lipid content increased significantly with more coconut milk, peaking in SVY 3 (13.66%). This reflects coconut milk's high-fat nature, contributing to energy density and mouthfeel. Protein increased notably with soybean fortification, highest in SVY 3 (17.16%), compared to the control (8.72%). Soy flour is rich in protein, improving the snack's nutritional quality. Carbohydrate decreased as protein and fat increased. SVY 1 had the highest carbohydrate (60.54%), while SVY 3 had the lowest (53.53%). This shows nutrient displacement, as higher protein and fat contents replace carbohydrate proportionally. Energy (kcal) increased with fat and protein levels, highest in SVY 3 (359.42 kcal), due to its high lipid and protein content. SVY 1 had the lowest energy value (230.92 kcal), corresponding with its lower fat content.

Table 2: Proximate composition of snacks from cassava, soybean flour, and coconut milk

Samples	Moisture (%)	Ash Content (%)	Crude Fibre (%)	Crude Lipid (%)	Protein Content (%)	Carbohydrate (%)	Energy (kcal)
SVY 1	11.82±0.33[a]	3.44±0.13[a]	5.50±0.10[a]	9.21±0.02[a]	9.49±0.85[a]	60.54±0.71[a]	230.92±3.62[a]
SVY2	11.48±0.38[a]	2.92±0.18[a]	5.25±0.01[a]	11.04±0.51[a]	10.50±0.29[a]	58.81±0.61[a]	268.36±3.13[a]
SVY 3	9.72±0.11[b]	2.28±0.09[ab]	3.65±0.01[ab]	13.66±0.55[ab]	17.16±0.67[ab]	53.53±0.32[b]	359.42±3.50[ab]
SVY 4	13.78±0.31[abc]	3.84±0.07[b]	7.38±0.03[bc]	9.78±0.05[abc]	8.72±0.68[bc]	56.50±0.96[c]	285.67±1.74[abc]

Key: SVY 1 = 70% HQCF + 20% Soybean flour + 10% Coconut milk; SVY 2 = 60% HQCF + 20% Soybean flour + 20% Coconut milk; SVY 3 = 50% HQCF + 30% Soybean flour + 20% Coconut milk; SVY 4 = Commercial Sample (Cookies)

Vitamins in snacks from cassava, soybean flour, and coconut milk

The results of the Vitamin Analysis of the samples are shown in Table 3. The values increase with the increase in fortification of soybean flour and coconut milk when compared to the control sample. Vitamin A ranged from 11.54mg/l to 17.41mg/l, Vitamin B1 ranged from 19.05mg/l to 23.26mg/l, Vitamin B2 ranged from 12.53mg/l to 14.68mg/l, Vitamin B3 ranged from 4.75mg/l to 6.33mg/l, Vitamin B12 ranged from 1.95mg/l to 2.53mg/l.

Table 3: Vitamins of snacks from cassava, soybean flour, and coconut milk

Samples	Vit. A	Vit. B1	Vit. B2	Vit. B3	Vit. B12
SVY 1	11.54±0.79[a]	19.05±0.01[a]	12.53±0.01[a]	4.75±0.02[a]	1.95±0.07[a]
SVY2	13.03±0.89[a]	21.18±0.01[a]	14.17±0.01[a]	5.29±0.05[a]	2.04±0.06[a]
SVY 3	17.41±0.97[ab]	23.26±0.01[ab]	14.68±0.01[ab]	6.33±0.03[ab]	2.53±0.07[ab]
SVY 4	4.49±0.78[abc]	11.44±0.01[abc]	9.08±0.01[abc]	3.18±0.02[abc]	0.74±0.08[b]

Key: SVY 1 = 70% HQCF + 20% Soybean flour + 10% Coconut milk; SVY 2 = 60% HQCF + 20% Soybean flour + 20% Coconut milk; SVY 3 = 50% HQCF + 30% Soybean flour + 20% Coconut milk; SVY 4 = Commercial Sample (Cookies)

Mineral analysis of snacks from cassava, soybean flour, and coconut milk

The results of Mineral Analysis of the samples are shown in Table 4. The values estimated for all minerals show significant differences between samples and increase with the increase in the fortification of soybean flour and coconut milk. The mean percentage for sodium ranged from 26.82mg/kg to 29.69mg/kg, zinc ranged from 11.82mg/kg to 16.71mg/kg, calcium ranged from 14.72mg/kg to 19.82mg/kg, copper ranged from 29.50mg/kg to 37.71mg/kg iron ranged from 59.51mg/kg to 68.22mg/kg. The fortified samples are a better source of minerals compared to the unfortified sample (control). The higher level of calcium in the fortified sample would promote good bone and tooth health for adults and children. Sodium and potassium are important in the regulation of body fluids.

Sensory attributes of snacks from cassava, soybean flour, and coconut milk

The organoleptic properties of snacks produced from Cassava, Soybean flour, and Coconut milk are presented in Table 5. The formulated samples SVY 1, SVY 2, and SVY 3 showed no significant difference in their color, taste, texture, appearance, and aroma. This showed that the level of substitution did not significantly have a negative influence on the colour, taste, texture, appearance, and aroma of the snacks. Interestingly, all formulated samples were overall accepted by the panelists when compared with the control. Sample SVY 3 has the highest acceptance.

Table 4: Mineral analysis of snacks from cassava, soybean flour, and coconut milk

Samples	Zinc	Sodium	Calcium	Copper	Iron
SVY 1	11.82±0.01[a]	29.69±6.31[a]	16.49±0.15[a]	29.50±0.08[a]	59.51±0.01[a]
SVY2	14.36±0.01[a]	28.85±7.57[a]	14.72±0.10[a]	33.27±0.08[a]	63.06±0.01[a]
SVY 3	16.71±0.01[ab]	26.82±6.43[ab]	19.82±0.15[ab]	37.71±0.07[ab]	68.22±0.00[ab]
SVY 4	4.69±0.01[abc]	19.70±6.51[bc]	7.64±0.17[abc]	14.10±0.07[bc]	38.8±0.00[abc]

Key: SVY 1 = 70% HQCF + 20% Soybean flour + 10% Coconut milk; SVY 2 = 60% HQCF + 20% Soybean flour + 20% Coconut milk; SVY 3 = 50% HQCF + 30% Soybean flour + 20% Coconut milk; SVY 4 = Commercial Sample (Cookies)

Table 5: Sensory attributes of snacks from cassava, soybean flour, and coconut milk

Samples	Colour	Taste	Aroma	Texture	Appearance	Overall Acceptability
SVY 1	8.15±1.71^{a}	8.10±1.50^{a}	8.15±1.52^{a}	8.05±1.31^{a}	8.05±1.13^{a}	8.10±1.21^{a}
SVY2	8.50±1.69^{a}	8.26±1.42^{a}	8.70±1.21^{ab}	8.62±1.40^{a}	8.00±1.20^{ab}	8.42±1.30^{a}
SVY 3	8.90±1.21^{b}	8.80±1.51^{a}	8.85±1.21a^{b}	8.90±1.21^{ab}	8.65±1.22^{b}	8.91±1.42^{ab}
SVY 4	7.15±1.42^{ab}	7.8±1.31^{b}	6.4±1.42^{b}	7.6±1.24^{b}	7.9±1.15^{b}	7.50±1.15^{b}

Key: SVY 1 = 70% HQCF + 20% Soybean flour + 10% Coconut milk; SVY 2 = 60% HQCF + 20% Soybean flour + 20% Coconut milk; SVY 3 = 50% HQCF + 30% Soybean flour + 20% Coconut milk; SVY 4 = Commercial Sample (Cookies)

DISCUSSION

The proximate composition of snacks produced from cassava, soybean flour, and coconut milk composite flour blends is shown in Table 2. The moisture content ranges from 9.72 to 11.82% for SVY 3 and SVY 1 respectively, which is lower than 13.78% for SVY 4 (control), this is higher than the 1.80– 2.75% reported for biscuits from Bambara nut, soybean and carrot flour blends (28) but similar to the 6.35– 11.88% reported for biscuit from cassava and soybean flour blends (29). The ash content of the snacks ranges between 2.28 and 3.84% with the least and highest values significantly ($p < 0.05$) obtained for samples SVY 3 (50:30:20%; cassava: soybean: coconut milk) and SVY 4 (control). It is interesting to note that the current results fall within the ranges of the 2.60–4.48% reported (30) for cassava-soybean breakfast flakes. The fat content ranged from 9.21 to 13.66%, with sample SVY 1 and SVY 3 having the least and highest contents, respectively. This is lower than 21.39–22.57% reported for biscuits from Bambara nut, soybean, and carrot flour blends (31), and another study (32) reported a fat content of 7.60–14.41% for cassava-soybean breakfast flakes. The low-fat content in the snacks makes it suitable as a refreshing and thirst-quenching product, which is a characteristic of a good beverage reported by (33).

The fibre content ranged from 3.65 – 7.38% for SVY 3 and SVY 4, respectively. This falls within the range of fibre content (2.47 to 9.65%) reported for cassava-soybean breakfast flakes (34). The protein content increases with an increase in the substitution of soy-coconut flour. This observation agrees with previous findings of (35). The protein content ranges from 8.72 to 17.16%. The controlled sample (SVY 4) has the lowest protein content, and sample SVY 3 has the highest protein content, respectively. This report is within the same range as the protein content reported by (36) for biscuit from cassava and soybean flour blends. The protein nutritional quality of bakery goods can be significantly increased by adding soybean flour to cassava flour. This is particularly crucial in developing nations, especially in rural areas where high-protein diets are more expensive. A rise in the protein content of cassava flour resulting from the addition and augmentation of soybean fractions was reported by (37). As the proportion of soybean flour and coconut milk increased, a decrease in carbohydrate level was observed; this observation agrees with (38).

The vitamin contents of snacks produced from cassava, soybean flour, and coconut milk composite flour blends are shown in Table 3. Vitamin A is crucial for vision, immune function, and cell growth. The fortified samples (SVY1–SVY3) had significantly higher Vitamin A content compared to the commercial sample (SVY4). The increase is likely due to the contribution of soybean flour, which contains precursors like β-carotene, and coconut milk, which may aid in the absorption of fat-soluble vitamins. incorporating soybean into baked products improved the provitamin A content significantly (39). Cassava-based snacks enriched with legumes like soybean had improved Vitamin A content due to the synergistic effects of both plant sources (40). Thiamine plays a vital role in carbohydrate metabolism and neural function. Fortified samples had higher levels, especially SVY3 (23.26 mg), indicating the role of soy flour, which is rich in thiamine. (41) found that thiamine content increased significantly when soy flour was used to supplement cassava-based products.

Similarly, (42) observed enhanced B-vitamin content in soy-fortified snacks compared to commercial products. Riboflavin is essential for energy production and skin health. The rise from 9.08 mg in the control to 14.68 mg in SVY3 indicates the positive contribution of both soy flour and coconut milk. (43) suggests that coconut milk, when used in baked snacks, enhances B-vitamin content due to its nutritional richness. Soybean is known to be a good source of riboflavin (44). Niacin supports digestive health and skin repair. SVY3 had the highest niacin (6.33 mg), more than double the control. Fortification with soybean, which is naturally rich in niacin, is the major contributor. (45) documented significant niacin increases in cassava-sweet potato-soy blends used for cookies. Vitamin B12, though more abundant in animal products, was notably increased in fortified samples. This may be due to the synergistic effects of fermentation-like processing during baking or possible microbial contributions during coconut processing. While plant sources rarely contain B12, soybeans have been reported to contain trace levels, particularly when fermented (46). Coconut milk may act as a medium that enhances the bioavailability of microbial-synthesized B12 during storage and baking (47).

The micro-nutrient properties of snacks produced from cassava, soybean flour, and coconut milk composite flour blends are shown in Table 4. Zinc content increased progressively with higher inclusion of soybean flour and coconut milk (SVY3 > SVY2 > SVY1 > SVY4). Soybean is known for their appreciable zinc content. Zinc is essential for immune function, enzyme activity, and wound healing. enrichment of cassava-based products with legumes significantly improves zinc content, enhancing the micronutrient profile of the product and addressing common deficiencies in local diets (48). Sodium levels were relatively low across all samples, with SVY3 having the least. This is beneficial for cardiovascular health, as excessive sodium intake is linked to hypertension. The lower sodium in SVY3 may be due to reduced commercial additives compared to the control. Incorporating local plant-based ingredients in snacks can reduce sodium content while boosting other nutrients, making the product healthier for long-term consumption (49). Calcium content improved with fortification, peaking at SVY3. This reflects the contributions of both soy flour and coconut milk, both of which are modest sources of calcium. Calcium is vital for bone and dental health. (50) demonstrated a similar increase in calcium levels when soybean was used to enrich cereal-based foods, suggesting that such blends can help combat calcium.

Copper showed a consistent increase from SVY1 to SVY3. Copper is necessary for iron metabolism and enzymatic reactions. The rise in copper levels can be attributed to soy's rich micronutrient profile. (51) found that legume fortification in snacks significantly raised copper and iron levels, thereby promoting hematologic health. Iron content was highest in SVY3 and lowest in the control (SVY4). Fortification clearly enhanced iron levels, with soybeans being a strong contributor. Iron is essential for oxygen transport and energy metabolism. (52) showed that cassava products fortified with legumes such as soy improved iron content significantly, providing a strategy for tackling iron-deficiency anemia in vulnerable populations.

The sensory attributes of snacks produced from cassava, soybean flour, and coconut milk composite flour blends are shown in Table 5. The highest colour rating was observed in SVY 3 (8.90), suggesting enhanced visual appeal, likely due to the browning effect of increased soy protein during baking and the creamy hue from coconut milk. Colour affects initial consumer perception and can enhance product appeal. Increasing soybean flour in cassava-based cookies improved colour, attributed to Maillard reactions during baking (53). Taste improved significantly with higher fortification, with SVY 3 scoring 8.80, likely due to the natural nutty flavour of soybeans and the mild sweetness of coconut milk, both enhancing palatability. (54) observed that coconut milk enhances the taste of composite snacks by adding a smooth, creamy mouthfeel and subtle sweetness, improving consumer acceptance. The aroma rating improved steadily across formulations, with SVY 3 again scoring highest (8.85). This can be attributed to volatile compounds from soy roasting and the aromatic oils in coconut milk. Coconut milk significantly improves the aroma in cereal-legume snacks, making them more desirable (55).

Texture was also best rated in SVY 3 (8.90), likely due to the protein content of soy flour improving structural integrity and mouthfeel. Coconut milk may also contribute to a smoother, less brittle texture. (56) reported that soy fortification enhances texture in cassava-based baked goods, while coconut milk acts as a fat replacer that improves cohesiveness. Appearance peaked in SVY 3 (8.65), correlating with improved colour, surface uniformity, and form. Appearance is often judged by uniform browning and shape retention, which soy flour helps maintain. (57) demonstrated that composite flours with higher soy inclusion led to more uniform and appealing cookie shapes and surfaces. The overall acceptability was highest in SVY 3 (8.91), indicating a strong consumer preference for snacks with balanced cassava-soy-coconut proportions. The control sample (SVY 4) had the lowest rating (7.50), suggesting commercial options may lack natural flavour and appeal. Consumer acceptability increases significantly when legume and coconut ingredients are incorporated at optimized levels into cassava snacks (58).

CONCLUSION

The results of this study suggest that blended snacks could be a healthy meal or snack that also helps to address the issue of protein-energy deficiency. The study further showed that the level of substitution of cassava flour with flour blends from locally grown soybean flour and coconut milk has a great influence on the nutritional quality of the snacks being produced. Sample SVY 3 has the highest protein, fat, vitamins, and minerals content. For emerging nations like Nigeria, this has economic significance because it encourages the production and processing of local crops. In order to lessen the demand for wheat imports, this study promotes the use of locally accessible tuber and leguminous crops in the manufacturing of baked foods.

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