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Comparative Evaluation of Black and Brown Sesame (*Sesamum indicum L.*) Varieties in the Development of Novel Food Products

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ABSTRACT

Sesame (*Sesamum indicum L.*) is a nutrient-rich oilseed crop with recognized health benefits, yet its utilization in innovative food products remains limited. This study aimed to develop sesame-based products and assess their microbial safety and consumer acceptance. Black and brown sesame varieties were processed into three products: sesame butter, sesame brittle, and sesame polvoron. Microbial testing was conducted at the Department of Science & Technology–Regional Standards and Testing Laboratory to ensure food safety, followed by a single-blind sensory evaluation with 75 respondents using a nine-point hedonic scale. Brown sesame butter demonstrated the highest overall acceptance, particularly in terms of taste and aroma, outperforming both Black sesame butter and the commercial control. For sesame brittle, only the brown variety passed microbial testing. While the commercial control was generally preferred, the brown brittle scored comparably in terms of aroma and texture. In contrast, only black sesame polvoron met microbial safety standards, but it was consistently rated lower than the control across sensory attributes. Results indicate that consumer acceptance varied by product and sesame variety, with brown sesame being generally preferred for butter and brittle, and black sesame being viable only for polvoron. The study highlights the pivotal role of microbial safety and sensory attributes (taste, texture, aroma, and above all, visual appeal) in the evaluation of consumer acceptance. As such, the results indicate that sesame seeds have good potential for product innovation, although their successful commercialization relies on the convergence of product level with customer perception.

Keywords: *sesame seeds, sesame butter, sesame brittle, sesame polvoron, comparative evaluation*

Introduction

Sesame is a self-pollinating annual plant of the genus Sesamum, one of the fundamental oilseed crops around the globe. Wei et al. (2022) reported on sesame seed nutrient data, showing protein and fat as major components of sesame seeds. Other constituents such as sesaminol, lignan glucosides, and sesame lignans have been proven to give antioxidative, anti-inflammatory, antihypertensive, neuroprotective, and cholesterol-lowering capacities (Cheng et al., 2006; Jiang & Ames, 2003; Lee et al., 2004; Nakano et al., 2003; Suja et al., 2005; Visavadiya & Narasimhacharya, 2008). Sesame meal, with 45–55% protein content alone, is one of the valuable proteins that can be consumed by humans because of its amino acids, rich in sulfur.

Further, sesamolin has also shown inhibition for the leukemia cell expansion (Miyahara et al., 2021), and consumption of sesame improves antioxidant status, blood lipids, and sex hormones in postmenopausal women (Wu et al., 2006). However, sesame is still rarely used in the Philippines because local sesame was mainly produced on a small scale, and little value-added processing was applied.

Although other studies also investigate the use of sesame-rich products as protein bars (Irshad et al., 2023), there is little exploration or other research on innovative sesame-based foods designed specifically to meet the requirements of the Filipino consumer. This gap demonstrates the importance of investigating product innovation using indigenous sesame varieties. That was why the current research was developed by the Department of Research and Development of Isabela State University–Cabagan to produce sesame-based products such as sesame butter, sesame brittle, and sesame polvoron by using the black and brown sesame varieties. The microbial safety and user acceptance were both evaluated by a single-blind sensory study.

By aligning sesame nutritional potential with product innovation, this study seeks to expand usage, sustain farmers, and inform consumer preferences, particularly the role of sensory attributes and visual appeal on food acceptance.

Methods

Materials

Black and brown sesame seeds were sourced from the project "Development of Production Protocols for Local Sesame Varieties" at Isabela State University–Cabagan. Other ingredients included refined white sugar, powdered milk, all-purpose flour, glucose syrup, margarine, and unsalted butter, all purchased locally. Equipment used included roasting pans, food processors, mixing bowls, saucepans, spatulas, baking sheets, polvoron molds, and airtight storage containers.

Product Processing

Product development involved systematic adjustments of ingredient ratios, processing times, and storage conditions to achieve acceptable sensory and microbial outcomes. Each product formulation was replicated three times to ensure consistency.

Sesame Butter

Black and brown sesame seeds were dry-roasted at 150°C for 10 minutes until fragrant. Seeds were cooled and ground in a food processor for 5–10 minutes until smooth. Oil and salt were added incrementally to adjust consistency and flavor. Variations in roasting time (8–12 minutes) and oil quantity (5–15 mL per 100 g seeds) were tested to optimize texture and taste.

Sesame Brittle

Brown sesame seeds were dry-roasted at 160°C for 8 minutes. Syrup was prepared by heating sugar and glucose to 145°C (hard crack stage). Toasted seeds were mixed into the syrup, spread on a greased surface, and flattened to a 3–5 mm thickness before cutting. Adjustments included varying syrup temperature (140–150°C) and seed-to-sugar ratios (1:1 to 1:1.5).

Sesame Polvoron

Black sesame seeds were roasted at 150°C for 7 minutes. Toasted seeds were blended with powdered milk, flour (toasted at 120°C for 10 minutes), sugar, and melted butter. Mixtures were molded into 10–12 g portions and wrapped. Adjustments included varying flour-to-sesame ratios (1:1 to 1:2) and chilling times (30–60 minutes).

Microbial Analysis

Samples were submitted to the Department of Science & Technology–Regional Standards and Testing Laboratory (DOST-RSTL). Standard plate count methods were used to determine Escherichia coli, coliforms, yeast, and mold counts. Results were expressed in CFU/g or MPN/g, compared against Philippine food safety standards. A limitation of this study was the absence of Salmonella testing, a critical pathogen in sesame-based products.

Sensory Evaluation

A single-blind sensory assessment involving 75 participants, comprising students, staff, and community members, was performed. Using a nine-point hedonic scale, participants rated the products, including taste, texture, aroma, and appearance. Descriptive statistics were used to describe the preferences. The nine-point hedonic scale has proven an excellent method for sensory assessment by which researchers can measure consumers' likes, dislikes, and appetites of food products. Its importance resides in the rich information it provides, which may be particularly helpful in the context of consumer attitudes, and such insights are necessary for product development, quality control, and market success. The following scales and their interpretations were used.

Table 1. Scale and Interpretation for Sensory Evaluation Result

Scale	Interpretation
8.13- 9.00	Like Extremely (LE)
7.34-8.12	Like Very Much (LV)
6.45-7.33	Like Moderately (LM)
5.56-6.44	Like Slightly (LS)
4.57-5.55	Neither Like nor Dislike (N)
2.79-3.67	Dislike Moderately (DM)
1.90-2.78	Dislike Very Much (DV)

Ethical Considerations

A significant contributing factor to the ethical construction of the project was that the researchers ensured the safety of food by verifying microbial testing, getting informed consent from sensory evaluation participants, respecting participants' privacy, honesty in reporting the outcomes, respecting cultural dietary preferences, and responsible sourcing of sesame seeds.

Results and Discussion

Microbial Analysis

Both quantitative findings from microbial testing confirmed product safety and also illustrated differences between black and brown sesame varieties. Microbial safety also differed widely per sesame variety and product type. Black sesame exhibited more stability in butter and polvoron, and brown sesame was safer in brittle. These results show that the formulation and processing of the sesame mix may interact with diversity in the system to influence microbial quality status. The most important limitation of the present study is that Salmonella was not tested. Since Salmonella is an established threat to sesame foods, the omission of Salmonella limits the microbial safety assessment. Pathogen-specific analyses should be performed in subsequent studies to enhance food safety assessments.

Since black sesame is more suitable for butter and polvoron production (Table 1), black sesame seems suitable in the future, given its microbial stability. Nevertheless, the high microbiological levels characteristic of some products indicate that stringent hygiene, optimum storage, and frequent pathogen monitoring are required to mitigate the threat to consumers. The observations will help to develop products and quality control in the preparation of sesame-based foods, which can potentially help food manufacturers.

Table 2. Microbial Analysis Results of Sesame Butter

Sample Description	Test Method	Result	Remarks
Sesame Butter (Black)	Escherichia coli Count	<3.0 MPN/g	*
	Aerobic Plate Count	<25x101*CFU/g	*
	Total Coliform Count	<3.0 MPN/g	*
	Yeast and Molds	<10x101* CFU/g	*
Sesame Butter (Brown)	Escherichia coli Count	<3.0 MPN/g	*
	Aerobic Plate Count	8.3 x 102*CFU/g	**
	Total Coliform Count	<3.0 MPN/g	*
	Yeast and Molds	2.4 x102* CFU/g	**

Legend: * *Low count* ** *Moderate count* ****High count*

Microbiological Quality of Sesame Butter

The microbial content of sesame butter has been studied, and the microbial profile of black and brown sesame butter samples demonstrated that the strains of *E. coli* and coliform bacteria levels were below 3 MPN/g, and the sample levels satisfied food safety (see Table 2). For the black sesame butter, aerobic plate counts were less than 250 CFU/g, and yeast and mold levels were also below 100 CFU/g. This indicates an excellent microbial stability of the black variant. On the contrary, brown sesame butter experienced an increase in aerobic plate counts to 8.3×10^2 CFU/g, yeast and mold counts 2.4×10^2 CFU/g, indicating that the brown variant presents a high risk of microorganism spoilage in storage.

Table 3. Microbial Analysis Results of Sesame Brittle

Sample Description	Test Method	Result	Remarks
	Escherichia coli Count	<3.0 MPN/g	*
Sesame Butter (Black)	Aerobic Plate Count	<4.8 x 102*CFU/g	**
	Total Coliform Count	15 MPN/g	*
	Yeast and Molds	<10 x 101* CFU/g	*
Sesame Butter (Brown)	Escherichia coli Count	<3.0 MPN/g	*
	Aerobic Plate Count	4.3 x 104*CFU/g	*
	Total Coliform Count	240 MPN/g	*
	Yeast and Molds	9.1 x 104* CFU/g	***

Legend: * *Low count* ** *Moderate count* ****High count*

Microbiological Quality of Sesame Brittle

Brown sesame brittle was microbiologically safe (E. coli < 3 MPN/g and yeast/mold counts < 100 CFU/g), as depicted in Table 3. However, black sesame brittle had a yeast/mold count of 9.1×10^4 CFU/g (unacceptable levels), making it unsafe to use. This explains to some extent the influence of sesame variety on the product stability, especially under storage conditions.

Table 4. Microbial Analysis Results of Sesame Polvoron

Sample Description	Test Method	Result	Remarks
	Escherichia coli Count	<3.0 MPN/g	*
Sesame Butter (Black)	Aerobic Plate Count	<7.4 x 1014*CFU/g	*
	Total Coliform Count	>1100 MPN/g	***
	Yeast and Molds	<1.0 x 1013* CFU/g	*
Sesame Butter (Brown)	Escherichia coli Count	<3.0 MPN/g	*
	Aerobic Plate Count	<4.8 x 101*CFU/g	*
	Total Coliform Count	75 MPN/g	*
	Yeast and Molds	2.7 x 102* CFU/g	*

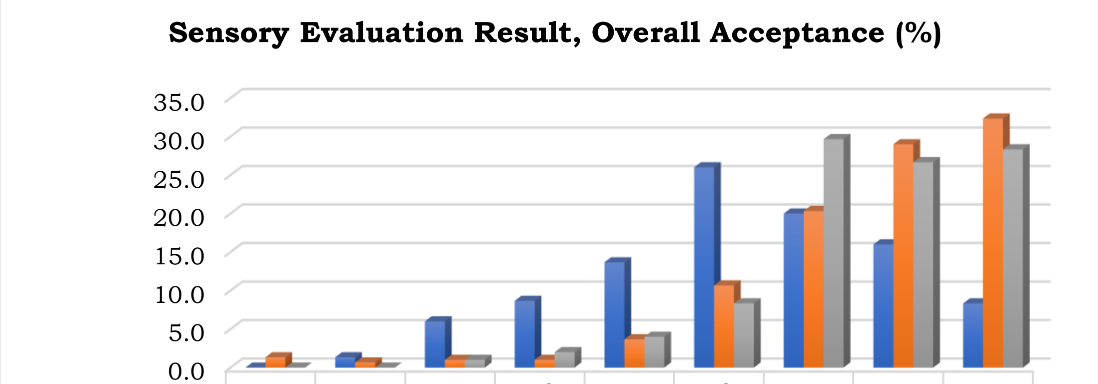
Legend: * *Low count* ** *Moderate count* ****High count*

Microbiological Quality of Sesame Polvoron

Black sesame polvoron showed low aerobic plate counts (75 CFU/g) and moderate yeast/mold counts (2.7 × 10^2 CFU/g), indicating acceptable microbial quality as presented in Table 3. Conversely, the brown variant exhibited a markedly high coliform count (>1100 MPN/g), raising concerns about contamination risk and potential food-safety compromise.

Sensory Evaluation

A single-blind sensory evaluation involving 75 respondents assessed taste, texture, aroma, and appearance using a nine-point hedonic scale of the different sesame-based products developed (Figure 2). The overall acceptance varied by product and sesame variety is presented in Figure 1.



	DE	DV	DM	DS	N	LS	LM	LV	LE
BLACK	0.0	1.3	6.0	8.7	13.7	26.0	20.0	16.0	8.3
BROWN	1.3	0.7	1.0	1.0	3.7	10.7	20.3	29.0	32.3
CONTROL	0.0	0.0	1.0	2.0	4.0	8.3	29.7	26.7	28.3

Figure 1. *Overall Sensory Evaluation Results for Sesame Butter*

For sesame butter, the brown sesame achieved the highest acceptance with 32.3% of panelists rating it "like extremely" and 29% "like very much". The commercial control followed closely, and black sesame butter was less favored, particularly for texture and aroma. In the brittle trials (brown brittle only), the commercial control received higher overall ratings (37% "like extremely"). However, brown brittle equaled the control in aroma (34.7%) and performed strongly in texture (32% "like extremely"). For polvoron, only the black sesame sample passed microbial testing, yet it scored consistently lower than the control across all sensory attributes. These results indicate that consumer preferences are driven by multiple sensory attributes: brown sesame was generally preferred for butter and brittle, while black sesame showed limited viability except for polvoron. Appearance notably influenced acceptance—especially for butter, where brown variants were visually preferred.

Figure 2. *Sesame-Based Products Developed Through the Project (Black and Brown Sesame Butter, Sesame Polvoron, and Sesame Brittle)*

Table 5. Simple Costing of Black Sesame Butter

Ingredients	Quantity (g)	Purchase Cost (₱)	Unit Cost (₱)	Total Cost (₱)
Sesame Seeds	150	380/kg	0.38	57
Refined Sugar	100	105/kg	0.105	10.50
Vegetable Oil	144	114/lit	0.114	16.42
Peanut Butter Jar	1		12	12
Recipe Yield at 250g/bottle				
Total Recipe Cost	96.00			
Recipe Cost Adjustment	4.79			
Percentage Cost (adjustable)	33.57			
Recipe Cost Adjustment	134.28			
Cost Per Portion/Unit Cost	135			

Table 6. Simple Costing of Brown Sesame Butter

Ingredients	Quantity (g)	Purchase Cost (₱)	Unit Cost (₱)	Total Cost (₱)
Sesame Seeds	150	260/kg	0.26	39
Refined Sugar	100	105/kg	0.105	10.5
Vegetable Oil	144	114/lit	0.114	16.42
Peanut Butter Jar	1		12	12
Recipe Yield at 250g/bottle				
Total Recipe Cost	78.00			
Recipe Cost Adjustment	3.89			
Percentage Cost (adjustable)	27.27			
Recipe Cost Adjustment	109.08			
Cost Per Portion/Unit Cost	110.00			

The cost-and-return analysis indicates that brown sesame butter is the most commercially attractive product, combining the lowest cost per serving of Php. 78.00 (Table 6) with the highest gross margin, which supports prioritizing it for scale-up and market entry. This finding aligns with studies showing that optimized roasting and heat treatment improve tahini (sesame butter) physicochemical properties and consumer acceptability, thereby supporting premium positioning when processing is controlled (El-Adawy & Mansour, 2000).

Table 7. Simple Costing of Brown Sesame Brittle

Ingredients	Quantity (g)	Purchase Cos (₱)	Unit Cost (₱)	Total Cost (₱)
Sesame Seeds	35.5	260/kg	0.26	9.23
Refined Sugar	120	44/kg	0.04	5.28
Refined Salt (pinch/tsp)	1.5	30/kg	0.03	0.05
Butter	58	54/200 g	0.27	15.66
Baking Soda	1.25	15.5/50g	0.31	0.39
Microwaveable Plastic (pcs)	5	50/10 pcs	5.00	25.00
Recipe Yield at 75g/2 packs				
Total Recipe Cost	55.60			
Recipe Cost Adjustment	2.78			
Percentage Cost (adjustable)	19.46			
Adjusted Recipe Cost:	77.84			
Cost Per Portion/ Unit Cost:	38.00			
Cost Per Pack:	78.00			

Sesame brittle's favorable sensory attributes, particularly texture and aroma, suggest it can be marketed as a premium snack, but its higher cost per serving, Php. 38.00 of (Table 7) means packaging and marketing must justify a higher price; similar formulation work on sesame-enriched bars shows that balancing seed content with binders and sweeteners preserves nutritional benefits while maintaining acceptable sensory scores (Irshad et al., 2023).

Sesame polvoron's weaker unit economics (Table 8) and lower sensory acceptance indicate a need for recipe reformulation or artisanal positioning unless production efficiencies or price premiums can be achieved. Economic analyses of sesame value chains emphasize that raw-material price volatility and production scale are primary determinants of profitability, which corroborates our sensitivity results showing that a 10% rise in sesame seed cost substantially compresses margins (Dossa et al., 2023).

From a food-safety and shelf-life perspective, the literature underscores the importance of controlled processing and packaging to limit oxidative deterioration and preserve phytochemicals, both of which affect product acceptability and storage costs (Elsafy et al., 2024). Moreover, documented occurrences of Salmonella in sesame products and formal risk assessments recommend routine pathogen screening and post-processing controls to ensure market access and consumer safety (Barmettler et al., 2025; Food Standards Australia New Zealand, 2023). Together, the empirical results and supporting literature validate brown sesame butter as the priority product for scale-up, identify brittle as a promising premium offering contingent on cost control, and indicate that polvoron requires targeted reformulation or niche marketing before broader commercialization.

Table 8. Simple Costing of Black Sesame Polvoron

Ingredients	Quantity (g)	Purchase Cost (₱)	Unit Cost (₱)	Total Cost (₱)
Sesame Seeds	35.5	380/kg	0.38	13.49
All-purpose Flour	120	44/kg	0.044	5.28
Refined Sugar	100	105/kg	0.105	10.5
Butter	58	54/200g	0.27	15.66
Packaging (self-adhesive cookie bag)		50/50	1	50
Microwavable Plastic (pcs)		50/10 pcs	5	25
Recipe Yield: 50 pcs. @ 10 pcs./pack				
Total Recipe Cost	120.00			
Recipe Cost Adjustment	5.99			
Percentage Cost (adjustable)	41.97			
Adjusted Recipe Cost:	167.90			
Cost Per Portion/Unit Cost:	3.36			
Cost Per Pack:	33.58			

Conclusion and Future Works

This research indicated the advantages of local black and brown sesame varieties for new-based sesame butter, brittle, and polvoron foods, and the significance of microbial safety and sensory attributes in the production of new products for consumption by consumers. The brown sesame butter was considered the preferred product to provide high scores as a taste, aroma, and appearance criterion, which was in line with existing studies, demonstrating how consumers' food choices are influenced by both aesthetics and sensory cues (Sheng, 2024; Vermeir & Roose, 2020). Brown sesame brittle exhibited potential in the field of texture and aroma, but it was less preferred than the commercial control, and black sesame polvoron was safe in a microbial safety test, but not appreciated in sensory evaluation.

Results highlight this important issue by explaining how microbial safety significantly affects product viability, which highlights food safety issues raised by recent research reports in sesame processing, where pathogens like Salmonella remain a risk (Food Standards Australia New Zealand, 2023). In the future, the processing methods may have to be optimized to minimize microbial loads, as well as improve roasting and storage conditions and pathogen testing to meet international food safety standards (FAO, 2023). Introducing more products with sesame in foods, such as snacks, spreads, and beverages, may lead to increased market demand, which aligns well with the new developments in sesame-enriched protein bars (Irshad et al., 2023). Additionally, packaging and marketing strategies that promote nutritional effects and include a visual design signal can also enhance consumer acceptance (Costa et al., 2024). Finally, further shelf-life studies, cost-return analysis, and the application of inferential statistics for sensory evaluation are suggested to improve scientific rigor and market feasibility, so the development of sesame products will be relevant for local agricultural value chains as well as public health.

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Conflict of Interest

No relevant conflicts of interest are declared by the researchers. The study focused exclusively on product development, testing, and evaluation, and no related financial, commercial, or personal relationships influenced the research outcomes or interpretations.

Artificial Intelligence (AI) Declaration Statement

This manuscript was constructed with the help of an artificial intelligence (AI) tool such as ChatGPT, which assisted in synthesizing literature, refining language, and enhancing the structure and clarity of the text. The AI tool did not provide any original data, perform analyses, or influence the interpretation of results. The results, tables, and conclusions are all compiled exclusively based on the authors' research and source materials. The extent of the AI role was limited to editing support, and the integrity of the scientific content is entirely the authors' responsibility.