Novelty Journals

ISSN 2394-966X

International Journal of Novel Research in Life Sciences
Vol. 13, Issue 4, pp: (1-11), Month: July - August 2026, Available at: www.noveltyjournals.com

Proximate Composition, Sensory Acceptability and Microbial Safety of Cookies Produced from Wheat Fortified with High Calcium Sources

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DOI: https://doi.org/10.5281/zenodo.21485489

Published Date: 22-July-2026

Abstract: **Cookies are popular baked snacks consumed worldwide because of their desirable taste. This study evaluated the production and nutritional properties of wheat cookies fortified with high-calcium sources (eggshell and fish bone powders). Four formulations were developed, including a control sample and three experimental samples with varying ratios of eggshell and fish bone powder such as (TGPO, KFAP, XOTP and PAFK), these were analyzed for proximate composition, microbial safety and sensory characteristics using standard AOAC methods. Five (5) point hedonic scale ranking in a descending order was used for sensory property evaluation. The two way analysis of variance (ANOVA) procedures was used to analyze all data using the minitab 17 version for window. Mean separation was performed by the LSD test ($p<0.05$). Results showed that crude protein, fat, crude fiber and carbohydrates ranges from (8.78±0.57a – 9.39±0.28b), (9.68±0.04a – 11.31±0.07d), (1.98±0.04a – 8.90±123.18b) and (53.04±0.76a – 54.66± 0.05b), respectively. Microbial loads ranges from (0.80–1.10 $\times 10^5$ cfu/g) and remained stable. All sensory attributes (colour, texture, taste, flavour, aftertaste and acceptability) showed no significant differences ($p>0.05$). However, sample 2 consistency scored the highest, indicating greater consumer preference. The cookies were generally acceptable, with average ratings between 2(fair) and 3(good) on a 5- point scale. In conclusion the use of local calcium source in cookie production presents a viable approach for achieving nutritional enhancement, economic sustainability, and product diversification in the food industry. Microbial analysis confirmed that all samples were safe for consumption, with low total bacterial counts, without compromising microbial safety. Sample 3 (XOTP) with 10% fishbone and egg shell is recommended as it is the most acceptable out of all.**

Keywords: **Cookies, Sensory acceptability, Proximate Composition, Microbial Safety, Wheat flour, High Calcium Sources.**

1. INTRODUCTION

Cookies are popular baked snacks consumed worldwide because of their desirable taste, extended shelf life, and ease of handling (Obinna-Echem and Robinson, 2021). Despite their popularity, cookies are generally calorie-dense and low in micronutrients—particularly calcium (Manchanda *et al.*, 2023). Calcium is an essential mineral involved in bone and teeth formation, muscle contraction, nerve transmission, enzyme activation, and blood clotting (Khan *et al.*, 2021). Inadequate calcium intake is a global public-health concern associated with rickets, osteoporosis, and other bone-related disorders (Heaney *et al.*, 2022). Recent evidence shows that approximately 3.5 billion people worldwide consume less than the recommended calcium intake, with the greatest deficiencies occurring in Africa and Asia (Prentice *et al.*, 2021; New York Academy of Sciences [NYAS], 2024). The growing demand for functional foods presents an opportunity to use cookies as a vehicle for calcium fortification, given their wide acceptance across age groups. Local calcium sources such as eggshell powder and sesame seeds are cost-effective, sustainable, and nutritionally rich alternatives to imported mineral supplements.

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Eggshells, a common waste material, contain approximately 35–40 % elemental calcium in the form of calcium carbonate (Kwon & Kim, 2021) and have been successfully incorporated into bakery products, improving calcium content while maintaining sensory acceptability (Al-Asmari *et al.*, 2022; Singh & Kaur, 2023). Therefore, fortifying cookies with locally available, calcium-rich ingredients such as eggshell powder and sesame seed flour provides a practical means to enhance the nutritional profile of a widely consumed snack, particularly in regions with high prevalence of calcium deficiency. This study seeks to formulate and evaluate the nutritional composition of calcium-enriched cookies produced from wheat flour supplemented with selected high-calcium sources.

2. MATERIALS AND METHOD

2.1 Source of Raw Materials.

The wheat flour, other baking ingredient and dried tilapia fishes was purchased at Kuto and Lafenwa market respectively while the crates of egg from which the eggshell was obtained were sourced from Ajayi Poultry farm in Abeokuta Ogun State and were transported to Nutrition and Dietetic Department Kitchen for Processing.

2.2 Preparation of Fish Bone into Powder

Dried fish was removed from the bones the fish bone was prepared into powder according to method descried by Abd El-Gawad *et al.*, (2023). It was sorted and oven dried at 10^{o}c for two hours and milled into powder using (Globe P44 china), sieved through 30mm stainless sieve to obtain fish bone powder.

Dried Tilapia fishes

↓

Deboning

↓

Sorting (the guts and intestine from bones)

↓

Drying (the gathered bone)

↓

Cracking (to ease milling)

↓

Milling (to powder using hammer mill)

↓

Sieving (with 30mm sieve)

↓

Packaging (in polyethylene)

↓

Fishbone powder

Figure 1: Preparation of Fish Bone into Powder

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Whole egg

↓

Sorting

↓

Cracking

↓

Washing (to remove the remaining albumin)

↓

Drying (the shells)

↓

Milling (to powder using hammer mill)

↓

Sieving (with 30mm sieve)

↓

Packaging (in polyethylene)

↓

Fishbone powder

Figure 2: Preparation of Egg Shell into Powder (Adeyeye, 2002).

2.3 Formulation of Blends

The blends for the samples was mixed at different proportions as follows: 100% wheat flour was used to prepare control cookies labeled as the reference (R) while the rest samples was supplemented as 10%, 20%, and 30% fish bone and eggshell.

Table 1: formulation of Cookies Samples at Different Ratios

Samples	Wheat	Fish bone	Egg shell
1: TGPO	100% (control)	-	-
2: KFAP	80%	15%	5%
3: XOTP	80%	10%	10%
4: PAFK	80%	5%	15%

2.4 Cookies Production

The cookies was produced according to the modified recipe describes by Achimugu *et al.*, (Achimugu *et al.*, 2025). flour (250 g), fat (63 g), sugar (63 g), salt (1 g), whole egg (20 ml), powder milk (5 g), nutmeg (1.5 g), baking powder (1 g), and water (20–60 ml). Cookie (biscuit) was prepared using the traditional creaming method described by Chinma and Gernah (2013). The fat and sugar were mixed until fluffy after which whole egg and powder milk was added while mixing for 30minutes. Flour and baking powder was mixed thoroughly and was added to the cream mixture and mixed together with kenwood blender (Model No: HR-1731) at speed 6 for 3minutes to form batter which was rolled and cut into shaped of 5cm diameter with biscuit cutter. It was baked at $183^{o}C$ for 15-25minutes. The samples was prepared by systematic replacement of 100% wheat samples with fish bone and eggshell proportion of 5-15% then finally cooled and stored in polyethylene for further analysis.

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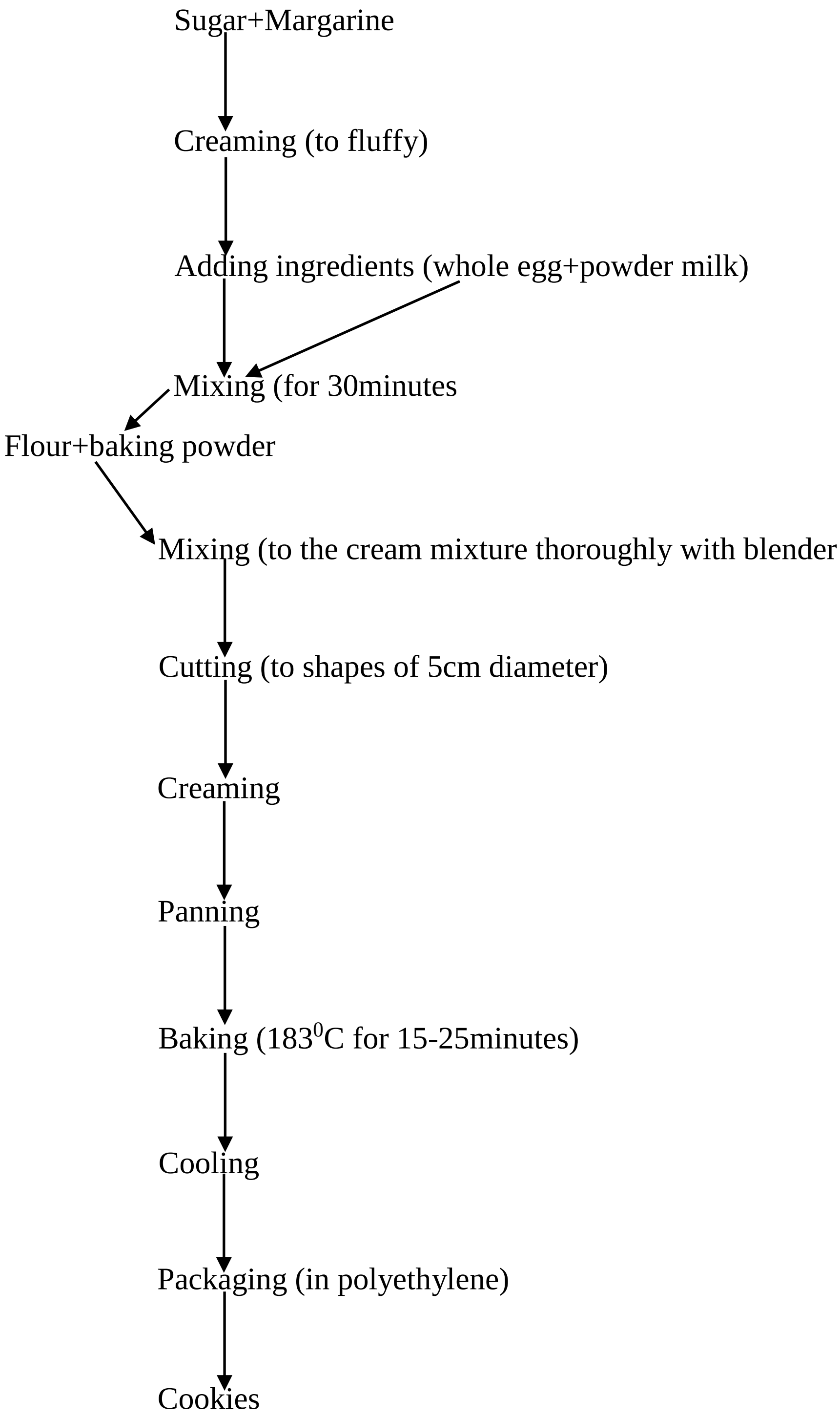

Figure 3: Flow Chart of Cookies Production

2.5 Determination of Proximate Composition

Proximate analysis of the cookies was carried out using Association of Official Analytical Chemist (AOAC, 2000) methods for moisture, crude fat, dietary fibre, ash and crude protein. Triplicate determinations was made with the average reported.

2.5.1 Protein Content Determination

Protein determination was carried out by Kjedahl digestion method. 5g of the sample was measured into the Kjedahl digestion flask, one tablet of the selenium catalyst was added and 5ml of concentrated H2SO4. The sample was place on the digestion stand to digest. The digested sample was transfer into 250ml volumetric flask and make up with distilled water. 10ml of the digest was measure into the "Markham" distilled apparatus, 10ml of 0.1 NaOH was added to the sample and distilled into a 4% boric acid, using ma-zua-zaga indicator. The distillate was titrated with 0.02NH2SO4 to the end point.

Calculation

$$\% \text{ Nitrogen} = \frac{Vs - V_B \text{ x Nacid x } 0.0140}{\text{Weight of sample}} \text{ x } \frac{100}{1}$$

Where:

Vs. =Volume (ml) of acid required to titrate sample,

V_B = Volume (ml) of acid required to titrate the blank,

N acid = Normality of acid (0.01N),

W= Weight of sample (g),

% crude protein = N x (conversion factor)

(100% Nitrogen in protein) = Conversion factor (6.25)

2.5.2 Fat content determination

The total crude fat was determined by the method of refluxing in Soxhlet apparatus.
Approximately 250ml of clean boiling flasks was dried in an oven at 105-110oc for about 30minutes. It was transferred into a desiccator and allowed to cool, then 2g of sample was weighed accurately into labeled thimbles. Correspondingly labeled and cooled boiling flasks were weighed, the boiling flasks were filled with 300ml of petroleum ether (boiling point 40-60^{o}C). The extraction thimble was lightly plugged with cotton wool, then the Soxhlet apparatus was assembled and allowed to reflux for about 3-6 h. The thimble was carefully removed and petroleum ether was collected into the top container of the set-up and drained into a container for re-use. Consequently, when flask was almost freed of ether, it was removed and dry at 105-110^{o}C for 1h and then transferred from the oven into desiccator, cooled, and weighed.

Calculation $\% \text{ fat} = \frac{\text{Weight of fat}}{\text{Weight of sample}} \text{ X } \frac{100}{1}$

2.5.3 Ash content determination

The total ash was determined by the method of AOAC (2019).

Approximately 2 to 5g of finely ground, dry sample was weighed into a porcelain crucible. The sample was charred on a bunsen flame inside a fume cupboard to drive away smoke and was later transferred into a pre-heated muffle furnace at 550^{o}C and left at this temperature for 2h or until white or light gray ash is formed. When the residue became black, it was moistened with a small amount of water to dissolve salts, dried in an oven and the ashing process was repeated. It was cooled in a desiccator and weighed.

Calculation: this was done thus: $\% \text{ Ash (dry basis)} = \frac{\text{Weight of Ash}}{\text{Weight of Original food}} \text{ x } \underline{100}$

$$\% \text{ Ash (dry basis)} = \frac{W_3 - W_1}{W_2 - W_1} \text{ x } \underline{100}$$

Where:

W1 = weight of empty crucible,

W2 =weight of crucible + sample before ashing,

W3 = weight of crucible +ash.

2.5.4 Moisture content determination

The moisture content was determined according to the standard methods of the Association of Official Analytical Chemists (AOAC, 2019). Crucibles were cleaned and dried in the oven at 100oc for 1 hour to achieve a constant weight. They were cooled in a desiccator and weighed. 2g of each sample was placed in one dish respectively and dried in the oven at 100oc until a constant weight is achieve. The samples in the dishes were removed from the oven, cooled in a dessicator and weighed.

Calculation: this was done thus:

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

Where:

W1 = weight of empty dish,

W2 =weight of dish + sample before drying,

W3 = weight of dish +sample after drying.

2.5.5 Crude fiber Content Determination

The crude fibre was determined according to the process described by Onwuka (2015) thus:
Sample weighing 2g was defatted with petroleum ether, it was boiled under reflux for 30 minutes with 200ml of a solution containing 1.25g of H2SO4 per 100ml of solution. The solution was filtered through several layers of cheese cloth on a fluted funnel and was washed with boiling water until the washings was no longer acidic. The residue was transferred to a beaker and boiled for 30 minutes with 200ml of a solution containing 1.25g of carbonate –free NaOH per 100ml. The final residue was filtered through a thin but closed pad of wash and ignite asbestos in a Gooch crucible

Calculation: this was done thus:
The loss in weight after incineration x 100 = % crude fibre

2.5.6 Carbohydrate Content Determination

Carbohydrate was determined by difference i.e. Carbohydrate content =100% — (% protein + % fat + % fibre + % ash + % moisture)

2.6 Qualitative Sensory Analysis (Preference Test) of the Cookies.

For the test, 10g of the cookies samples were served to the consumers at 22±1ºC in disposable plates, randomly codified with four alphabets. The overall acceptability of the cookies from the resulting samples were evaluated by 30 panel of judges to indicate their preference for the samples on a five point hedonic scale, where 1 and 5 represent dislike extremely and like respectively (Achimugu *et al.*, 2025).

2.7 Determination of Microbiological Quality of the Cookies

The microbiological stability of the cookies were determined by method described by Ilori *et al.*, 2021; Onyango *et al.*, 2019. The samples were stored for a period of 3 weeks and the bacterial and fungi growth were observed, identified and counted. This was determined on weekly basis.

2.7.1 Total (Aerobic) Plate Count

One gram (1g) of the samples each was added to 10ml of sterile distilled water to make 10% of the stock solution. Ten (10) fold diluted sample was aseptically transferred to sterile petri dish containing cooled (46ºc) 20ml of Total plate count agar (TCPA) and Potato dextrose agar (PDA). Spore and bacterial count were done manually by counting the number of colonies and the result was multiply by the dilution factor **(**Achimugu *et al.*, 2025**)**.

2.8 Data Analysis

The data obtained was analyzed using SPSS version 21.00. Analysis of Variance (ANOVA) was used to separate means while all result analyzed was expressed as means of three replicates ± S.D (Standard Deviation). Pearson correlation test was used to evaluate significant association between the nutrient compositions of the samples with the level of significance set at $P < 0.05$.

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3. RESULT

3.1 Proximate Composition of the Cookies

The Proximate composition of the cookies produced is presented in Table 2. The properties analyzed include Ash, ether extract, crude fibre, moisture and carbohydrate.

There was a significant ($p<0.05$) difference observed in the ether extract and moisture indicating formulation impact on fat and water levels. Ash, crude fibre and CHO did not show significant variation ($p>0.05$) meaning fibre and carbohydrate content remained stable. The low moisture and high fat of some samples especially sample XOTP and PAFK suggest longer shelf life and enhanced sensory appeal. Overall, the cookies are nutritionally adequate, with balanced composition suitable for energy and moderate nutrient contribution.

Table 2: Proximate Composition of the Cookies

Samples	Ash	Ether extract	Crude fibre	Moisture	CHO
TGPO	2.53 ± 2.81^{a}	9.68 ± 0.04^{a}	1.98 ± 0.04^{a}	20.61 ± 0.01^{d}	54.43 ± 0.42^{b}
XOTP	4.51 ± 0.14^{a}	10.16 ± 0.14^{b}	2.51 ± 0.01^{a}	18.72 ± 0.02^{a}	54.66 ± 0.05^{b}
KFAP	4.43 ± 0.04^{a}	10.79 ± 0.04^{c}	2.42 ± 0.02^{a}	19.54 ± 0.14^{b}	54.59 ± 0.66^{b}
PAFK	3.88 ± 0.04^{a}	11.31 ± 0.07^{d}	8.90 ± 123.18^{b}	20.22 ± 0.01^{c}	53.04 ± 0.76^{a}
P-value	0.537	0.000	0.483	0.000	0.086

Values are means± standard deviation of triplicate determination

Different letter scripts in the same column indicates statistical difference ($p<0.05$)

3.2 Sensory Attributes of the Cookies

The sensory attributes of the cookies produced from composite flours is presented in Table 3. The properties analyzed include colour, appearance, texture, taste, flavour, aftertaste and overall acceptability. All sensory attributes (colour, texture, taste, flavour, aftertaste and acceptability) showed no significant differences (>0.05). However, sample (XOTP) consistency scored the highest, indicating greater consumer preference. The cookies were generally acceptable, with average ratings between 2(fair) and 3(good) on a 5- point scale. Sensory performance correlates positively with proximate composition - sample XOTP has higher fat content and lower moisture likely enhanced flavour, texture and overall appeal.

Table 3: Sensory Attributes of the Cookies

Samples	Colour	Appearance	Texture	Taste	Flavor	After taste	Overall acceptability
TGPO	1.95^{a}	2.05^{a}	2.15^{a}	1.80^{a}	2.15^{a}	2.30^{ab}	2.20^{a}
XOTP	2.20^{a}	2.30^{a}	2.65^{a}	2.75^{b}	3.05a	3.05^{c}	3.20^{b}
KFAP	2.30^{a}	2.35^{a}	2.45^{a}	2.45	2.05^{a}	2.70^{bc}	2.40^{a}
PAFK	2.10^{a}	2.15^{a}	2.20^{a}	1.90^{a}	1.85^{a}	1.85^{a}	1.90^{a}

Values are means± standard deviation of triplicate determination

Different letter scripts in the same column indicates statistical difference ($p<0.05$)

3.3 Microbial Composition of the Cookies

The microbial composition of the cookies is shown in Table 4. The microbial properties assessed is TBC (Total Bacteria Count). There is non-significant differences in the total bacteria count (TBC). The low microbial count confirm that all cookie samples were microbiologically safe.

Table 4: Microbial Composition of the Cookies

Samples	TBC (Total Bacteria Count)
TGPO	0.80 ± 0.14^{a}
XOTP	0.81 ± 0.01^{a}
KFAP	0.95 ± 0.07^{a}
PAFK	1.10 ± 0.14^{a}

Values are means± standard deviation of triplicate determination

Different letter scripts in the same column indicates statistical difference ($p<0.05$)

4. DISCUSSION

4.1 Proximate Composition of the Cookies

Table 2 presents the proximate composition of cookies produced from different composite flour samples. The parameters analyzed include ash content, ether extract (fat), crude fibre, moisture content, and carbohydrate.

The ash content of the cookie samples ranged from 2.53±2.81% in Sample TGPO to 4.51±0.14% in Sample XOTP. Although the variation among the samples was not statistically significant ($p = 0.537$), Sample XOTP recorded the highest ash value, indicating a higher mineral content. Ash content is an index of the total mineral composition of food products, and higher values suggest the presence of more nutritionally essential minerals such as calcium, magnesium, and potassium (Oyewole *et al.*, 2020). The observed differences might be attributed to the varying proportions of the composite flour ingredients used in the formulation.

The ether extract values ranged from 9.68±0.04% in Sample TGPO to 11.31±0.07% in Sample PAFK. The difference among samples was statistically significant ($p = 0.000$). The increase in fat content across the samples could be due to the differences in flour composition or the amount of fat-retaining ingredients such as egg or margarine. The relatively high fat content enhances the palatability and energy density of the cookies, contributing to improved mouth feel and flavor. Similar trends were reported by Olaoye *et al.*, (2018), who observed that fat content in baked goods increases with the addition of fat-rich ingredients.

Crude fibre content ranged between 1.98±0.04% (Sample TGPO) and 2.51±0.01% (Sample XOTP), with no significant difference among samples ($p = 0.483$). Fibre plays a vital role in improving digestive health and reducing the risk of chronic diseases such as diabetes and cardiovascular disorders. The low fibre content is typical of cookies, which are often produced from refined or partially refined flours. However, slight variations might be due to the inclusion of composite ingredients such as whole grains or plant-based flours (Ilori *et al.*, 2021).

Moisture content ranged from 18.72±0.02% in Sample 2 to 20.61±0.01% in Sample TGPO, with significant variation ($p = 0.000$). Lower moisture levels are desirable in baked products as they enhance shelf stability and reduce microbial growth. Sample XOTP, with the lowest moisture value, is expected to have better storage stability compared to the others (Ilori *et al.*, 2021). The variation in moisture could be attributed to differences in baking time, flour composition, and water absorption capacity of the composite flours used.

Carbohydrate content ranged from 53.04±0.76% in Sample PAFK to 54.66±0.05% in Sample XOTP. Although the difference was not statistically significant ($p = 0.086$), carbohydrates remained the major macronutrient in all cookie samples, as expected for flour-based products. The relatively high carbohydrate levels provide a good source of energy (Adebayo *et al.*, 2021), making the cookies suitable as a quick snack or energy-dense food product.

Crude protein content varied between 8.78% and 9.39%, with no significant differences ($p > 0.05$) across samples. This indicates that protein contribution remained relatively stable despite formulation changes. While cookies are not primary protein sources, the observed protein levels suggest that the products can contribute modestly to daily protein intake, particularly when consumed as part of a balanced diet. Crude protein (CP) content increased from 8.78 to 9.39. This reflects the presence of amino acids and protein residues in the fortificants. Higher protein levels improve the nutritional profile of cookies, enhancing satiety and contributing to growth and tissue repair. Similar increases were reported by Mephae *et al.* (2019) when mineral-rich plant powders were used to fortify composite flours.

The proximate analysis indicates that the cookies produced from different composite flours exhibited comparable nutritional qualities with slight variations across the samples. The differences in ether extract and moisture content were statistically significant, suggesting that flour composition influenced the fat and water retention capacities. Generally, all samples maintained acceptable nutritional standards for cookie products.

4.2 Sensory Attributes of the Cookies

The sensory attributes of cookies prepared from different composite flour formulations were evaluated to assess their overall acceptability. The parameters considered include colour, appearance, texture, taste, flavour, aftertaste, and overall acceptability. The evaluation was conducted using a 5-point hedonic scale, where higher scores indicate greater preference by the panelists.

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The colour scores ranged from 1.95 (Sample TGPO) to 2.30 (Sample KFAP). Colour is a key quality attribute influencing consumer preference for bakery products. The result shows that there were no significant differences (p>0.05) among samples, indicating that substitution with composite flour did not significantly alter the colour of the cookies. Sample 3, which recorded the highest score, suggests that moderate substitution levels may promote the desirable brownish-golden appearance associated with baked product.

The appearance scores ranged from 2.05 (Sample TGPO) to 2.35 (Sample KFAP). There was no significant difference among samples (p>0.05), indicating that the substitution ratios produced cookies with a uniform and acceptable appearance. Appearance plays a major role in the initial perception of quality, and uniformity in surface smoothness and colour contributes to consumer acceptance (Adeleke & Odedeji, 2020). The close scores suggest that the various flour combinations were well-mixed and properly baked, result.

Texture scores ranged from 2.15 (Sample TGPO) to 2.65 (Sample XOTP). Texture is critical to cookie quality as it determines crispness, crunchiness, and mouth feel. Sample 2 had the best texture, likely due to an optimal balance of wheat and alternative flours that improved dough structure and air retention during baking. The relatively lower score in Sample 1 may be due to a higher substitution of low-gluten or high-fibre flours, which tend to reduce dough elasticity and crispness (Oluwamukomi et al., 2020).

Taste scores ranged from 1.80 (Sample TGPO) to 2.75 (Sample XOTP). Taste is a primary determinant of consumer preference and overall acceptability. The result indicates that Sample 2 was the most preferred in terms of taste, suggesting that its composite flour proportion enhanced sweetness and flavour balance. The lower score in Sample 1 might be due to higher substitution with less sweet or slightly bitter-tasting flours, which could alter the desirable taste characteristics of cookies (Oyewole *et al.*, 2020).

Flavour scores ranged from 1.85 (Sample PAFK) to 3.05 (Sample XOTP). Flavour contributes significantly to product appeal. The highest flavour score recorded by Sample 2 suggests that moderate inclusion of alternative flours may have enhanced aromatic and volatile compounds during baking. Conversely, Sample 4, with the lowest score, might have contained higher levels of components that suppressed flavour intensity (Ilori *et al.*, 2021).

Aftertaste values ranged from 1.85 (Sample PAFK) to 3.05 (Sample XOTP). Aftertaste contributes to lasting sensory satisfaction after consumption. Sample 2 had the most desirable aftertaste, indicating that its formulation produced a clean and pleasant residual flavour. Lower scores in Sample 4 could be due to the presence of certain phytochemicals or higher fibre content that impart bitterness or astringency (Akubor & Ishiwu, 2013).

The overall acceptability of the cookies ranged from 1.90 (Sample PAFK) to 3.20 (Sample XOTP). Panelists preferred Sample XOTP, which consistently showed higher scores across most parameters. This implies that its formulation achieved a balance in sensory attributes appearance, texture, taste, flavour, and aftertaste making it the most acceptable cookie sample. Sample PAFK, on the other hand, was the least preferred due to lower ratings in key sensory parameters.

The results demonstrate that moderate levels of flour substitution (as in Sample XOTP) enhanced the sensory properties of the cookies, while higher substitution levels (Sample PAFK) reduced overall quality. This trend aligns with earlier findings that partial substitution of wheat flour with locally sourced alternatives (such as cassava, soybean, or plantain flour) can yield cookies with comparable or improved sensory characteristics if substitution ratios are optimized (Olaoye et al., 2018; Adebayo *et al.*, 2021)

Among all samples, Sample XOTP was rated highest in terms of texture, taste, flavour, and overall acceptability. This suggests that moderate inclusion of composite flour produced cookies with the most desirable sensory attributes. Hence, optimization of composite flour formulations can result in nutritionally enriched and consumer-acceptable baked products.

4.3 Microbial Composition of the Cookies

The microbial composition of the cookies is shown in Table 2. The microbial properties assessed is TBC (Total Bacteria Count). There is non-significant differences in the total bacteria count (TBC). The low microbial count confirm that all cookie samples were microbiologically safe.

The total bacterial count (TBC) remained low with values from 0.80 to 1.10, confirming that the fortified cookies were microbiologically safe for consumption. These results collectively demonstrate that fortification improved nutritional and functional qualities without compromising safety, supporting the use of locally available calcium sources in bakery applications. The microbial count determines the microbiological quantity and safety of food products by estimating the number and types of microorganisms' present (Onyango *et al.,* 2019). The microbial load of the cookie samples was generally low and it was within the acceptable limit of 10^4 CFU/g for baked products as specified by international commission on microbiological specifications for foods (Ilori *et al.*, 2022). The bacterial count was low across samples, suggesting that products were well-dried and properly stored. This aligns with findings by Obinna-Echem and Robinson (2011).

5. CONCLUSION

The use of local calcium source in cookie production presents a viable approach for achieving nutritional enhancement, economic sustainability, and product diversification in the food industry. Microbial analysis confirmed that all samples were safe for consumption, with low total bacterial counts, without compromising microbial safety

6. RECOMMENDATION

This study determined the proximate, microbial and sensory attributes of cookies. Cookies of acceptable quality were produced from wheat flour. The cookies produced had increased nutrient contents which are all desirable for good health and wellbeing. The study shows that production of cookies with 10% of fish bone and eggshell powder (equal proportion) were well accepted cookies. The use of waste calcium sources in cookies will significantly improve the consumers' nutrition, health, and well-being.

Acknowledgement: The researchers acknowledged and appreciate financial aid benefited from TETfund through the Directorate of Reseach and Development of Moshood Abiola Polytechnic, Abeokuta Ogun state Nigeria for supporting this research to fruition. Also, our gratitude goes to the management of the institution for the privilege.

Conflict of Interest: The researchers declared that there was no conflict of interest and all the researchers unanimously decided on the roles played in carrying out the research and where to publish the paper. Also, the article has not been send for publication elsewhere.

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