Journal homepage: www.fia.usv.ro/fiajournal
Journal of Faculty of Food Engineering,
Ştefan cel Mare University of Suceava, Romania
Volume XXV, Issue 1 - 2026, pag. 13 – 21

FOOD AND ENVIRONMENT SAFETY

SENSORY AND MICROBIOLOGICAL QUALITIES OF COOKIES PRODUCED WITH BLENDS OF FLOUR FROM CASSAVA AND BAMBARA NUT

AKANNI Abubakar Adegboyega[1], SANNI Lateef Oladimeji,[1] ALIMI Janet Omolola[2], ALIMI John Praise[1], OKUNLADE Adijat Funmilayo[1], JIMOH Medinat Oyiza[1]

[1]*Durable Crops Research Department, Nigerian Stored Products Research Institute, Ilorin, Kwara State, Nigeria*

[2] *Perishable Crops Research Department, Nigerian Stored Products Research Institute, Ilorin, Kwara State, Nigeria*

Corresponding author: abuakanni@gmail.com

Received 12 August 2025, accepted 31 March 2026

Abstract: *Cookies produced solely from cassava flour are inherently low in protein and dietary fiber, which may negatively influence their functional and sensory attributes. Bambara nut (Vigna subterranea) has been recognized as a nutrient-dense legume with the potential to enhance the nutritional quality of staple-based food products. This study evaluated the sensory and microbiological qualities of cookies produced from composite flours of cassava and Bambara nut. Cassava and Bambara nut were processed into flours and blended using a D-optimal simple lattice mixture design, resulting in eight experimental formulations. Cookies were produced from the composite flours, while control samples included cookies made from 60% wheat flour and 40% Bambara nut flour, as well as 100% wheat flour (conventional cookies). Sensory scores for appearance, color, aroma, taste, texture, and overall acceptability ranged from 5.48 to 8.08%, 5.52 to 7.88%, 5.48 to 7.64%, 5.52 to 7.60%, 5.76 to 7.32%, and 5.16 to 8.12%, respectively. The results indicated that cookies containing up to 40% Bambara nut flour exhibited sensory attributes comparable to conventional wheat cookies. Microbiological evaluation revealed no detectable bacterial or fungal growth in any of the cookie samples. The 100% wheat flour cookies recorded the lowest microbial counts, followed by samples containing 65% wheat flour and 35% Bambara nut flour. Overall, the microbial quality of all samples complied with established national and international food safety standards for consumption and storage.*

Keywords: *bambara nut, cassava flour, cookie, microbial safety, sensory properties*

1. Introduction

Cookies are among the most widely consumed thermally processed snack items globally, attributed to their extended storage stability, sensory appeal, and ease of consumption [1]. Conventionally formulated using refined *Triticum aestivum* (wheat) flour, sucrose, lipid-based shortening systems, and chemical leavening agents, recent innovations in bakery technology are steering toward the incorporation of composite flours derived from non-gluten-containing cereals, legumes, and tubers. This transition is driven by macroeconomic pressures, including the escalating market price of wheat, growing prevalence of gluten-related disorders such as celiac disease and non-celiac gluten sensitivity, and increased demand for functional foods with improved nutrient density and bioactive compound profiles [2]. Cassava (*Manihot esculenta*), a starchy tuberous crop of tropical origin, serves as a prominent source of digestible carbohydrates, particularly amylose and amylopectin polymers. It is extensively cultivated and subjected to post-harvest unit operations, including peeling, drying, milling, and sieving to produce cassava flour, a gluten-free alternative to conventional cereal-based flours. This flour is increasingly utilized as a functional ingredient in bakery, extruded, and composite food systems, especially across

DOI: https://doi.org/10.4316/fens.2026.02

developing economies within sub-Saharan Africa. However, its inherently low crude protein and dietary fiber concentrations may negatively influence techno-functional attributes such as water-holding capacity, emulsification, and textural integrity, thereby impacting overall product organoleptic properties and consumer acceptability [3]. Conversely, *Vigna subterranea* (Bambara groundnut) is a bioresource legume classified as underutilized despite its favorable proximate composition, notably its elevated crude protein levels, well-balanced essential amino acid profile, and substantial dietary fiber content [4]. It has been recognized as a strategic fortifying agent for enhancing the macro- and micronutrient quality of carbohydrate-dense staple foods [5]. The incorporation of Bambara nut flour into cassava-based formulations presents a synergistic opportunity to augment protein density and modulate techno-functional characteristics, including dough rheology, texture modulation, and emulsion stability, while concurrently refining sensory attributes such as flavor profile, crumb structure, and visual appeal in baked goods like cookies [6]. Empirical evaluations indicate that the binary blending of cassava and Bambara nut flours yields bakery products with organoleptically acceptable features and improved nutritional indices, alongside heightened microbial safety metrics due to inherent antimicrobial compounds and improved matrix water activity regulation. However, the functional performance of such composite flour systems requires optimized formulation strategies to balance consumer sensory acceptance with shelf-life extension through microbial risk mitigation. This is especially critical given the heterogeneous microbial bio-loads that may be introduced during decentralized or artisanal processing workflows, as emphasized [7]. In the broader context of transforming the food system toward sustainable and nutritionally enriched products, cassava–Bambara nut flour blends exemplify value-added innovation in functional food development. Comprehensive evaluation of both sensory quality metrics and microbial stability parameters remains essential for establishing the commercial scalability and dietary relevance of such formulations.

2. Materials and methods

2.1. Materials

Cassava roots IITA-TMS-0700593 (Sunshine) were obtained from the International Institute of Tropical Agriculture (IITA), Ibadan, and Bambara groundnut from a local farm at Mokwa, Niger State. Other ingredients such as sugar, margarine, egg, nutmeg, cinnamon, vanilla essence, and salt were procured from Mandate market, Ilorin, Kwara State.

2.2. Methods

2.2.1 Preparation of high-quality cassava flour (HQCF)

The high-quality cassava flour (HQCF) used for the study was produced from four varieties of low postharvest physiologically deteriorated (PPD) and one variety of high postharvest physiologically deteriorated (PPD) cassava, with a flash dryer with a model (LPG series) is used to rapidly dry cassava mash into fine flour using hot air, ensuring low moisture content and good product quality as described by [6]. The flow chart for the production of HQCF is presented in Figure 1.

2.3 Production of bambara nut flour

High-quality *Vigna subterranea* (Bambara groundnut) seeds were sourced from Mokwa, Niger State. Post-harvest primary processing involved manual sorting to eliminate defective units, including mechanically damaged, insect-compromised kernels, and extraneous particulates, ensuring only physiologically sound seeds were selected. The specific genotype utilized (SAMNUT 21) underwent hydrothermal treatment via static soaking in potable water for 24 h,

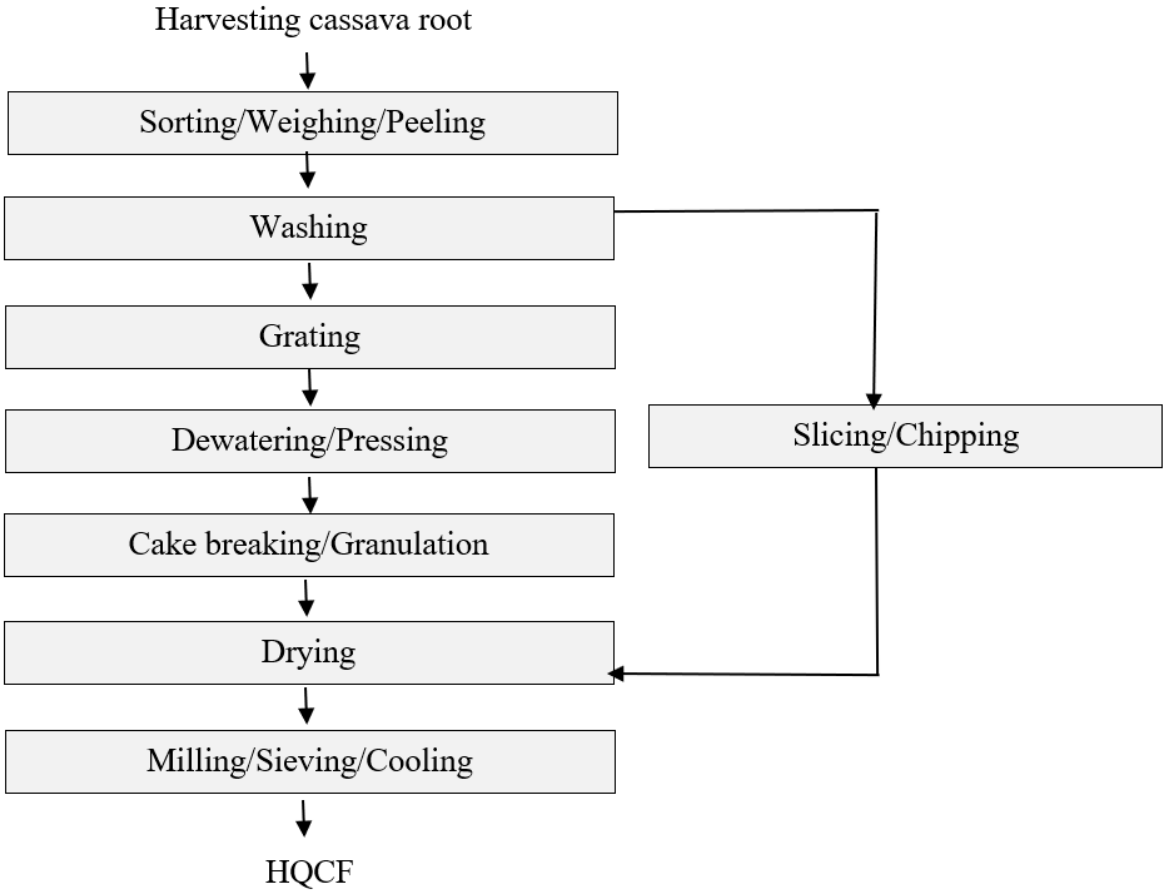

Fig. 1. **Flow chart for the production of high-quality cassava flour [1]**

followed by convective drying at 70 °C for 14 h, aiming to attain a final moisture content threshold of ≤12%, conducive for subsequent value-addition processes. During aqueous steeping, intermittent water replacement at 6 h intervals facilitated partial dehulling, enhanced leaching of water-soluble antinutritional factors (e.g., tannins, phytates), and minimized potential micronutrient degradation. This pre-treatment was succeeded by controlled germination under ambient conditions for 72 h, as documented by [8], in alignment with findings from [9], which highlight sprouting as a biochemical modulation strategy to reduce carbohydrate and lipid fractions, while biofortifying the protein content and amino acid composition of leguminous seeds.

Post-germination, the sprouted seeds were subjected to surface drainage and spatially distributed on food-grade drying trays, then dehydrated using the Nigerian Stored Products Research Institute (NSPRI) parabolic-shaped solar dryer (PSSD) at 60 ℃ over 24 h, ensuring moisture reduction without compromising thermolabile nutrients.

Upon completion of drying, the biomass was equilibrated at room temperature, comminuted using a mechanical hammer mill (GFS-18 model) into fine particle flour, and passed through a 250-micron aperture sieve to standardize granulation.

The resultant flour was stored in hermetically sealed, high-density polyethylene (HDPE) pouches for downstream compositional analysis and

functional evaluation.

2.4 Experimental design

D-optimal simple lattice design (version 12.0), for two-component mixtures expanded with internal points with constraints, was used to investigate some attributes as well as sensory and microbial qualities of flour mixtures composed of high-quality cassava flour (X_1) and Bambara nut (X_2) as independent variables and some quality attributes of cookies, made from these mixtures as dependent variables.

A total of eight combinations were generated, as shown in Table 1.

2.5 Preparation of the flour blends

One hundred grams (100 g) of each of high-quality cassava flour and Bambara nut flour were blended as depicted by the design expert. The blended flour was used for the production of the cookies, as indicated in the formulation and recipe.

Table 1.

Formulation of high-quality cassava flour and Bambara nut flour blends using D - optimal mixture design

S/N	HQCF	BNF	SAMPLE CODE
1	80.00	20.00	$HQCF_{80}BNF_{20}$
2	65.00	35.00	$HQCF_{65}BNF_{35}$
3	70.00	30.00	$HQCF_{70}BNF_{30}$
4	60.00	40.00	$HQCF_{60}BNF_{40}$
5	75.00	25.00	$HQCF_{75}BNF_{25}$
6	80.00	20.00	$HQCF_{80}BNF_{20}$
7	60.00	40.00	$HQCF_{60}BNF_{40}$
8	70.00	30.00	$HQCF_{70}BNF_{30}$

2.6 Preparation of cookies

The recipe for the production of cookies is presented in Table 2. The method described by [10] was adopted with slight modification. The high-quality cassava flours, Bambara nut flour, sugar, simas margarine, cinnamon, egg, nutmeg, vanilla essence, baking powder, and a pinch of salt were thoroughly mixed at an appropriate rate in a large bowl to achieve homogenous mixing. Baking powder used in the formulation is a chemical leavening agent composed of sodium bicarbonate (the base), one or more acid salts (such as cream of tartar or monocalcium phosphate), and a filler like starch, which helps to prevent premature reaction and improve shelf stability.

When mixed with liquid and exposed to heat, the acid reacts with the base to release carbon dioxide gas, which forms air bubbles in the dough. This process causes the cookies to rise, resulting in a light, soft, and Evenly textured product. After mixing, the stiff dough was rolled tightly to 1cm thickness on a board and cut into a round shape. The baking oven was preheated at 180 °C, the cut dough was then baked at 190 °C for 10 min in an electric oven (Macadams, UK, model: Convecta B) until fully baked.

After baking, the cookies were allowed to cool for 1-2 min, packed, and sealed for subsequent analyses [1].

2.7 Sensory evaluation of the cookies

A total of fifty sensory panelists, comprising 35 females and 15 males, were trained in organoleptic assessment protocols for baked products.

The evaluators, consisting of interns and technical personnel from the Nigerian Stored Products Research Institute (NSPRI), Ilorin, Kwara State, Nigeria, were aged between 20 and 40 years. Approximately 70% of the panelists were actively pursuing tertiary-level education in

Table 2.

Recipe for the production of cookies

Sample	Sugar (g)	Margarine (g)	Baking Powder (g)	Egg (g)	Nutmeg (g)	Water (L)	Salt (g)	Cinnamon (g)	Vanilla essence (g)
$HQCF_{80}BNF_{20}$	50	100	5	90	1.5	54	2.0	0.5	2
$HQCF_{65}BNF_{35}$	50	100	5	90	1.5	54	2.0	0.5	2
$HQCF_{70}BNF_{30}$	50	100	5	90	1.5	54	2.0	0.5	2
$HQCF_{60}BNF_{40}$	50	100	5	90	1.5	54	2.0	0.5	2
$HQCF_{75}BNF_{25}$	50	100	5	90	1.5	54	2.0	0.5	2
$HQCF_{80}BNF_{20}$	50	100	5	90	1.5	54	2.0	0.5	2
$HQCF_{60}BNF_{40}$	50	100	5	90	1.5	54	2.0	0.5	2
$HQCF_{70}BNF_{30}$	50	100	5	90	1.5	54	2.0	0.5	2
$WF_{60}BNF_{40}$	50	100	5	90	1.5	54	2.0	0.5	2
WF_{100}	50	100	5	90	1.5	54	2.0	0.5	2

food-related disciplines. Cookie samples were wrapped in food-grade laminated aluminum foil to maintain product integrity and minimize oxidative degradation. Each sample was assigned randomized alphanumeric codes to ensure blind assessment and eliminate bias. Samples were presented for evaluation three hours post-baking, allowing for thermal equilibrium and optimal sensory readiness. Panelists conducted descriptive sensory profiling based on standardized attributes, including visual appearance, chromatic properties (color), olfactory quality (aroma), gustatory perception (flavor), mechanical characteristics (texture), and overall hedonic impression. The assessment was performed using a 9-point hedonic scale, under established sensory analysis frameworks [11]; [6], where: 1 = Dislike extremely, 5 = Neither like nor dislike, 9 = Like extremely.

2.8 Microbiological assay on the cookies

After baking and packaging, 25 g of each cookie sample was immersed in 225 mL of sterile water for 1h, after which a fivefold serial dilution was performed. From the diluted samples, one milliliter (1 mL) of the 10^{-3} dilution was aseptically transferred in duplicates and plated using the pour plate technique. Specific media were prepared according to the manufacturer's instructions, and the pour plate technique was employed for the culture and enumeration of microbial counts. These included total heterotrophic counts (on Nutrient Agar incubated at 30 °C for 24 h), total coliform counts (on MacConkey Agar incubated at 37 °C for 24 h), and total yeast and mold counts (on Potato Dextrose Agar incubated at 28 °C for 24-72 h). After incubation, the average number of colony-forming units (CFU) per gram of the sample was determined by counting the microbial colonies on both plates and multiplying by the dilution factor [12]; [13]; [14]. Identification of isolates was done using morphological and biochemical methods [15; 16].

2.9 Statistical analysis

Statistical tools of the Statistical Package for Social Scientists (SPSS version 25) were employed in analyzing data generated, and separation of significant means was done with the application of Duncan Multiple Range Tests (DMRTs).

3. Results and discussion

3.1 Consumer acceptability of cookies from high-quality cassava and bambara nut flour blends

Table 3 presents the sensory attributes of cookies made from composite flour comprising high-quality cassava flour (HQCF) and Bambara nut flour (BNF). The results revealed significant differences ($p < 0.05$) across the samples for attributes such as appearance, colour, aroma, taste, texture,

and overall acceptability. The cookies made with flour blends $HQCF_{60}BNF_{40}$ showed a high score for colour (8.00±0.17), which was comparable to the 100% wheat flour sample (WF_{100} or conventional wheat cookies).

This suggests that high-quality cassava flour and Bambara nut flour blends can produce visually appealing cookies.

The Maillard reaction between amino acids in Bambara nut and reducing sugars in high-quality cassava flour could likely have contributed to this improved colour that was observed by Adeola et al. [17] and Oladele et al. [18]. Aroma was rated highest in WF_{100} or conventional wheat cookies (7.64±0.24) and $HQCF_{70}BNF_{30}$ (7.08±0.26), indicating the positive influence of Bambara nut on the aroma profile. This aligns with Adebayo et al. [19], who noted that Bambara nut adds a characteristic nutty aroma due to its volatile compounds. Taste scores were also highest in WF_{100} (conventional wheat cookies) (7.60±0.25), followed closely by $HQCF_{60}BNF_{40}$ (7.40±0.25) and $HQCF_{75}BNF_{25}$ (7.28±0.36). The nutty flavour of Bambara nut is a likely factor, as supported by findings from Olagunju et al. [20]. Texture was most acceptable in WF_{100} (conventional) wheat cookies (7.32±0.33) and $HQCF_{60}BNF_{40}$ (7.12±0.31), indicating that BNF inclusion in the blend enhances mouthfeel and structural integrity.

Table 3.
Sensory attributes of cookies produced with blends of flour from cassava flour and bambara nut

Sample	Appearance	Colour	Aroma	Taste	Texture	Overall acceptability
$HQCF_{80}BNF_{20}$	6.52±0.31^{bc}	6.56±0.30^{bc}	6.20±0.25^{abc}	6.12±0.27^{ab}	5.40±0.33^{a}	6.48±0.25^{bc}
$HQCF_{65}BNF_{35}$	6.36±0.30^{b}	6.44±0.25^{b}	5.84±0.31^{ab}	5.92±0.33^{ab}	6.24±0.41^{abc}	6.16±0.32^{b}
$HQCF_{70}BNF_{30}$	7.36±0.28^{cd}	6.80±0.28^{bcd}	7.08±0.26^{cd}	7.20±0.30^{c}	6.68±0.34^{bc}	7.32±0.22^{cd}
$HQCF_{60}BNF_{40}$	7.08±0.30^{bcd}	6.92±0.23^{bcd}	6.56±0.37^{bc}	7.40±0.25^{c}	7.00±0.31^{c}	6.92±0.28^{bc}
$HQCF_{75}BNF_{25}$	7.36±0.35^{cd}	7.28±0.28^{bcde}	6.96±0.29^{cd}	7.28±0.36^{c}	6.48±0.31^{bc}	6.96±0.32^{bc}
$HQCF_{80}BNF_{20}$	7.12±0.36^{bcde}	6.76±0.29^{bcd}	6.24±0.37^{abc}	6.72±0.37^{bc}	6.92±0.25^{c}	6.48±0.37^{bc}
$HQCF_{60}BNF_{40}$	8.00±0.17^{de}	7.60±0.22^{de}	6.24±0.37^{abc}	7.16±0.30^{c}	7.12±0.25^{c}	7.28±0.26^{cd}
$HQCF_{70}BNF_{30}$	7.60±0.27^{de}	7.36±0.21^{cde}	6.96±0.30^{cd}	6.64±0.37^{bc}	6.44±0.37^{bc}	6.76±0.33^{bc}
$WF_{60}BNF_{40}$	5.48±0.43^{a}	5.52±0.48^{a}	5.48±0.40^{a}	5.52±0.43^{a}	5.76±0.43^{ab}	5.16±0.40^{a}
WF_{100}	8.08±0.23^{ae}	7.88±0.22^{e}	7.64±0.24^{d}	7.60±0.25^{c}	7.32± 0.33^{c}	8.12±0.19^{d}

Values are mean ± standard deviation. Mean values with different superscripts within the same column are significantly different at 5% level.

when combined with HQCF. This corroborates Ezeocha et al. [21], who reported that Bambara nut proteins improve the textural qualities of baked goods. Overall, the acceptability of the WF_{100} (conventional) sample was rated the most acceptable (8.12±0.19). However, blends such as $HQCF_{70}BNF_{30}$ (7.32±0.22) and $HQCF_{60}BNF_{40}$ (7.28±0.26) also showed high acceptability. These results confirm the potential of HQCF-BNF blends as functional

replacements for wheat flour Ayayi et al. [20]. $WF_{60}BNF_{40}$ exhibited significantly lower sensory scores across all attributes, indicating that the exclusion of HQCF adversely affected product quality. This poor performance may be attributed to reduced binding capacity and impaired flavour integration, resulting in suboptimal texture and overall acceptability Ayayi et al. [22].

3.2 Microbiological qualities of cookies from high quality cassava and bambara nut flour blends

The total viable counts of microbial load in cookies made from high-quality cassava flour (HQCF) and Bambara nut flour are

summarized in Table 4. The total heterotrophic bacterial count ranged from 2.0×10^3 to 4.7×10^5 CFU/g. The sample with 70% high-quality cassava flour and 30% Bambara nut flour had the highest bacterial load, while the 100% wheat flour sample (conventional wheat cookies) recorded the lowest, likely because the sample was produced and packaged under hygienic conditions. Probable bacterial species include *Bacillus* spp. and *Pseudomonas* spp. The total coliform count ranged between 1.0×10^3 and 2.2×10^5 CFU/g. The sample containing 65% high-quality cassava flour and 35% Bambara nut flour exhibited the highest coliform level, while the 100% wheat flour sample (conventional wheat cookies) showed the lowest. Probable coliforms identified include *Enterobacter aerogenes*, *Klebsiella* spp., and *Escherichia coli*. Contamination may have occurred through food handlers. The persistence of high total coliform counts could be associated with post-baking contamination during cooling or handling, or may be attributed to ineffective packaging or storage under unfavorable conditions, as reported by Ali et al. [23]. The total fungal count ranged from 0 to 5.2×10^5 CFU/g.

The sample containing 80% high-quality cassava flour and 20% Bambara nut flour had the highest fungal count, whereas the 100% wheat flour sample (conventional wheat cookies) recorded the lowest. Likely fungal species include *Saccharomyces cerevisiae* and *Candida* spp. The maximum permissible limits for baked products (cake, bread, and biscuits) are $<10^5$ CFU/g for total plate count (TPC), $<10^4$ CFU/g for yeasts and moulds, and < 200 MPN/g for total coliforms as noted by Ali et al. [23].

Table 4.
Microbial properties of cookies produced with blends of flour from cassava and bambara nut

Samples	Total heterotrophic counts (cfu/g)	Total coliform counts (cfu/g)	Total fungal counts (cfu/g)
$HQCF_{80}BNF_{20}$	2.0×10^3	1.0×10^3	0
$HQCF_{65}BNF_{35}$	$3{,}1 \times 10^5$	2.2×10^5	2.7×10^5
$HQCF_{70}BNF_{30}$	0	7.0×10^3	1.0×10^3
$HQCF_{60}BNF_{40}$	5.4×10^4	1.6×10^4	6.0×10^3
$HQCF_{75}BNF_{25}$	5.1×10^4	5.6×10^4	1.4×10^4
$HQCF_{80}BNF_{20}$	4.4×10^5	9.6×10^4	5.2×10^5
$HQCF_{60}BNF_{40}$	1.9×10^5	1.0×10^5	1.4×10^5
$HQCF_{70}BNF_{30}$	4.7×10^5	1.3×10^5	2.7×10^5
$WF_{60}BNF_{40}$	1.9×10^5	1.3×10^5	2.5×10^5
WF_{100}	9.0×10^3	1.2×10^5	3.1×10^5
Control	0	0	0

Also, the observed microbial levels of heterotrophic bacteria and fungi align with international and national food safety guidelines, remaining within permissible limits of 10^4 to 10^6 CFU/g according to ICMSF [24]. In this study, it was observed that the control agar plates for all tested parameters, including total bacterial count (TBC), total fungal count, and total coliform count, showed no microbial growth. This confirms that the microbial analyses were conducted under sterile laboratory conditions.

4. Conclusion

This study demonstrates that cookies made with up to 40% Bambara nut flour in HQCF blends can achieve comparable sensory qualities to conventional wheat cookies. This supports the promotion of underutilized legumes like Bambara nut in functional food applications. The

microbiological evaluation of all cookie samples revealed elevated total coliform counts, which are generally not expected in baked products and may indicate post-processing contamination or hygiene deficiencies. The heterotrophic bacteria and fungi were within international and national food safety guidelines, remaining within permissible limits. The 100% wheat flour sample (conventional wheat cookies) consistently demonstrated the lowest microbial counts, indicating the highest level of sterility among the samples, followed by the sample containing 65% high-quality cassava flour and 35% Bambara nut. Health education is recommended to ensure the proper handling of bakery products. Further studies are recommended for monitoring the presence of antimicrobial resistance genes in these products.

5. References

[1]. ALIMI, J.P., AHEMEN, S.A., ALIMI, J.O., YEPSHAK, N. B., AND OKE, O.A. Physical and sensory qualities of cookies produced with high-quality cassava flour from low postharvest physiologically deteriorated cassava. *Journal of Current Research in Food Science,* 3(2): 50-54, (2022). Retrievable on https://www.foodresearchjournal.com/archives/2022.v3.i2.A

[2]. AYOADE, L. A., OYEYINKA, S. A., & OLATUNDE, G. O. Development and quality evaluation of cookies from cassava and Bambara nut composite flour. *Journal of Culinary Science &Technology*, 19(4), 341–355, (2021). https://doi.org/10.1080/15428052.2020.1762167

[3]. SHITTU, T. A., LASEKAN, O. O., & ADEBOWALE, A. A. Functional and sensory properties of cookies from cassava and legume flour blends. International Journal of Food Science and Technology, 55(6), 2658–2665, (2020) https://doi.org/10.1111/ijfs.14438

[4]. ALIMI JOHN PRAISE, AKANNI ABUBAKAR ADEGBOYEGA, ALIMI JANET OMOLOLA, AYANDA, IFEDAPO SOLOMON, OMOPARIOLA MODUPE FOLASHAYO, and OLEDIBE CHIOMA FRANCISCA. "Proximate and Physical Properties of Tidbits Produced with Flour from Cassava and Bambara Nut". *European Journal of Nutrition & Food Safety* 17 (7):197-212, (2025) https://doi.org/10.9734/ejnfs/2025/v17i71778.

[5]. IJAROTIMI, O. S., & KESHINRO, O. O., Nutritional potential and sensory acceptability of functional cookies from Bambara groundnut and cassava flour. *Heliyon*, 8(3), e09021 (2025). https://doi.org/10.1016/j.heliyon.2022.e09021

[6]. ALIMI, J.P., OTITODUN, O.G., AKANNI, A.A., JIMOH, M.O., ADEGBOLA, R.Q., HARUNA, P.B., AKANDE, E.J., ISHOLA, D.T., AJAYI, O.A., YISSA, A.I. & ODUTOLA, B.S. "Quality Characteristics of Cake Produced with Blends of Flour from Bambara Nut Seeds (*Vigna Subterranea*) and Cassava (Manihot Esculenta). *Asian Food Science Journal*, 23(12):99-116, (2024). https://doi.org/10.9734/afsj/2024/v23i12762.

[7]. OCHEME, O. B., ADEDEJI, O. E., & IBRAHIM, S. Microbiological and sensory evaluation of cookies from composite flour of wheat, cassava, and Bambara nut. *Nigerian Journal of Food Science and Technology*, 39(1), 12–20, (2021).

[8]. JAMES, S., NWOKOCHA, L., JAMES, Y., ABDULSALAM, R. A., AMUGA, S. J., & IBRAHIM, I. B. Chemical composition and sensory acceptability of partially gelatinized pasta produced from blends of wheat, Bambara nut, and cassava flours. *Agro-Science*, 16, 26–30, (2018).

[9]. LYIMO, M. E., BERLING, S., & SIBUGA, K. P. Evaluation of the nutritional quality and acceptability of germinated Bambara nut (Vigna subterranea (L.) Verdc) based products. *Ecology of Food and Nutrition*, 43(3), 181–191, (2004). https://doi.org/10.1080/036702404904467 95

[10]. GUL K, BALA A, SINGH RIAR1 C., Functional and sensory properties of cookies prepared from wheat flour supplemented with cassava and water chestnut flours. *Cogent Food and Agriculture*. 2015; 1:10-12.

[11]. IWE, M.O. Handbook of sensory methods and analysis. Ro Joint Communication Service Ltd, Enugu. 2002;78-82.

[12]. ALIMI, J. O., OGUNBANWO, S. T., ALIMI J. P., GBADAMOSI, T. A. & ADARABIERIN, I. G. Influence of Cell-free Supernatant of Lactic Acid Bacteria as an Additive in the Preservation of Pineapple Juice. *Food and Environment Safety Journal*, Vol. 24, No. 1, (2025). Available at: https://fens.usv.ro/index.php/FENS/article/view/1313

[13]. MEDALCHO, T., NIGUSSE, G., AND BANERJEE, S. Assessment of Beef Meat Handling, Physicochemical and Bacteriological Properties of Selected Butcheries in Hawassa City, Ethiopia. SINET Ethiopia. *Journal of Science*. 44, 62–73, (2021), https://doi.org/10.4314/sinet.v44i1.6

[14]. ONYEMATA, E.K., and IBRAHIM, R.O. Isolation and identification of fungi and

pathogenicity assessment of some spoiled fruits sold in Wuse market, Abuja, Nigeria. *International Journal of Current Research*. 10(12), 76256-76259, (2018).

[15]. OLUTIOLA, P.O., FAMUREWA, O., SONNTAG, H. G. An Introduction to General Microbiology: a practical approach. Heldelbayer Verlag, Sansalfund Druckard GmbH, Heldeberg, Germany, p. 267. (1991).

[16]. ROBERT A. SAMSON, ELLEN S. HOEKSTRA, JENS C. FRISVAD, OLE FILTENBORG. Introduction to Foodborne Fungi, Fourth revised edition, pp. 84, 222. (1995).

[17]. ADEOLA, A. A., OKOYE, C. O., & OLATUNDE, G. O. Effect of composite flours on the functional and sensory properties of cookies. Food Science & Nutrition, 8(7), 3845–3853, (2020).https://doi.org/10.1002/fsn3.1649

[18].OLADELE, A. K., & AINA, J. O. Consumer perception and sensory evaluation of cookies made from cassava and legume blends. Future Foods, 3, 100902. (2021). https://doi.org/10.1016/j.fbio.2020.100902

[19]. ADEBAYO, S. E., & AZEEZ, L. A. Aroma and flavour profiling of cookies enriched with Bambara groundnut. Journal of Food Measurement and Characterization, 16(5), 2890–2901, (2022).

OLAGUNJU, A. I., AFOLABI, W. A. O., & OLUBOYO, M. A. Nutritional and functional potential of Bambara groundnut in bakery products. Nigerian Journal of Food Science and Technology,41(2),152–160, (2023).

[20]. EZEOCHA, V. C., OBI, F. O., & UGOCHUKWU, S. C. Protein–starch interactions in composite flours: Effect on texture of baked products. *International Journal of Food Science*, 2022, Article ID9346578.https://doi.org/10.1155/2022/9346578

[21]. AJAYI, S. A., OYEBANJI, O. T., & OGUNYEMI, C. E. Limitations of Bambara nut flour in wheat composite cookies. African Journal of Food Science, 17(3), 52–60, (2023)

[22]. ALI MANUAL A., HASHISH MONA H, AND FEKRY MARWA M. Microbiological quality of some packed and unpacked bread products in Alexandria, Egypt. J*ournal of the Egyptian Public Health Association. 98:16* (2023). https://doi.org/10.1186/s42506-023-00141-9

[23]. International Commission for the Microbiological Specifications for Foods. Microbiological Testing in Food Safety Management, Springer US Publishers, pp 125-128, (2006). USA.