

Nutritional Composition and Sensory Evaluation of Cakes Fortified With Plantain, Soybeans and Sesame Seed for Sustainable Economic Development

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Abstract

Cakes represent a convenient and readily consumable baked product, playing a vital role as a significant food item. They contribute to sustainable economic development, employment opportunities, and poverty alleviation, particularly within the baking sector. In Nigeria, fostering the production of cakes that are both nutrient-dense and affordable involves fortifying them with locally available food materials. This study investigates the nutritional composition and sensory attributes of cakes fortified with plantain, soybeans, and sesame seeds, aiming to contribute to sustainable economic development. To achieve this, six distinct blends of composite flours were developed, combining plantain, soybeans, sesame seeds, and wheat flour at varying ratios: 85:5:5:5, 80:10:5:5, 75:10:10:5, 70:15:5:10, 60:10:15:15, and 55:15:15:15. Cake samples were prepared from these blends, with the control being cakes made solely from 100% wheat flour. The samples were coded as follows: WPSS1 to WPSS7. Nutritional and sensory evaluations were conducted on these samples. The nutritional analysis revealed a statistically significant increase ($p > 0.05$) in the nutritional content of cakes fortified with plantain, soybeans, and sesame seed flour across all composite blends. Interestingly, there was no significant difference ($p < 0.05$) in panelist ratings for texture, flavor, taste, mouthfeel, and overall acceptability between the composite cake samples and the control (100% wheat flour cake).

Keywords

Fortification;
Plantain; Soybeans;
Sesame Seed;
Sustainable
Economic
Development



I. Introduction

Cake, a delectable sweet dessert typically baked (Ben-Nun, 2019), represents a convenient, ready-to-eat treat enjoyed across all socioeconomic classes and cultures, cherished by both adults and children alike. Its universal appeal makes it a centerpiece of numerous celebrations. Moreover, cakes play a pivotal role in promoting sustainable economic development, employment generation, and poverty reduction among Nigerian bakers. However, the predominant use of wheat as the primary flour in the baking industry overlooks the potential of locally available, nutrient-rich indigenous crops. Notably, Nigeria and other developing countries heavily rely on imported wheat due to unfavorable climatic conditions for wheat cultivation, leading to escalating prices of baked goods like bread, cake, pastries, and other wheat-based products (Muhammad et al., 2022).

In light of the current global economic challenges, there is a pressing need to shift towards local food production in developing countries, especially Nigeria (Arubayi and Ogbonyomi, 2019). Utilizing locally available foods to partially or completely substitute

wheat without compromising product quality becomes crucial (Arubayi & Ogbonyomi, 2019). Composite flours, combining wheat with indigenous foods like roots, tubers, legumes, and oil seeds, have demonstrated practical uses worldwide, enhancing nutritional value and functional properties of bakery products (Ogbonyomi, 2018). This practice, known as composite flour, involves blending wheat flour with local raw materials to produce high-quality, nutritious food products economically (Adegunwa et al., 2019).

The enrichment of cereal-based foods with alternative protein sources, such as oil seeds and legumes, has gained considerable attention (Feyera, 2020). In the context of Nigeria, fortifying cakes with locally available food materials like plantain, soybean, and sesame seeds emerges as a strategy to achieve sustainable cake production that is nutrient-dense, healthy, and affordable. The nutritional richness of plantain, soybean, and sesame seeds makes them ideal candidates for partially substituting wheat flour in cake production.

Plantain, a staple in Africa and Asia, offers 25% of calories for millions of people and boasts a nutritional profile rich in starchy carbohydrates, fiber, vitamins, and minerals (Ogbonyomi, 2018; Oyeyinka & Afolayan, 2019; USDA, 2019). Soybean, a leguminous vegetable, is a cost-effective protein source containing essential amino acids, vitamins, and minerals (Adelakun et al., 2013; O'Neil et al., 2012). Sesame seeds, with potential health benefits, contribute essential fatty acids, proteins, vitamins, and minerals (McCulloch, 2019; Loza et al., 2014). Combining these ingredients in cake production not only enhances nutritional content but also contributes to the development of functional foods with potential health benefits (Ogwu, Azonuche & Okumebo, 2021).

The concept of sustainable development, as defined by the United Nations, emphasizes meeting present needs without compromising future generations' ability to meet their own needs (United Nations, 2015). In alignment with this principle, the study explores the suitability of composite flour, incorporating wheat, plantain, soybean, and sesame seeds, for cake production. The evaluation encompasses nutritional composition, sensory attributes, and overall consumer acceptability, aiming to establish cakes fortified with plantain, soybean, and sesame seeds as a pathway to sustainable economic development. The broader perspective involves addressing nutritional needs, ensuring food security, and contributing to economic growth through the production of composite snacks. Sustainable nutrition, as outlined by Rosales (2021), involves providing nutrient-dense, accessible, affordable, and culturally acceptable foods—a goal that aligns with the study's objectives.

II. Research Method

2.1 Materials

Ripe green plantains (*Musa paradisiaca*), wheat flour, soybeans, and sesame seeds, along with other essential cake ingredients, were obtained from the local market in Warri, Delta State. The procurement included matured green plantains to ensure optimal quality and flavor. Additionally, the reagents required for laboratory analysis were supplied by the laboratory analyst overseeing the research. This approach ensures the use of fresh and locally sourced ingredients, contributing to the authenticity and relevance of the study's findings.

2.2 Sample and Sampling Technique

A sample size of fifteen (15) participants was selected for the study, comprising 10 male and female academic members of staff, and an additional five (5) postgraduate students

from the Department of Vocational Education at Delta State University, Abraka. The individuals chosen for the sensory evaluation were intentionally selected due to their familiarity with the taste of cake, ensuring a panel of judges with a discerning palate. Simultaneously, a separate group of 25 participants was purposively selected from the postgraduate student body of the same department. These individuals were chosen as respondents for the survey research component of the study. The intentional selection aimed to gather insights and perspectives from individuals with a specific academic background and familiarity with the subject matter under investigation. This approach ensures that the study benefits from the expertise and informed opinions of individuals closely connected to the field of Vocational Education at Delta State University.

2.3 Research Instrument

The data collection instrument employed for this study consisted of two questionnaires, labeled as Questionnaire A and Questionnaire B. Questionnaire A utilized a Nine-Point Hedonic Scale to gather data for sensory evaluation. This scale, ranging from one to nine, allowed participants to express their preferences and perceptions regarding the sensory attributes of the cakes produced. On the other hand, Questionnaire B was designed to inquire about respondents' perspectives on the utilization of cakes made from composite flour as a means for sustainable economic development. This questionnaire aimed to capture insights and opinions on the potential economic implications and benefits associated with incorporating composite flour in cake production. The dual-questionnaire approach facilitated a comprehensive understanding of both the sensory aspects of the cakes and the broader economic implications of using composite flour, ensuring a well-rounded analysis of the study's objectives.

2.4 Method of Sample Preparation

Plantain, soybean, and sesame seeds flour were manufactured using a traditional dehydration method, specifically sun drying, followed by milling. In the initial stage, matured green plantains, soybeans, and sesame seeds were subjected to the sun drying process. This traditional dehydration method involves exposing the raw materials to sunlight over a period, allowing them to gradually lose moisture and attain the desired level of dryness. Sun drying is a common practice, particularly in regions with abundant sunlight, as it offers a natural and cost-effective means of dehydration.

Once adequately dried, the dehydrated plantains, soybeans, and sesame seeds were then processed through milling. Milling involves grinding or crushing the dried materials into fine particles to obtain the desired flour consistency. This process enhances the convenience and versatility of the resulting flour, making it suitable for various culinary applications, including baking. The combination of sun drying and milling in the production of plantain, soybean, and sesame seeds flour through traditional methods ensures the preservation of natural flavors and nutrients while achieving the desired texture and particle size for effective utilization in baking and other food preparations.

2.5 Preparation of Plantain Flour

Mature unripe plantains were washed to remove dirt and latex. Hand-peeling extracted the pulp, which was soaked in water during the process to minimize enzymatic reactions. The pulp was manually sliced into 2 mm cylindrical pieces for efficient drying. Blanching in hot water at 80°C for 5 minutes halted enzymatic reactions and produced a relatively white flour. Sun drying followed, and the dehydrated plantains were milled using a hammer mill. Sifting with a kitchen sieve refined the plantain flour, which was then packaged in labeled polythene

bags and stored at room temperature until needed. This meticulous process ensured the production of high-quality plantain flour.

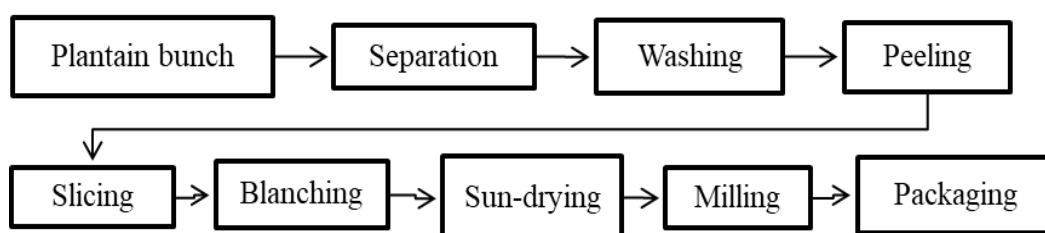


Figure 1. Flow chart for the production of plantain flour. Source: Ogbonyomi (2018)

2.6 Preparation of Soybean Flour

The soybean preparation process, as described by Ndife et al. (2011), involved a series of steps to transform raw soybeans into a finely processed flour. Firstly, the soybeans underwent a thorough cleaning and washing process to remove any impurities. This initial step is crucial to ensure the quality and purity of the final product. Following the cleaning, the soybeans were subjected to a drying process, which aimed to reduce excess moisture content. This is essential for both the preservation of the soybeans and the subsequent roasting step. Roasting, the next phase, is a key step that contributes to enhancing the flavor and aroma of the soybeans. The heat applied during roasting also plays a role in modifying the texture and overall quality of the soybeans.

After roasting, the soybeans went through decortication and winnowing. This involved the removal of the outer husk, a process known as decortication, and the separation of the desired components through winnowing. Subsequently, the decorticated soybeans were milled into a coarse powder. This milling process is pivotal in breaking down the soybeans into smaller particles, preparing them for the final refinement step. The milled soybeans then underwent sieving, where the coarse powder was sifted to achieve a finer texture. This step is crucial for obtaining a smoother and more uniform soybean flour, enhancing its overall quality. Once the desired texture was achieved, the finely sieved soybean flour was carefully packaged in polythene bags. Each package was labeled to provide information about its contents, and the bags were then stored at room temperature until needed for future use. This comprehensive process, outlined by Ndife et al. (2011), ensures that the soybeans are transformed into a finely processed flour, ready for various culinary applications.

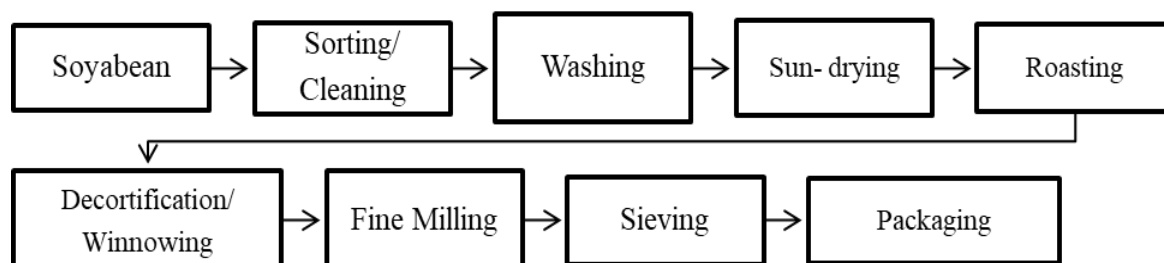


Figure 2. Flow chart for the production of soybean flour
Source: Ndife et al. (2011)

2.7 Preparation of Sesame Seeds Flour

Sesame seeds were meticulously cleaned, washed, and dehulled after soaking in salted water to remove tannins. Subsequent sun drying, light roasting, and milling produced sesame flour. The flour was then packaged in labeled polythene bags, stored at room temperature for

future use. This systematic process, focused on cleanliness, dehulling for tannin removal, and careful milling, ensures the production of high-quality sesame flour ready for versatile culinary applications.

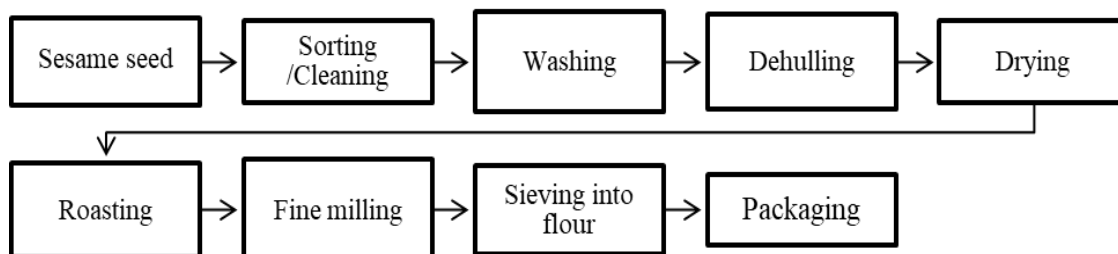


Figure 3. Flow chart for the production of Sesame flour. Source: Ogbonyomi (2023)

2.8 Preparation of plantain/Soybean/ Sesame seed and wheat composite flour

Seven composite flour samples, denoted as (WPSS1) through (WPSS7), were formulated by substituting wheat flour with varying ratios of plantain, soybean, and sesame seed flours. Each sample represented a distinct blend, with (WPSS7) serving as the control containing 100% wheat flour. The formulations aimed to assess the impact of different ratios on the nutritional and sensory attributes of the resulting cakes. This systematic approach allowed for a comparative analysis of the seven composite flour samples, providing insights into the potential benefits of incorporating plantain, soybean, and sesame seed flours in cake production.

a. Formulation of Composite Flour (Plantain/Soybean/ Sesame Seed and Wheat Composite Flour)

Table 1. Formulation of composite and 100% wheat cakes

INGREDIENTS	SAMPLES (g)						
	WPSS1	WPSS2	WPSS3	WPSS4	WPSS5	WPSS6	WPSS7
Wheat flour	212.5	200	185.5	175	150	137.5	250
Plantain flour	12.5	25	12.5	25	37.5	12.5	Nil
Soybean	12.5	25	25	12.5	37.5	37.5	Nil
Sesame seeds	12.5	12.5	12.5	25	37.5	37.5	Nil
Margarine	200	200	200	200	200	200	200
Sugar	160	160	160	160	160	160	160
Eggs	3 large	3 large	3 large	3 large	3 large	3 large	3 large
Nutmeg	5g	5g	5g	5g	5g	5g	5g
Baking powder	15	15	15	15	15	15	15
Vanilla extract	15ml	15ml	15ml	15ml	15ml	15ml	15ml
Lemon rind	15g	15g	15g	15g	15g	15g	15g

Preparation of Cake Samples

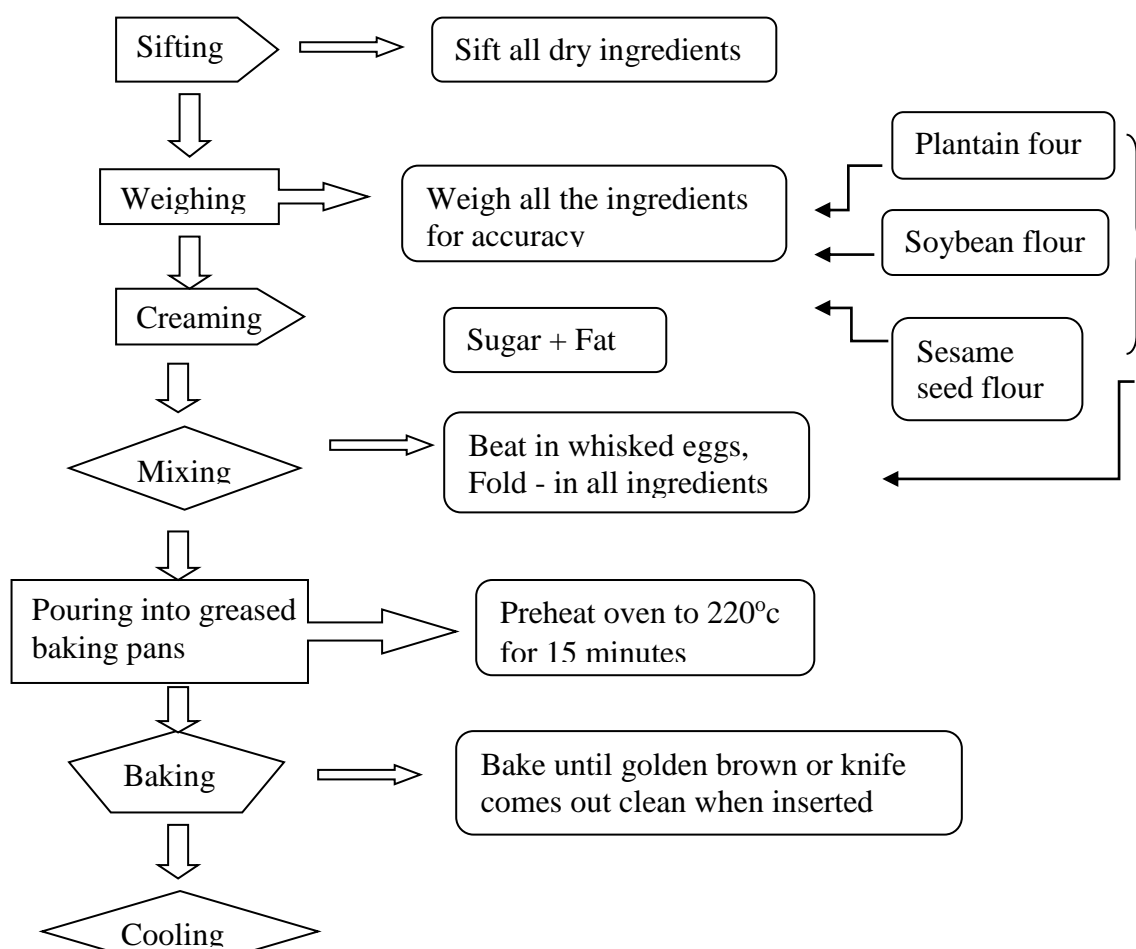


Figure 4. Flow chat for cake samples preparation. Source: Ogbonyomi (2023)

2.9 Sensory Evaluation of Cake Samples

Cake samples, including a 100% wheat flour control and various blends of plantain/soybean/sesame/wheat composite flour (WPSS1 to WPSS6), underwent evaluation for general appearance, color, flavor, texture, taste, mouthfeel, and overall acceptability. A panel of fifteen semi-trained judges, selected purposefully from the academic staff of the Vocational Education Department at Delta State University, Abraka, participated in the sensory assessment. Familiar with cake quality attributes, judges used a 9-point hedonic scale, with a cut-off mark at 5. This preference method allowed for a comprehensive evaluation of the sensory characteristics of the different cake samples.

2.10 Nutritional Analysis

Nutritional analysis of all cake samples, including the control (100% wheat flour) and various plantain/soybean/sesame/wheat composite flour blends (WPSS1 to WPSS6), was conducted following the Association of Official Analytical Chemists (AOAC) methods (AOAC, 2010; AOAC, 2012; AOAC, 2015). This analytical approach covered the determination of key nutritional components, including moisture, protein, fat, fiber, and ash. Carbohydrate content was calculated by difference, subtracting the sum of protein, fat, ash, fiber, and moisture percentages from 100%. Additionally, vitamin A, vitamin C, and mineral content (iron, phosphorus, magnesium, and calcium) were meticulously analyzed to provide a comprehensive nutritional profile for each cake sample.

2.11 Determination of Moisture Content

The moisture content of the flour samples was assessed using the forced air oven method in accordance with AOAC (2015) guidelines. This method relies on measuring the weight lost through the evaporation of water and other volatile components. Specifically, 2g of the flour sample was accurately weighed into a pre-cleaned dish with a known weight. The dish, along with its contents, was then placed in a forced air oven set at 105°C and dried until a constant weight was achieved. The moisture content was calculated as a percentage of the original sample weight, providing an accurate measure of the water content in the flour.

Moisture Content was calculated as:

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

W_1 = weight of dish + sample before drying

W_2 = weight of dish + sample after drying

2.12 Determination of Protein

In the determination of protein content, 1g of the sample was carefully weighed into a digestion tube, and 12 ml of concentrated H₂SO₄ was added for dissolution. To initiate the digestion process, Kjeldahl tablets were introduced, and the mixture was digested in a fume cupboard pre-set at 420°C for 60 minutes, resulting in a clear solution. To prevent solidification after digestion, 80 ml of distilled water was added. The digestion tube was then placed in a distilling unit, and 50 ml of 40% NaOH was dispensed into the diluted solution. The resulting distillate was combined with 25 ml of 40% boric acid for 5 minutes. Titration against 0.1 HCl ensued until the appearance of a blue-grey color. A blank run was conducted for each batch, and the recorded titre value adhered to AOAC (2015) guidelines. Calculation of crude protein

$$\% \text{ Protein} = \frac{(T - B) \times N \times 14.007 \times 100}{W_1 \text{ (mg)}} \times F$$

$$\text{gN/L} = \frac{(T - B) \times N \times 14.007}{\text{Volume}_{\text{sample}} \text{ (ml)}}$$

Keys

W_1 = Sample weight (mg)

T = Titration volume of sample (ml)

B = Titration volume of blank (ml)

N = Normality of acid to 4 decimal places

F = Conversion factor for nitrogen to protein = 6.25 for food & feeds

gN/L = Gram Nitrogen per Liter

14.007 = Molecular weight of Nitrogen

2.13 Determination of Fat content

The determination of fat content involved using the Soxhlet apparatus. Specifically, 2g of the sample was accurately weighed into a labeled thimble, which was then filled with petroleum ether (300ml) and sealed with cotton wool. The Soxhlet apparatus was set up to reflux for approximately 6 hours, and subsequently, the thimble containing the sample was carefully removed. The petroleum ether collected in the top was drained into a container for potential reuse. The flask was then removed, dried at 105°C for 1 hour in an oven, cooled in a desiccator, and finally weighed. This process facilitated the extraction and measurement of

the fat content in the sample. The percent crude fat was calculated using the following equation:

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

Determination of Ash Content (AOAC, 2010).

The crucibles were meticulously washed, dried in an oven at $130 \pm 150^\circ\text{C}$ for 30 minutes, and cooled in desiccators. The initial weight (W_0) was recorded. Samples were pulverized into powder, and 1g of each sample was accurately weighed into the crucible (W_1). The samples were charred over a Bunsen flame and ashed in a muffle furnace at 550°C for 2 hours. After cooling, the final weight (W_2) was noted. This process was repeated for all samples, and the total ash content was calculated as a percentage of the original sample weight. The ash content was calculated mathematically as follows:

$$\% \text{ ASH content} = \frac{(W_2 - W_0)}{W_1} \times 100$$

Determination of Crude Fiber

Procedure

For each sample, 1g was precisely weighed into dried crucibles containing celite. The Fibertec hot extraction unit was activated. To each column, 150ml of preheated 1.25% H_2SO_4 (reagent 1) was added, along with 2–4 drops of n-Octanol. The mixture was moderately boiled, and the boiling time was recorded. After boiling, it was cooled and filtered. The sample was washed three times with hot deionized water and then dried. Subsequently, 150ml of preheated 1.25% NaOH solution (reagent 2) was added to each column. The crucibles were then transferred to the Fibertec cold extraction unit. To each crucible, 25ml of acetone was added, and the solvent was extracted and filtered, a process repeated three times. The crucibles were cooled to room temperature, the samples were ashed at $525 \pm 150^\circ\text{C}$ for 3 hours, slowly cooled in a desiccator, and accurately weighed to 0.1mg.

% Crude Fibre content was calculated as:

$$\% \text{ Crude Fiber} = \frac{W_2 - (W_3 + C)}{W_1} \times 100$$

Key: W_1 = Sample weight (g)

W_2 = Crucible + residue weight after drying (g)

W_3 = Crucible + residue weight after ashing (g)

C = Blank

2.14 Determination of Carbohydrate

The method of (AOAC, 2015) was used to calculate the carbohydrate value. The carbohydrate content of each sample was determined using the formula below:

Carbohydrate = $100 - (\% \text{ moisture content} + \% \text{ ash} + \% \text{ protein} + \% \text{ fat})$

Mineral content were determined using the AOAC, (2010) analytical procedures for minerals and heavy metals

Wet Digestion and AAS Determination

1. 1g of each sample were weighed into a a conical flask, 10ml of H_2SO_4 and 30 ml of nitric acid were added and placed on a hot plate in a fume cupboard and digested until the digest becomes clear
2. It was diluted to 100ml and taken to AAS for metal and heavy metal determination

2.15 Spectrophotometric Determination

In the Atomic Absorption Spectrophotometer (AAS) analysis, lamps specific to the minerals or heavy metals under examination, such as Calcium (Ca) at 422.8nm, Magnesium (Mg) at 285.20nm, Iron (Fe) at 248.30nm, and Potassium (K) at 766.50nm, were appropriately positioned. The AAS siphoning hose was then introduced into the digested sample after running standards for the targeted metal. The AAS machine, through its calibrated settings, displayed the concentration of the metal in the solution directly on its screen. This analytical process allowed for accurate determination of the metal content in the samples using the unique absorption wavelengths associated with each element.

2.16 Determination of Ascorbic Acid (Vitamin C)

In the determination of ascorbic acid content, 5g of thoroughly blended sample was weighed into a flask. Subsequently, 25ml of a 5% metaphosphoric acid-10% acetic acid solution was added and agitated thoroughly. The content was then transferred into a 50ml volumetric flask and gently shaken to achieve a homogenous dispersion. The solution was diluted to the mark (50ml) with 5% metaphosphoric acid-10% acetic acid solution, followed by filtration, and the filtrate was used for ascorbic acid determination. To 4.0ml of the filtrate, 0.3ml of 3% bromine water was added until the solution acquired color. Then, 0.2ml of thiourea solution was added to obtain a clear solution. Subsequently, 1ml of 2,4-dinitrophenyl hydrazine dye was added to both the sample and standards. The solutions were kept in a water bath at 37 degrees Celsius for 3 hours and then cooled in an ice bath. Following this, 5ml of very cold 85% H₂SO₄ was added and stirred. Absorbance readings of the sample solution and standards were taken at a wavelength of 521nm. Utilizing the absorbance of the standard vitamin C, a calibration curve/graph was constructed. From the standard graph, the absorbance of the sample was extrapolated down to the concentration axis to determine the concentration of the sample solution in mg/l, taking into account dilution factors.

Calculation

$$\text{Ascorbic acid (mg/kg)} = \frac{\text{conc. (mg/l)} \times \text{vol. of extract} \times \text{dil. factor}}{\text{Sample weight}}$$

2.17 Spectrophotometric Determination of Vitamin A (Retinol)

In the extraction process, 1g of a well-prepared and homogenous sample was accurately weighed into a conical flask. A known volume of chloroform was added, and the flask was stoppered. The mixture was agitated at intervals for approximately 15 to 30 minutes, and the volume used for extraction was duly recorded. Following the separation of the phases, an aliquot (2ml) of the solvent extract was pipetted into a 1cm spectrophotometer quartz glass cuvette. An equal volume of trichloroacetic acid (TCA) was added to the chloroform. Absorbance readings were immediately taken within 5 seconds at a wavelength of 620nm using a spectrophotometer. This process allowed for the assessment of specific characteristics or components within the sample, providing valuable analytical information.

Calculation:

$$\text{Conc. of Vitamin A (mg/kg)} = \frac{\text{mg/l} \times V \times DF}{W \times V_a}$$

mg/l = Conc. Reading obtained for sample from the standard graph

V = Total volume of extract (volume of chloroform used in sample extraction)

DF: Dilution factor (if diluted for reading on spec)

W = Weight of sample

V_a = Volume of aliquot analyzed

2.18 Method of Data Analysis

The data obtained from questionnaire scores underwent analysis using descriptive statistics, including Means (μ) and Standard Deviations (SD). Further statistical analysis was conducted through Analysis of Variance (ANOVA). To determine the level of significant differences, a Tukey test was employed, and the entire statistical process was executed using the Statistical Package for Social Sciences (SPSS) version 23. A significance level of $p \leq 0.05$ was accepted for determining meaningful differences between means. The second questionnaire focused on understanding how cakes made from composite flour could contribute to sustainable economic development. The data collected were analyzed and recorded in terms of mean (μ) and standard deviation (SD).

III. Results and Discussion

Research Question 1. What are the mean (\square) ratings of sensory evaluation (appearance, colour, flavour, texture, taste, mouth feel and general acceptability) among cakes fortified with Plantain, Soybean and Sesame seeds composite flour (WPSS1- WPSS6) as compared with 100% wheat cake?

Table 2. Mean Ratings of sensory evaluation of all the Cake Samples.

Parameters	Samples						
	WPSS1 85:5:5:5	WPSS2 80:10:5:5	WPSS3 75:10:10:5	WPSS4 70:15:5:10	WPSS5 60:10:15:15	WPSS6 55:15:15:15	WPSS7 100%
Appearance	7.67±0.72 ^a	7.33 ±0.8 ^a	7.27 ±0.88 ^a	6.60±0.73 ^b	6.80±0.77 ^a	6.73±0.70 ^b	7.47±0.64 ^a
Colour	7.53±0.53 ^a	7.13±1.30 ^a	7.27 ±1.39 ^a	6.67±0.72 ^b	6.87 ±0.74 ^b	7.00 ±0.76 ^a	7.40±0.72 ^a
Flavour	7.20±0.86 ^a	7.07±0.80 ^a	6.73±0.96 ^a	7.13±1.06 ^a	7.00 ±0.93 ^a	7.07 ±0.76 ^a	7.13±0.74 ^a
Taste	7.33±0.97 ^a	7.47±1.69 ^a	7.27±0.59 ^a	7.87 ±0.64 ^a	7.20 ±0.68 ^a	7.13 ±1.06 ^a	7.80±1.02 ^a
Texture	7.07±0.80 ^a	7.53±0.64 ^a	7.13±0.52 ^a	7.33±0.90 ^a	6.87±0.52 ^b	7.47 ±0.64 ^a	7.87±0.35 ^a
Mouth feel	6.93±0.89 ^a	7.33±0.82 ^a	6.87±0.92 ^a	6.87±1.06 ^a	6.80 ±0.78 ^a	7.13±1.06 ^a	7.27 ± 0.6 ^a
Acceptability	7.07±0.96 ^a	7.20±1.21 ^a	7.07±0.83 ^a	7.00±1.25 ^a	6.73 ±1.28 ^a	6.80 ±1.01 ^a	7.47±0.64 ^a

Mean and standard deviation of sensory evaluation result

**Samples with different superscripts within same roll are significantly different ($P < 0.05$).*

**Key: 9 - liked extremely, 8 - liked very much, 7- liked moderately, 6 - liked slightly, 5 - neither like nor dislike, 4 - disliked slightly, 3 - disliked moderately, 2 - very much disliked, 1 - disliked extremely*

**liked extremely being highest (9) scale and dislike extremely (1) being the lowest scale.*

**Cut off mark = 5 (Neither like nor dislike)*

Table 2 showed the mean (\square) ratings of sensory evaluation of cake samples. The table shows that all the cake samples have a mean (\square) rating of appearance between 6.60 ±0.73 and 7.67(±0.72). WPSS1 (5% plantain, 5% soybean, 5% sesame / 85% wheat cake) was rated higher in appearance than all the cake samples with a mean (\square) rating of 7.67(±0.72), while WPSS4 (15% plantain, 5% soybean, 10% sesame / 70% wheat flour) had the least mean (\square) rating of 6.60 ±0.73. Colour preference mean (\square) was between 6.67 (±0.72) and 7.53 (±0.64). WPSS1(5% plantain, 5% soybean, 5% sesame / 85% wheat cake) was rated higher in terms of colour than all the cake samples with a mean rating of 7.53 (±0.64) and WPSS4 (15% plantain, 5% soybean, 10% sesame / 70% wheat flour) the least rating. The mean of flavour of all the cakes varied between 6.73 (±0.96) and 7.20 (±.86) The table showed that WPSS1

(5% plantain, 5% soybean, 5% sesame / 85% wheat cake) was rated higher in terms flavour than all the cake samples with a mean rating of 7.20 ± 0.86 while WPSS3 (10% plantain, 10% soybean, 5% sesame / 75% wheat cake) had the least mean rating of 6.73 ± 0.961 .

Texture mean rating was between $6.87 (\pm 0.52)$ and $7.87 (\pm 0.35)$. WPSS7 (100% wheat cake) had the highest mean texture rating of $7.87 (\pm 0.35)$ while WPSS5 (10% plantain, 15% soybean, 15% sesame / 60% wheat cake) had $6.87 (\pm 0.52)$ respectively. Taste mean rating was between $7.13 (\pm 1.06)$ and 7.87 ± 0.64 . WPSS4 was rated higher in terms of taste than all the cake samples with a mean rating of $7.87 (\pm 0.064)$ while WPSS6 had the least taste mean rating of $7.13 (\pm 1.06)$. Mouth feel preference of was between $6.80 (\pm 0.78)$ and $7.33 (\pm 0.88)$. The table showed that the WPSS2 had the highest mean mouth feel rating preference of $7.33 (\pm 0.88)$, while WPSS5 had the least mean rating of $6.80 (\pm 0.78)$. The mean (\square) rating of overall acceptability was between $6.73 (\pm 1.28)$ and $7.47 (\pm 0.64)$. WPSS7 had the highest mean rating of $7.47 (\pm 0.64)$ while WPSS5 had the least mean preference of $6.73 (\pm 1.28)$ respectively.

Question 2: What are the nutritional compositions of cakes produced from the composite blends and 100% wheat cake in terms of proximate composition, vitamins and minerals?

Table 3. Mean (\square) value of proximate analysis of all cake samples
Samples Parameters (%)

	Moisture	Crude protein	Crude Fat	Crude Fiber	Total Ash	Carbohydrate
WPSS1	15.93 ± 1.80^c	12.60 ± 0.20^c	26.25 ± 0.24^d	1.23 ± 0.13^d	2.57 ± 0.20^b	41.18 ± 1.80^a
WPSS2	19.31 ± 1.48^b	13.05 ± 0.05^c	26.62 ± 0.22^d	2.84 ± 0.00^c	2.85 ± 0.21^b	40.12 ± 0.48^b
WPSS3	19.91 ± 0.84^b	14.67 ± 0.83^b	28.47 ± 0.83^c	2.91 ± 0.01^b	3.17 ± 0.02^b	36.65 ± 0.46^c
WPSS4	20.33 ± 0.58^b	14.27 ± 1.07^b	28.95 ± 1.03^c	2.98 ± 0.00^b	3.64 ± 0.16^a	35.66 ± 0.10^c
WPSS5	20.22 ± 0.70^b	15.40 ± 0.48^a	30.08 ± 0.08^b	3.00 ± 0.00^b	3.66 ± 0.18^a	34.51 ± 1.06^c
WPSS6	22.33 ± 0.58^a	15.91 ± 0.36^a	32.07 ± 0.07^a	3.27 ± 0.00^a	3.92 ± 0.20^a	26.04 ± 0.04^d
WPSS7	14.67 ± 0.58^c	11.37 ± 0.61^d	25.25 ± 0.50^d	0.51 ± 0.61^e	2.35 ± 0.10^b	42.66 ± 0.06^a

Mean and standard deviation of proximate analysis result

**Samples with different superscripts within the column are significantly different ($P < 0.05$).*

Key:

WPSS7 (100% wheat flour cake) which serves as the control

WPSS1 (5% plantain, 5% soybean, 5% sesame / 85% wheat flour) cake

WPSS2 (10% plantain, 10% soybean, 5% sesame / 80% wheat flour cake)

WPSS3 (10% plantain, 10% soybean, 5% sesame / 75% wheat flour) cake

WPSS4 (15% plantain, 5% soybean, 10% sesame / 70% wheat flour) cake

WPSS5 (10% plantain, 15% soybean, 15% sesame / 60% wheat flour) cake

WPSS6 (15% plantain, 15% soybean, 15% sesame / 55% wheat flour) cake

Table 3 .0: shows the mean (\square) of proximate composition of all the cake samples. The analysis shows that the mean moisture content of cake samples was between $14.67 (\pm 0.58)$ and $22.33 (\pm 0.58)$. Crude protein mean ranged between 11.37 ± 0.61 and 15.91 ± 0.61 . Fat content also increased from $25.25 (\pm 0.50)$ to $32.07 (\pm 0.70)$. Crude fibre mean increased from $0.51 (\pm 0.61)$ to $3.27 (\pm 0.00)$. Total ash mean was between $2.35 (\pm 0.10)$ and $3.92 (\pm 0.20)$. Carbohydrate mean decreased from 42.66 ± 0.06 to $26.04 (\pm 0.04)$ respectfully. The table indicates that WPSS6 WPSS6 (15% plantain, 15% soybean, 15% sesame / 55% wheat flour) had the highest mean value in proximate composition except in carbohydrate mean value that is higher in WPSS7 (100% wheat cake). The hypothesis tested on proximate composition of

all the cake samples differ significantly at $P \leq 0.05$ level with the control, therefore the hypothesis of no significance difference was rejected at $P \leq 0.05$.

Table 4. Mean (\bar{x}) Mineral composition of all the cake samples
Samples Parameters (%)

	Calcium (mg/100g)	Magnesium (mg/100g)	Phosphorus (mg/100g)	Iron (mg/100g)
WPSS1	120.63 \pm 0.66 ^f	13.48 \pm 0.15 ^e	72.62 \pm 0.09 ^e	3.271 \pm 0.79 ^e
WPSS2	131.76 \pm 1.33 ^e	54.14 \pm 0.01 ^d	94.73 \pm 0.01 ^d	3.935 \pm 0.02 ^d
WPSS3	141.51 \pm 0.58 ^c	54.62 \pm 0.30 ^d	96.99 \pm 0.05 ^d	4.173 \pm 0.07 ^c
WPSS4	162.98 \pm 0.02 ^b	57.81 \pm 0.45 ^c	139.28 \pm 0.12 ^c	4.599 \pm 0.15 ^b
WPSS5	167.40 \pm 0.19 ^b	67.97 \pm 0.03 ^b	164.45 \pm 0.04 ^b	5.658 \pm 0.02 ^a
WPSS6	170.86 \pm 0.20 ^a	76.85 \pm 0.22 ^a	184.94 \pm 0.03 ^a	5.828 \pm 0.01 ^a
WPSS7	70.11 \pm 0.04 ^g	10.50 \pm 0.51 ^f	51.85 \pm 0.22 ^f	2.70 \pm 0.09 ^f

Values are means \pm standard deviation of triplicate determination. Values in the same column with different superscript are significantly ($p \leq 0.05$) different.

Key:

WPSS7 (100% wheat flour cake) which serves as the control

WPSS1 (5% plantain, 5% soybean, 5% sesame / 85% wheat flour) cake

WPSS2 (10% plantain, 10% soybean, 5% sesame / 80% wheat flour cake)

WPSS3 (10% plantain, 10% soybean, 5% sesame / 75% wheat flour) cake

WPSS4 (15% plantain, 5% soybean, 10% sesame / 70% wheat flour) cake

WPSS5 (10% plantain, 15% soybean, 15% sesame / 60% wheat flour) cake

WPSS6 (15% plantain, 15% soybean, 15% sesame / 55% wheat flour) cake

Mean (\bar{x}) of Mineral composition of all the cake samples is shown in Table 4.0. The table revealed that Calcium mean value increased from 70.11(\pm 0.04) to 170.86 (\pm 0.20). Magnesium varied between 10.50 (\pm 0.01) and 76.85 (\pm 0.23). The mean value of Phosphorus was between 51.85 (\pm 0.22) and 184.94 (\pm 0.03). Iron mean value varied between 2.70 (\pm 0.09) and 5.83 (\pm 0.01).

Table 5. Vitamin Composition of Cake Samples Samples Parameters (mg/100g)

	Vitamin C	Vitamin A
WPSS1	15.04 \pm 0.72 ^b	2.74 \pm 0.52 ^e
WPSS2	15.03 \pm 0.01 ^b	4.46 \pm 0.12 ^d
WPSS3	19.81 \pm 0.30 ^a	5.17 \pm 0.03 ^c
WPSS4	19.99 \pm 0.75 ^a	5.17 \pm 0.00 ^c
WPSS5	19.26 \pm 0.50 ^a	6.39 \pm 0.01 ^b
WPSS6	20.05 \pm 0.04 ^a	7.11 \pm 0.01 ^a
WPSS7	1.02 \pm 0.04 ^c	1.01 \pm 0.01 ^f

*Values are means \pm standard deviation of triplicate determination. Values in the same column with different superscript are significantly ($p \leq 0.05$) different

Key:

WPSS7 (100% wheat flour cake) which serves as the control

WPSS1 (5% plantain, 5% soybean, 5% sesame / 85% wheat flour) cake

WPSS2 (10% plantain, 10% soybean, 5% sesame / 80% wheat flour cake)
 WPSS3 (10% plantain, 10% soybean, 5% sesame / 75% wheat flour) cake
 WPSS4 (15% plantain, 5% soybean, 10% sesame / 70% wheat flour) cake
 WPSS5 (10% plantain, 15% soybean, 15% sesame / 60% wheat flour) cake
 WPSS6 (15% plantain, 15% soybean, 15% sesame / 55% wheat flour) cake

Table 5.0 depicted the Mean (\bar{x}) of Vitamin A and C of all the cake samples. Vitamin C mean value ranged between 1.02 (± 0.00) and 20.05 (± 0.42). Vitamins A content of cake samples was between 1.01 (± 0.01) and 7.11 (± 0.01) respectively. Vitamin A and C differ significantly at $P \leq 0.05$ level among the cake samples and the control, therefore the hypothesis of no significance difference was rejected at $P \leq 0.05$.

Question 3: In which ways can cakes fortified with plantain, soybean and sesame seeds serve as an avenue for sustainable economic development?

Table 6. Responds to Structured Questionnaire

S/N	QUESTIONS	MEAN	SD	REMARK
1	Teaching youths the skill of producing composite flour for snacks production such as cake is a way of empowering them for sustainable wealth creation	3.68	0.48	Agreed
2	Teaching youths the skill of producing composite flour for snacks production such as cake is a way of empowering them for sustainable employment generation	3.56	0.51	Agreed
3	Creating awareness about the nutritional composition of composite flour made from plantain, soybeans, sesame seeds flour among the general public will increase sales	3.4	0.5	Agreed
4	Creating awareness about the nutritional composition of composite flour made from plantain, soybeans, sesame seeds flour among the general public will increase income	3.64	0.49	Agreed
5	Teaching people in composite flour production from plantain, soybeans, sesame seeds will serve as a way of emphasizing on entrepreneurship in composite snack in schools, colleges	3.4	0.5	Agreed
6	Opening of more composite flour processing factories will generate income to workers thereby increase economy sustainability	3.56	0.51	Agreed
7	Teaching people in composite flour production for sale will generate more jobs	3.4	0.5	Agreed
8	Teaching people in composite flour production for sale will generate create wealth for sustainable economic development	3.52	0.51	Agreed
9	Fortifying foods such as cake with composite flour will reduce micronutrient deficiency among children; adult thereby reducing the money government would have spent on drugs	3.28	0.46	Agreed
10	Composite flour production can be use to create new knowledge to improve sustainable food production	3.44	0.51	Agreed
11	Composite flour production can be use to create innovative approaches to improve sustainable food production	3.44	0.51	Agreed
12	The development of requisite skills in Composite flour production can be used to create decent job	3.52	0.51	Agreed
13	Composite flour as fortifier encourage the formalization, growth of food related micro, small, medium - sized enterprises for sustainable economic development	3.4	0.5	Agreed
14	Fortifying food with indigenous foods is the cheapest, efficient, most effective way to reach large populations essential nutrients	3.6	0.5	Agreed

Table 6.0 shows the mean and standard deviation of respondents. From the above, all the items had their mean score higher than the cut-off point of 2.50, which means that all the respondents agreed to all the 14 items on question nine. The values of the standard deviation indicate that the respondents' opinion did not deviate widely.

Discussion of Results

Discussion on the Nutritional and Sensory Evaluation of Composite Cakes and Their Role in Sustainable Economic Development: The discourse on the outcomes of the nutritional and sensory assessment of cake samples enriched with plantain, soybean, and sesame seed, with a control cake comprising one hundred percent wheat flour, explores the potential of composite cakes as a catalyst for sustainable economic development. The sensory evaluation unveiled that all composite cakes received favorable responses from judges, displaying no statistically significant differences ($P \leq 0.05$) in texture, flavor, taste, mouthfeel, and overall acceptability when compared to the control. Specifically, WPSS1 (5% plantain, 5% soybean, 5% sesame / 85% wheat flour), WPSS2 (10% plantain, 5% soybean, 5% sesame / 80% wheat flour), and WPSS3 (10% plantain, 10% soybean, 5% sesame / 75% wheat flour) exhibited comparable attributes to the control. These findings align with prior research employing plantain or sesame seeds in wheat-based composites for cakes, biscuits, and breads (Olaoye et al., 2013; Agu and Okoli, 2014; Loza et al., 2017; Opaleke et al., 2020; Oledimma, 2021; Arubayi & Ogbonyomi, 2019; Sampson et al., 2018). Notably, WPSS2 (10% plantain, 5% soybean, 5% sesame / 80% wheat flour) emerged as the top-rated composite cake in sensory evaluation.

Moisture content, a crucial factor affecting the textural quality and chemical reactions in bakery products, demonstrated an increase ranging from 14.67 (± 0.58) to 22.33 (± 0.58) with higher fortificant percentages (plantain/soybean and sesame seed flour). WPSS6 (15% plantain, 15% soybean, and 15% sesame flour) exhibited the highest moisture content, while WPSS7 (control) had the lowest. These results corroborate findings by Loza et al. (2017), Opaleke et al. (2020), Ndife et al. (2011), and Kiin-Kabari and Banigo (2015), who reported elevated moisture content in cakes using sesame seeds, bread with soybean blends, and cakes with wheat and unripe plantain flour. Adebowale et al. (2012) noted that soy flour addition enhances the water-binding capacity of plantain flour, leading to improved reconstitution and textural ability due to the high fiber content of the fortificants.

Protein content increased from 11.37 ± 0.61 to 15.91 ± 0.61 in tandem with fortificant increments, attributed to the protein-rich nature of soybean and sesame seeds. WPSS6 (15% plantain /15% soybean/ 15% sesame seed substitution) boasted the highest protein content, while WPSS7 (control) had the least. This aligns with Kiin-Kabari and Banigo (2015), Agu & Okoli (2014), and Ndife et al. (2011), who observed protein content elevation in cakes, biscuits, and bread with legume additions. The rise in protein content signifies an advantage for consumers, aiding in the prevention of protein-energy malnutrition.

Fat content displayed an increase from 25.25 (± 0.50) to 32.07 (± 0.70) with escalating substitution levels. WPSS6 (15% plantain /15% soybean/ 15% sesame seed substitution) recorded the highest fat content, attributable to the lipid-rich nature of soybean and sesame seeds. Notably, the fats from soybean and sesame contain beneficial mono and polyunsaturated fats (Tunde-Akintunde et al., 2012), enhancing mouthfeel and flavor retention. Similar observations were reported by Agu and Okoli (2014), Ugwuona et al. (2017), and Loza et al. (2017) in the production of composite biscuits, bread, and cookies. Fiber content increased with substitution, with WPSS6 (15% plantain /15% soybean/ 15% sesame) displaying the highest value, while WPSS7 (control) had the lowest. The surge in fiber content is attributed to the abundant fiber in unripe plantain flour and sesame seed hull.

This aligns with Loza et al. (2017) and Ndife et al. (2011), who reported elevated crude fiber in composite bread with sesame seeds and soybean blends in composite bread, respectively. The consumption of such fiber-rich products holds great potential for health benefits, preventing diseases like cardiovascular issues, diverticulitis, constipation, irritable colon, cancer, and diabetes.

Ash content in all composite cake samples, excluding WPSS1 (cake with 5% plantain /5% soybean/ 5% sesame seed substitution), significantly differed from the control. The higher fiber content in plantain, soybean, and sesame seeds suggests an enhanced mineral intake in these cakes. This finding aligns with Zubair et al. (2021) and Taghdir et al. (2016), who observed increased ash content in cakes made from wheat and sesame seed flour blends and corn flour supplemented with soy flour.

Carbohydrate content decreased in all composite samples compared to the control, with WPSS6 (15% plantain /15% soybean/ 15% sesame seed substitution) recording the least carbohydrate content. This mirrors the results of Kiin-Kabari and Banigo (2015), Ugwuona et al. (2017), Emmanuel-Ikpeme et al. (2012), and Adegunwa et al. (2019), indicating a decrease in carbohydrate content with increasing substitutions. Wheat flour was identified as the primary contributor to carbohydrate content in the cakes. The decrease in carbohydrate content did not impede the increase in fiber content in composite samples, explaining the higher ash content in all composite samples. Proximate composition differed significantly ($P \leq 0.05$) from the control, rejecting the hypothesis of no significant difference.

Minerals play a vital role in overall health, impacting the musculoskeletal system and various biological functions. Mineral analysis indicated an increase in calcium, magnesium, phosphorus, and iron with higher substitution levels. WPSS6 (15% plantain, 15% soybean, and 15% sesame seed substitution) exhibited the highest mineral content, highlighting the potential of composite cakes to contribute essential minerals to the diet. These findings align with Zubair et al. (2021), Abbas et al. (2020), and Emmanuel-Ikpeme et al. (2012), who reported increased mineral content in cakes and doughnuts substituted with sesame seed flour. The incorporation of plantain, soybean, and sesame seed flour in baked products, especially cakes, offers a promising avenue to enhance mineral intake in the diet.

Vitamin A and C content increased with substitution, with WPSS6 (15% plantain /15% soybean/ 15% sesame seed substitution) demonstrating the highest levels. Composite cakes fortified with plantain, soybean, and sesame seeds can significantly contribute to vitamin intake. This aligns with Emmanuel-Ikpeme et al. (2012), who reported increased vitamin A and C content in bread and cake using different blends of sesame seed flour.

The findings suggest that composite cakes fortified with plantain, soybean, and sesame seeds have the potential to provide nutritious and well-received baked goods. The incorporation of these alternative flours aligns with health and sustainability goals. Additionally, the study proposes that composite cakes can serve as a means to achieve sustainable economic development goals, such as addressing malnutrition, empowering women and youth through skills training, and fostering innovation in food-related enterprises. These findings underscore the potential of composite cake production in contributing to multiple Sustainable Development Goals. The nutritional composition of these cakes, rich in protein, healthy fats, fiber, and essential minerals and vitamins, positions them as a valuable tool in combating malnutrition and promoting overall health. The survey results indicating public agreement on the cost-effectiveness of fortifying foods with indigenous ingredients and the potential for composite cake production to empower women and youth further underscore the societal benefits and economic potential of this approach. Thus, composite cake production emerges as a promising strategy for achieving sustainable development objectives related to nutrition, health, and economic empowerment.

IV. Conclusion

The findings indicate the feasibility of replacing wheat flour with a blend of unripe plantain, soybean, and sesame seed flours, each constituting up to 15% of the total composition in cake production. This substitution not only enhances the nutritional content of baked goods but also contributes to the broader utilization of plantain, soybean, and sesame seed resources. Additionally, it holds the potential to mitigate postharvest losses and alleviate the economic strain associated with wheat importation in countries where wheat cultivation faces challenges, thereby conserving valuable resources in developing nations.

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