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# Nutrient Composition and Sensory Evaluation of Chin-Chin Produced from Cassava (*Manihot esculenta*) and Soybean (*Glycine max*) Composite Flours

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**Abstract**

This study evaluated the proximate, mineral (calcium, iron, potassium and magnesium) composition and sensory properties of chin-chin made from composite flours of cassava and soybean flours. Standard procedures were used to process the cassava and soybean composite flours. The flour blends were obtained as follows: WF-100 percent wheat flour (control); and four cassava flour and soybean flour blends were prepared as follows: SCF1 (90:10); SCF2 (80:20); SCF3 (70:30) and SCF4 (60:40). Standard recipe for chin-chin preparation was used with some modifications. Standard procedures were employed in the evaluation of the proximate and mineral composition as well as the sensory properties of the samples. Mean data were compared using Analysis of Variance (ANOVA) at $p<0.05$. Results showed that increasing soybean flour inclusion significantly improved the nutritional quality of the products. The 60:40 cassava-soybean formulation contained the highest protein (40.07%), fat (13.49%), calcium (5.07 mg/g), iron (0.101 mg/g), and magnesium (0.084 mg/g) contents ($p < 0.05$), while maintaining acceptable moisture and ash levels. Although the control sample received the highest sensory scores, all composite flour samples achieved mean acceptability scores above six, indicating that they were generally liked by the panelists.

**Keywords**: Cassava; Soybean Flour; Chin-chin; Nutrient Composition; Sensory Evaluation.

## Introduction

Nigeria's heavy reliance and overdependence on wheat importation has been exerting so much strain on the economy with a debilitating effect on food security at all levels with the country spending billions of dollars annually on wheat importation. Specifically, Nigeria spends $3.03 billion annually on wheat importation since the local production which is about 200,000 metric tonnes is grossly insufficient to satisfy the 6 million metric tonnes demand (WECAWheat, 2024). More still, the National Bureau of Statistics reported that Nigeria spent N1.15trillion on wheat importation between October 2021 and September 2022, and N970.22billion from December 2022 to November 2023 on durum wheat importation (National Bureau of Statistics, 2023). The widening gap between demand and supply may be attributable to the growing population, urbanization and evolving preference for bread, noodles and other wheat-based products while the low local production may be as a result of unfavorable climatic conditions, limited access to improved seed varieties, insecurity, high cost of production, inadequate irrigation infrastructure, etc (Umar &Mohammad, 2022).

Nigeria's heavy reliance on wheat importation places a significant strain on its economy, particularly draining its foreign exchange reserves and contributing to food inflation which further weakened the Naira thus increasing costs of imports, exacerbating the financial burden and exposes Nigeria to food insecurity (Haruna *et al*., 2017). Food inflation results since high cost of imported wheat directly translates to increased prices of bread and other wheat-based products, thus, impacting the affordability of essential food items for the average Nigerians, potentially leading to social unrest (Haruna *et al*., 2017).

Nigeria's tropical climate and fertile land favor the local production of cassava and most cereal grains except wheat, barley, oats and rye. Nigeria is the highest producer of maize and sorghum in Africa, second highest producer of sorghum globally and fifth highest producer of maize worldwide (FAOSTAT, 2014). However, Nigeria is the 13th highest importer of wheat worldwide because wheat grows poorly under Nigerian climate (Erenstein *et al.,* 2022). Urbanization, increasing population, civilization and copying of western feeding lifestyle has made wheat-based products increasingly consumed in Nigeria thus making the country spend huge amount of foreign exchange on wheat importation (Haruna *et al*., 2017). This however necessitates the diversification into other food sources like cassava flour which is one of the strategies for agricultural policy on cassava in Nigeria.

Nigeria, being the largest producer of cassava globally (FAO, 2007) needs to harness the potentials of this root crop especially in overcoming the plight of 'wheat trap' (Otekunrin, 2024). It is in respect of this that the Nigeria's agricultural policy on cassava was established in 2002 under the Presidential Initiative on Cassava. This initiative was part of a broader strategy to promote food security and reduce reliance on wheat importation by the use of cassava flour in food processing.

The Nigeria's cassava policy primarily focuses on increasing production, promoting industrial utilization and improving market access to boost farmers' income and enhance food security with a concomitant reduction in dependence on wheat importation. For instance, there is a policy on 'Mandatory inclusion of cassava flour in edible flour production by substituting wheat flour with 10 to 40% cassava flour to conserve foreign exchange and promote industrial cassava utilization' (Adamu, 2022). However, much success rate has not been recorded in the cassava inclusion policy (Substitution of wheat flour with cassava flour in bakery products) due to lack of technical know-how by bakers, low acceptability of cassava made products by consumers, high cost of non-cassava inputs, low supply of cassava flour and policy inconsistencies (Onyekuru *et al*., 2019).

Unwillingness of consumers to embrace cassava bread is a call for action to draw our attention to other food products in which wheat flour is commonly used. One of such food products in Nigeria is chin-chin which is a crunchy and crispy deep-fried snack commonly made with wheat flour. The use of a combination of cassava and soybean flours in baked chin-chin production may produce an acceptable, healthier and more nutritious chin-chin option. Soybean flour is highly functional especially when mixed with other ingredients in the course of food processing. Its constituents (soy proteins) exert their functionality alone or in interaction with other food components by enhancing the sorption, solubility, surfactancy, ligand-binding, gelling, film formation encapsulation, fat replacers, meat analogues and emulsifying properties (Pandey *et al*., 2025; Ma *et al*., 2025). This soybean flour's attribute may be useful in the combination with cassava flour in the production of baked cassava/soybean chin-chin.

**Objectives of the study**

The general objective of this study was to evaluate the nutrient composition and sensory properties of baked chin-chin produced with different ratios of cassava and soybean composite flours with the control made with 100% wheat flour. Specifically, the study determined:

- proximate composition of the chin-chin samples and compared with that of control (100% wheat flour)
- mineral composition (calcium, iron, potassium and magnesium) of the chin-chin samples and compared it with that of control
- sensory properties of the chin-chin samples and compared it with that of the control.

**Materials and Method**

***Design of the study:*** The study adopted experimental design.

**Raw materials procurement**: Raw cassava roots, soybeans, refined wheat flour, granulated sugar, salt, baking powder, milk flavor, nutmeg powder and eggs were purchased from Orita market in Ibadan. Olive oil was purchased from a supermarket in Ring Road, Ibadan, Nigeria.

**Preparation of materials:** The following materials (flours) were prepared.

**Cassava flour**: Cassava flour was produced using the method of Adekunle and Adeyemi (2021) with slight modification. Firm and healthy cassava roots that were free from rot, pest damage, etc, were selected; washed in clean water with sponge to remove soil and dirt; peeled with knives to remove the outer brown layer and the adjoining next layer. Peeled cassava was soaked in clean water for three days; drained in cheese cloth and pressed to extract moisture; then sundried in plastic trays for five days. Plate attrition mill was then used to mill this into flour followed by sieving. The sieved cassava flour was then packaged in airtight containers until use.

**Soybean flour**: The method of Adeyemi and Bello, (2023) was used with slight modification. Soybeans were sorted and cleaned to remove foreign matters, spoilt seeds, etc; washed; soaked in clean water for 16 hours; drained; rinsed in water and boiled in water for 10 minutes. This was then drained, cooled with cold water and dehulled to remove the seed coat after which it was oven dried at 60$^{o}$C for two days. The dried soybean was then milled into flour using plate attrition mill, allowed to cool and packaged in airtight container.

**Formulation of the Flour Blends for Chin-chin Samples**

| Samples | Wheat flour% | Cassava flour% | Soybean flour% |
|---|---|---|---|
| **WF (Control)** | 100 (500g) | 0 | 0 |
| **SCF1** | 0 | 90 (450g) | 10 (50g) |
| **SCF2** | 0 | 80 (400g) | 20 (100g) |
| **SCF3** | 0 | 70 (350g) | 30 (150g) |
| **SCF4** | 0 | 60 (300g) | 40 (200g) |

**Procedure for baked chin-chin preparation**

**Recipe for chin-chin**

| Ingredients | Measurements |
|---|---|
| Flour or Composite flour | 500g |
| Baking powder | 10g |
| Nutmeg powder | 5g |
| Powdered milk flavor | 5g |
| Margarine | 50g |
| Sugar | 75g |
| Egg | 1 (large) |
| Salt | 3g |
| Water | 200ml |
| Olive oil (for kneading the dough) 12ml | |

Chin-chin samples were prepared using the method of Onuoha *et al.*, 2025 with slight modification. The steps involved in the process were as follows:

- Margarine was rubbed into the flour gently until uniformity in consistency was achieved
- All dry ingredients (salt, sugar, nutmeg, milk flavor, baking powder) were mixed with the flour and fat mixture until evenly dispersed.
- Egg and water were then added and these were mixed until dough of smooth consistency was formed.
- Olive oil was added in bits and the dough was kneaded.
- Dough was rolled on a board and cut moderately into cubes, then transferred into a baking tray and into an oven to bake for 30minutes at 160$^{o}$C after which the baked chin-chin was allowed to cool and packaged in airtight containers.

**Nutrient analyses:** Analyses were carried out using the method of A.O.A.C., (2023). All analyses were carried out in triplicates.

**Proximate analysis**: The following nutrient content were determined:

**Crude protein content** was determined by the routine semi-micro Kjeldahl procedure. This consists of digestion, distillation and titration. A known quantity (0.5g) of the finely ground dried sample was weighed in the Kjeldahl digestion tubes after which one Kjeldahl catalyst tablet was added followed by 10ml conc. H2SO4 and digested for 4 hours. The digest was allowed to cool after which distillation was done with Markham Distillation apparatus. The green colored solution obtained from distillation was titrated against 0.01N HCl and Crude protein was calculated using appropriate formula.

**Crude fat** was determined using Soxhlet apparatus. After 1g of dried sample was passed through the soxhlet apparatus, tha fat content was calculated using appropriate formular.

**Ash** was determined by weighing 2.0g of the sample into a porcelain crucible and transferred into a muffle furnace set at 550°C for 4 hours after which these were cooled and weighed. Ash content was calculated using appropriate formular.

**Crude fiber** was determined by placing 2g of the sample in a fiber flask and 100ml of 0.255N $H_2SO_4$ was added. This was heated for 1 hour, filtered and the residue was heated with 100ml of 0.313N NaOH for another 1 hour. This was followed by filtration, and the residue was treated with 10ml acetone after which it was washed with 50ml hot water and turned into ash in a crucible and furnace.

**Carbohydrate** was determined by difference of moisture, protein, fat, fiber and ash from 100.

**Mineral analyses**: The ash (2g) of each sample was digested with 5ml of 2M HCL. This was heated to boil and filtered through a Whatman No.1 filter paper into a 100ml volumetric flask. The filtrate was made up to mark with distilled water and the concentration reading was done at wavelength required for each mineral (calcium, iron, potassium and magnesium) using Jenway Digital Flame Photometer (Model-PFP7)

**Sensory Evaluation:** A total of twenty (20) taste panelists who were staff and students of the Department of Human Nutrition and Dietetics, Lead City University were purposively selected for sensory evaluation of the cookies.

A 9-point hedonic scale was used for data collection and the scale was as follows: 1- Dislike extremely; 2- Dislike very much; 3- Dislike moderately; 4- Dislike slightly; 5- Neither like nor dislike; 6- Like slightly; 7- Like moderately; 8- Like very much and 9- Like extremely. This was adapted from the method of Lawless and Heymann, (2013).

The chin-chin samples were cooled to room temperature and presented in identical containers coded to avoid bias. Each panelist was provided with potable water for mouth rinsing between tastings. The sensory attributes evaluated included taste, aroma, color, texture, appearance, and overall acceptability.

**Statistical analyses**: Data were analyzed using mean ± standard deviation. Means for proximate and mineral composition were compared using Analysis of Variance (ANOVA- Least Significant Difference) at $p<0.05$. Duncan Multiple Range Test was used to compare the mean data at $p<0.05$ for sensory evaluation scores.

**Results**

**Table 1: Proximate Composition of the Baked Chin-chin Samples (%)**

| Samples | Moisture | Fat | Protein | Crude fiber | Ash | Carbohydrate |
|---|---|---|---|---|---|---|
| WF(Control) | 5.49±0.10 | 4.86±0.15 | 31.05±0.15 | 1.19±0.03 | 1.55±0.15 | 55.87±0.50 |
| SCF1 | 5.69±0.20 | 8.22**±0.20 | 18.10*±0.15 | 1.06±0.07 | 1.70**±0.20 | 58.23**±0.82 |
| SCF2 | 7.99**±0.11 | 10.53**±0.30 | 21.96*±0.20 | 0.85*±0.08 | 1.03*±0.07 | 57.64**±0.28 |
| SCF3 | 4.73*±0.20 | 11.24**±0.20 | 27.01*±0.20 | 0.88*±0.03 | 1.99**±0.20 | 54.15*±0.79 |
| SCF4 | 5.68±0.20 | 13.49**±0.21 | 40.07**±0.30 | 1.36±0.32 | 1.91**±0.20 | 37.48*±1.17 |

*Mean data significantly lower than the control (p<0.05)**- Mean data significantly higher than the control (p<0.05) WF = 100% Wheat flour; SCF1= 90% cassava flour and 10% soybean flour; SCF2 = 80% cassava flour and 20% soybean flour; SCF3 = 70% cassava flour and 30% soybean flour; SCF4 = 60% cassava flour and 40% soybean flour*

Table 1 shows the proximate composition of the baked chin-chin samples. SCF1 and SCF4 were not significantly different from the control in moisture content while SCF2 and SCF3 were significantly higher than the control. All the trial samples were significantly higher than the control in fat content. SCF4 was significantly higher than the control in protein and ash content. SCF1 and SCF2 were significantly higher than the control in carbohydrate content (Table 1).

**Table 2: Mineral Composition of the Baked Chin-chin Samples (mg/g)**

| Samples | Calcium | Iron | Potassium | Magnesium |
|---|---|---|---|---|
| WF (Control) | 4.67±0.10 | 0.092±0.002 | 0.106±0.011 | 0.054±0.003 |
| SCF1(90:10) | 4.51±0.08 | 0.038*±0.005 | 0.045*±0.004 | 0.024*±0.001 |
| SCF2(80:20) | 4.73±0.13 | 0.066*±0.005 | 0.063*±0.011 | 0.034*±0.003 |
| SCF3(70:30) | 4.83±0.12 | 0.086±0.006 | 0.078*±0.004 | 0.079**±0.013 |
| SCF4(60:40) | 5.07**±0.04 | 0.101**±0.001 | 0.103±0.006 | 0.084**±0.003 |

*Mean data significantly lower than the control (p<0.05)**- Mean data significantly higher than the control (p<0.05) WF = 100% Wheat flour; SCF1= 90% cassava flour and 10% soybean flour; SCF2 = 80% cassava flour and 20% soybean flour; SCF3 = 70% cassava flour and 30% soybean flour; SCF4 = 60% cassava flour and 40% soybean flour*

Table 2 shows the mineral composition of the baked chin-chin samples. Only SCF4 was significantly higher than the control in calcium and iron content but was comparable or like the control in potassium content. Both SCF3 and SCF4 were significantly higher than the control in magnesium content.

**Table 3: Sensory Evaluation Scores of the Baked Chin-chin Samples**

| Samples | Color | Taste | Texture | Aroma | CtA | CbA | OvA |
|---|---|---|---|---|---|---|---|
| WF | 7.60a±0.68 | 7.30a±1.42 | 6.85a±1.76 | 7.70a±1.30 | 7.40a±1.76 | 7.05ab±1.64 | 7.45a±1.36 |
| SCF1 | 6.80b±1.06 | 6.50ab±1.00 | 6.60a±0.82 | 7.35a±1.09 | 6.90a±1.25 | 7.35a±1.18 | 6.95ab±1.15 |
| SCF2 | 6.45b±1.00 | 6.60ab±1.70 | 6.75a±1.52 | 6.15b±1.73 | 6.60a±1.50 | 6.40b±1.31 | 7.00ab±1.34 |
| SCF3 | 6.55b±1.32 | 6.65ab±1.66 | 6.70a±1.72 | 6.15b±1.04 | 6.50a±1.50 | 6.55ab±1.43 | 6.65ab±1.57 |
| SCF4 | 6.50b±1.47 | 6.20b±1.06 | 6.10a±1.07 | 6.40b±1.10 | 6.65a±1.23 | 6.25b±1.12 | 6.45b±1.00 |

*Mean data significantly lower than the control (p<0.05)**- Mean data significantly higher than the control (p<0.05) WF = 100% Wheat flour; SCF1= 90% cassava flour and 10% soybean flour; SCF2 = 80% cassava flour and 20% soybean flour; SCF3 = 70% cassava flour and 30% soybean flour; SCF4 = 60% cassava flour and 40% soybean flour*

Table 3 shows the sensory evaluation scores of the baked chin-chin samples. All the trial samples are comparable or like the control in texture and crust appearance. The control sample (WF) was most liked and had the highest scores for all the sensory parameters (color, taste, texture, aroma, crust appearance, crumb appearance and overall acceptability. The control was not significantly different from SCF1 in aroma (p<0.05). All the sensory scores for the trial samples were >6 showing that the consumers still liked them.

**Discussion of findings**

The fat and protein content of samples increased with increase in the proportion or quantity of soybean flour (Table 1). This may be as a result of the richness of soybean in these two nutrients. The proximate composition of chin-chin made with refined wheat flour (control- WF) was: moisture 5.49%; fat 4.86%; protein 31.05%; crude fiber 1.19%; ash 1.55% and carbohydrate 55.87%. This is in disparity with the report of Deedam *et al.,* 2020 who observed a proximate composition of fried chin-chin made from refined wheat flour thus: moisture (4.85%), ash (0.42%), fat (34.39%), protein (5.53%), crude fiber (0.98%) and carbohydrate (53.84%). This disparity may be as a result of differences in preparation methods (they fried the chin-chin while it was baked in this study) and variation in ingredients used. However, the sensory evaluation scores for color, crispness, texture, flavour, taste and overall acceptability were comparable with that of this study because they reported sensory score range of 7.20 to 7.55 while in this study the range was 6.85 to 7.60. There is paucity of past scientific reports on the nutritional composition of chin-chin made with cassava flour blended with legume flour; hence, other relevant studies are used for comparison. For instance, chin-chin produced with blends of Bambara nut flour and orange-fleshed sweet potato flour was observed to contain protein content that ranged between 10.71 and 13.78% (Obomeghei *et al*., 2020) while in this report a higher protein content was observed (18.10% to 40.07%).

Increase in the proportion of cassava flour inclusion in wheat/cassava composite flour used in preparing fried chin-chin resulted in increase in moisture content from 8.29 % (in 70% wheat flour: 30% cassava flour) to 10.40% (in 30% wheat flour: 70%cassava flour), and carbohydrate (63.63% to 66.54%) but exerted a reduction effect in protein (6.66 to 3.50%), fat (17.57 to 16.84), ash (1.88 to 1.38%) and fiber (1.96 to 1.69%) (Okwunodulu *et al.,* 2022) showing that as cassava flour composition increased, the protein and fat contents decreased which is in line with the observation in this study. More still, the combination of wheat and soybean flours in the production of fried chin-chin resulted in crude protein content of 19.20% to 24.62%, ash content of 0.95% to 2.16% and crude fiber content of 0.25% to 0.91% while increase in soybean flour proportion increased these proximate parameters in the chin-chin samples (Ugwuanyi *et al.,* 2020). This report is comparable with the observations in this study since protein, fat and ash contents increased with increase in soybean flour inclusion but there is disparity in the crude fiber content because it did not follow this trend. The use of maize, wheat, orange-fleshed sweet potato, sorghum, rice, soybean flours in fried chin-chin production have been reported but there is paucity of reports on baked chin-chin production using cassava and soybean flours, even in blends with other food staples.

For mineral composition, only SCF4 (60% cassava flour: 40% soybean flour) was significantly higher than the control (WF) in calcium, iron while both SCF3 and SCF4 followed this trend in magnesium content (Table 2). All the trial samples were significantly lower than the control in potassium content except SCF4 which was similar to control in this parameter. Calcium, iron, potassium and magnesium contents of the trial samples ranged from 4.51 – 5.07mg/g; 0.038 – 0.10mg/g; 0.045 – 0.103mg/g and 0.024 – 0.054mg/g respectively. These values are in disparity with the report of Agwu *et al*., 2025 who observed potassium, calcium, magnesium and iron content of 0.96 – 1.39mg/g, 0.89 – 1.59mg/g, 0.59 – 0.94mg/g, 0.65 – 0.82mg/g respectively in fried chin-chin produced from blends of rice, cowpea and sweet potato flours. This disparity may be as a result of different staple base used. In the same vein the mineral composition of baked chin-chin in this study is different from the observation of Olusina *et al.,* 2024 who reported magnesium and calcium contentof fried chin-chin made with blends of rice and cowpea flours as 0.19 – 0.21mg/g and 0.10- 0.12mg/g respectively. Chin-chin produced from maize, soybean and orange-fleshed sweet potato flour blends were significantly higher in mineral content than the control which was made with 100% wheat (Ndife *et al*., 2020). This report is partially in line with the observation in this study since only SC4 was significantly higher than the control in calcium and iron, SCF3 and SCF4 were significantly higher than the control in magnesium while SCF4 was comparable or similar to the control in potassium content.

In sensory evaluation, the control sample had the highest scores for color, taste, texture, aroma, crust appearance, crumb appearance and overall acceptability which ranged from 6.85 to 7.60 and fell into the likeness range (6 to 9)(Table 3). However, the control sample was not significantly different from the trial samples in texture and crust appearance, and the sensory evaluation scores of all the trial samples for all the sensory parameters fell in the likeness range (6 to 9) since these were >6, hence, they were liked, though these can be improved upon for them to compete favorably with the baked chin-chin produced using wheat flour. Since SCF4 that was produced with 60% cassava flour and 40% soybean flour contained the highest proximate and mineral composition, it can be regarded as the best sample among the trial samples because it was also liked in sensory parameters. The report of Apata and Joseph, 2023 was similar to the observation of the sensory evaluation of the baked chin-chin in this study. They reported that cassava-based fried chin-chin samples were liked in all the sensory parameters assayed which is in line with our observation in this study. This shows that chin-chin produced using cassava as a staple base has the potentials of gaining consumer acceptability, thus, overcoming one of the challenges of the utilization of cassava in bakery products in the cassava inclusion strategy of the Nigerian cassava policy In the same vein, fried chin-chin produced with corn-breadfruit-date flour were liked and acceptable in mouth feel, aroma and appearance and the most preferred sample contained 40% corn flour, 50% breadfruit flour and 10% date flour (Ahaotu *et al*., 2021) showing that harnessing the potentials of adequate research and development in producing chin-chin by using other locally available staples, aside from wheat, can produce products or snacks with notable and favorable consumer acceptability, thus overcoming one of the challenges of the Nigerian cassava policy. The higher nutritional composition of SCF4 in this study can be useful in combating under nutrition and the use of soybean as a functional food can be helpful in combating some non-communicable diseases such as cardiovascular diseases, cancer, type 2 diabetes, osteoporosis etc (Yip *et al*., 2023; Hu *et al*., 2023).

## Conclusion

The use of cassava and soybean flours in the production of baked chin-chin is workable, feasible and applicable. It improved the proximate and mineral content of the snack. The sample produced with 60% cassava flour and 40% soybean flour (SCF4) can be referred to as the best sample because it contained the highest quantity of proximate, calcium, iron, magnesium and potassium, and is also well acceptable in sensory parameters.

## Recommendations

Based on the findings of this study the following recommendations were made:

1. Household and commercial use of cassava and soybean composite flour in baked chin-chin production and consumption should be encouraged.
2. Cassava and soybean composite flour can be made at 60% cassava flour and 40% soybean flour in the production of baked chin-chin for higher nutritional value of the chin-chin produced and may be applicable in combating under nutrition among all age groups.
3. Cassava and soybean flour blend is recommended for use as a wheat replacement in the production of chin-chin and this may help in reducing overdependence on wheat thus helping Nigeria to escape the wheat trap bedeviling her economy.

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