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Saba Banana (*Musa balbisiana*) Flour-based Soup Noodles Enriched with Alugbati (*Basella alba L.)* Powder

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Abstract

This study aimed to develop and evaluate Saba banana (*Musa balbisiana*) flour–based soup noodles enriched with Alugbati (*Basella alba L.)* powder in terms of formulation, sensory acceptability, nutritional composition, shelf life, and economic viability. Grounded in functional food theory and composite flour technology, the study employed a Randomized Complete Block Design involving five formulations and seventy-five respondents composed of trained and untrained panelists. Sensory evaluation was conducted using the Nine-point Hedonic Scale, while proximate analysis determined moisture, protein, fat, fiber, ash, and carbohydrate content. Statistical analysis using ANOVA and Tukey HSD identified significant differences among treatments. The findings revealed that all formulations were generally acceptable, with formulation F1 obtaining the highest ratings across color, aroma, taste, firmness, and overall acceptability. Nutritional analysis showed increased dietary fiber and mineral content with higher substitution levels, while protein, moisture, and lipid contents slightly decreased, and carbohydrate levels remained stable. Shelf-life assessment indicated that the product remained acceptable for up to two days under ambient conditions. Cost and return analysis confirmed that all formulations were economically viable, with F1 identified as the most cost-efficient and suitable for commercialization. The study concluded that moderate substitution provides optimal sensory quality, nutritional enhancement, and economic feasibility, although shelf-life limitations require further improvement. This study supports SDG 2 (Zero Hunger), SDG 3 (Good Health and Well-Being), SDG 8 (Decent Work and Economic Growth), and SDG 12 (Responsible Consumption and Production) by promoting nutrient-enriched food products, reducing post-harvest losses, and encouraging efficient utilization of locally available agricultural resources. It contributes to socio-economic and community sustainability by enhancing food security, supporting value-added processing, and strengthening small-scale enterprise development through sustainable food innovation.

Keywords: Alugbati powder; Banana flour; Composite flour noodles; Nutritional composition; Sensory acceptability; Shelf life

1. Introduction

Banana-based food innovation presents a practical response to rural challenges such as post-harvest losses, limited livelihood opportunities, and nutritional deficiencies. The transformation of Saba banana (*Musa balbisiana*) into flour and its integration with nutrient-rich Alugbati (*Basella alba L.*) in a culturally familiar product like noodles offers a pathway toward nutrition-sensitive, community-based enterprise development. Given the widespread consumption and adaptability of noodles, this study investigates the formulation, acceptability, nutritional value, and enterprise potential of Saba banana flour–based soup noodles enriched with Alugbati powder, linking food science innovation with rural development and sustainability.

1.1 Background of the Study on Saba Banana–Alugbati Soup Noodle Innovation for Community Livelihood

Banana-based innovations provide an opportunity to convert underutilized agricultural produce into shelf-stable, nutrient-rich products that support both nutrition and income generation. The use of Saba banana as flour addresses wheat dependency while enabling local food processing initiatives (Department of Agriculture, 2023). Noodles serve as a suitable platform due to their cultural familiarity, market demand, and adaptability to ingredient substitution. Banana flour has gained attention for its functional properties, including high starch and dietary fiber content, making it suitable for processed foods such as noodles (Kumari et al., 2023; Journal of Environmental and Food Research, 2025). In banana-producing areas like Region II, the abundance of Saba banana provides a reliable raw material for value-added processing, reducing post-harvest losses and enhancing rural livelihoods (Department of Agriculture, 2023; Ohagan, 2023). Alugbati (*Basella alba L.*), widely cultivated in Philippine households, complements banana flour due to its rich nutritional profile, including vitamins, minerals, and antioxidants (GSC Biological & Pharmaceutical Studies, 2024). Its integration into food products enhances micronutrient content while supporting local agricultural systems.

1.2 Themes and Insights from Related Literature on Banana Flour, Alugbati, and Fortified Noodles

Existing literature highlights the functional and nutritional benefits of both Saba banana and Alugbati. Studies show that banana flour improves dietary fiber and functional properties in food systems (Kumari et al., 2023), while Alugbati enhances micronutrient content and antioxidant capacity (Soriano et al., 2020; Felicilda, 2025; Bagabaldo et al., 2023). Research on fortified noodles demonstrates that incorporating local ingredients such as banana, cassava, and vegetables can improve nutritional quality without compromising acceptability when properly formulated (Balmurugan et al., 2022; Mabesa, Rodriguez, and Dizon, 2020; Dela Cruz and Panganiban, 2023). However, excessive substitution may affect texture and cooking properties (Zhang, Liu, and Chen, 2021). Sensory acceptability studies indicate that consumer preference depends on taste, texture, color, and familiarity, with moderate fortification levels yielding higher acceptance (Santos and Lee, 2021; Rahman, Yusoff, and Hassan, 2022). Cultural integration of noodles, particularly in Filipino cuisine, further supports their suitability as a vehicle for food innovation (Mercado & Andalecio, 2020; Coballes, 2022).

1.3 Local, National, and Global Context of Banana–Vegetable Fortified Noodles

Globally, noodles have evolved as a staple food with diverse formulations using locally available ingredients (National Geographic, 2022; Freeman, 2015). In the Philippines, noodles (pancit) hold cultural and social significance, symbolizing longevity and community cohesion (Mercado & Andalecio, 2020). Locally, banana cultivation is widespread in Region II, providing opportunities for value-added processing (Balderama, 2012). The integration of local crops such as Saba banana, Alugbati, and cassava aligns with national efforts to promote food security, reduce import dependence, and support rural economies (Department of Agriculture, 2023; Agricultural Training Institute, 2021). Community-based nutrition programs, including the use of cassava-based Sagip Nutri Powder, demonstrate the feasibility of localized food interventions to address malnutrition (Department of Agriculture–Region II, 2022). However, their application in composite food systems such as noodles remains limited.

1.4 Theoretical and Conceptual Basis on Composite Flour and Functional Food Development

This study is grounded in functional food theory and composite flour technology, which emphasize enhancing staple foods with nutrient-dense ingredients to improve health outcomes. Banana flour contributes starch functionality and energy, while Alugbati provides micronutrients and antioxidants, supporting the concept of nutrient-dense food systems (Tongco et al., 2015; Gupta & Prakash, 2019). Food fortification theory suggests that combining multiple local ingredients can improve nutritional quality while maintaining product acceptability (Balmurugan et al., 2022). However, successful application depends on balancing physicochemical properties, sensory attributes, and processing conditions (Zhang et al., 2021; Nguyen & Tran, 2022).

1.5 Research Gaps and Rationale on Saba Banana–Alugbati Composite Soup Noodles

Despite extensive studies on banana flour and Alugbati individually, significant gaps remain. Existing research often examines these ingredients separately, lacking integrative studies on their combined effects in a single product (Soriano et al., 2020; Felicilda, 2025; Bagabaldo et al., 2023; Reginio et al., 2020). Methodological gaps exist between wheat-based formulations and composite flour approaches, with limited standardized protocols for banana–vegetable noodle systems (Yu et al., 2020). Additionally, most studies focus on physicochemical properties rather than holistic evaluation, including sensory acceptability, shelf life, and enterprise feasibility. There is also a population gap, as many studies are conducted outside the Philippine context and do not address Filipino dietary patterns and preferences. Limited empirical data exist on Saba banana–Alugbati soup noodles, particularly in community-based settings (Cagatan et al., 2026). These gaps highlight the need for an integrated approach combining formulation, nutritional analysis, sensory evaluation, and livelihood assessment to support community-level food innovation.

1.6 Alignment with Relevant Sustainable Development Goals (SDGs)

This study aligns with key Sustainable Development Goals by integrating nutrition, innovation, and livelihood development through the use of locally available resources. It contributes to SDG 2 – Zero Hunger and SDG 3 – Good Health and Well-Being by developing nutrient-enriched noodles that help address malnutrition and improve dietary diversity using Saba banana and Alugbati. It supports SDG 8 – Decent Work and Economic Growth by creating opportunities for smallholder farmers, local processors, and micro-entrepreneurs through community-based food production and enterprise development. The study also advances SDG 9 – Industry, Innovation, and Infrastructure by promoting localized food processing innovation, and SDG 12 – Responsible Consumption and Production by reducing post-harvest losses and encouraging efficient utilization of agricultural resources. Together, these contributions position the research within a sustainable framework that links food security, economic resilience, and responsible resource use.

1.7 Importance of the Study to Multidisciplinary Sustainability

This research contributes to multiple dimensions of sustainability. From a socio-economic perspective, it supports livelihood development by enabling small-scale enterprises using locally available crops. From a nutritional and public health perspective, it promotes the consumption of functional foods that address micronutrient deficiencies. In terms of agricultural sustainability, the study encourages efficient crop utilization and reduces post-harvest losses. It also contributes to technological and innovation sustainability by advancing community-based food processing techniques. Furthermore, the study strengthens community sustainability by fostering collaboration among farmers, processors, and local institutions, while supporting policy and educational initiatives in nutrition and livelihood development.

1.8 Study Focus on Formulation, Acceptability, and Enterprise Potential of Saba Banana–Alugbati Soup Noodles

This study investigates the formulation, sensory acceptability, physicochemical properties, nutritional value, shelf life, and cost-return potential of Saba banana flour–based soup noodles enriched with Alugbati powder. It integrates food science evaluation with community-level feasibility, aiming to generate practical, evidence-based solutions for nutrition improvement and livelihood development.

2. Materials and methods

2.1 Research Design

The study employed a Randomized Complete Block Design (RCBD) to evaluate the effects of different formulations of Saba banana flour-based soup noodles enriched with Alugbati powder. This design enabled systematic comparison of sensory attributes, nutritional composition, and product quality across treatments. The approach is consistent with similar fortified noodle studies, allowing statistical comparison of product characteristics (Soriano et al., 2020; Balmurugan et al., 2022).

2.2 Locale of the Study

The study was conducted at Isabela State University – Echague Campus, San Fabian, Echague, Isabela. Laboratory analyses, including proximate analysis, were carried out at Quirino State University – Diffun Campus, College of Health and Sciences Food Laboratory.

2.3 Respondents of the Study

The respondents consisted of seventy-five (75) panelists composed of both trained Food Technology experts and untrained students from Isabela State University – Echague Campus. These participants were selected based on their health condition, lifestyle, and ability to participate in sensory evaluation, ensuring safety and minimizing variability in perception (Stone & Sidel, 2004). The sample size aligns with recommended standards for sensory testing, which indicate that 60–100 panelists provide sufficient statistical reliability (Balmurugan et al., 2022).

2.4 Sample and Sampling Procedure

Five formulations of Saba banana flour-based soup noodles enriched with Alugbati powder were prepared, representing varying substitution levels of Saba banana flour, including a control without substitution. The formulations involved decreasing bread flour and increasing Saba banana flour proportions, while maintaining constant levels of Alugbati powder, cassava-based Sagip Nutri-Powder, water, and salt. This approach reflects composite flour formulation strategies that enhance nutritional value while maintaining product acceptability (Hsu & Chou, 2024). Each formulation was randomly coded and assigned to panelists to prevent bias during sensory evaluation. The ingredients used included bread flour, Saba banana flour, Alugbati powder, cassava-based Sagip Nutri-Powder, water, and salt, all inspected for quality prior to processing (Mabesa, Rodriguez, & Dizon, 2020).

2.5 Research Instrument

The primary instrument used was a sensory evaluation score sheet based on the Nine-point Hedonic Scale, which measures acceptability in terms of color/appearance, odor/aroma, taste/flavor, firmness, and general acceptability. The scale ranges from 9 (like extremely) to 1 (dislike extremely) and is widely recognized for assessing consumer preference and product acceptability (Lawless & Heymann, 2010). Proximate analysis was conducted to determine the nutritional composition of the samples, including moisture, protein, fat, crude fiber, ash, and carbohydrate content. Standard analytical methods were used, including moisture analyzer for moisture, Raghuramalu for ash, fiber, and carbohydrates, Folch for lipid extraction, Biuret for protein determination, and Randive for metabolizable energy. These methods align with established procedures in food product evaluation (Yu et al., 2020; DOST-FNRI, 2016).

2.6 Data Gathering Procedure

The preparation of Saba banana flour-based soup noodles enriched with Alugbati powder followed modified procedures from Soriano et al. (2020). Ingredients were sourced from local institutions and markets and inspected for freshness and suitability (Mabesa, Rodriguez, & Dizon, 2020). Alugbati leaves were washed, air-dried, dehydrated at 70°C for seven hours, and ground into powder (Soriano et al., 2020). The noodle preparation involved sifting dry ingredients, dissolving salt in water, mixing and kneading into dough, rolling into thin sheets, cutting into strands, and storing under refrigeration at 2–3°C. The process ensured uniform texture, consistent thickness, and proper preservation of the product. For sensory evaluation, each formulation was cooked into soup using a standardized preparation method involving sautéing, boiling, seasoning, and thickening. The prepared samples were coded and randomly presented to panelists, who evaluated them based on sensory attributes after receiving proper instructions. Ethical procedures were observed during data collection, including informed consent, safety, confidentiality, and professional conduct (Dela Cruz & Panganiban, 2023). Cost analysis was also conducted to determine production cost, selling price, income, and return on expenses, assessing the product's economic feasibility for community-based enterprise (Mabesa et al., 2020; DAR, 2022).

2.7 Data Analysis Techniques

Descriptive statistics, including mean and standard deviation, were used to summarize sensory evaluation results. Inferential analysis using One-way Analysis of Variance (ANOVA) determined significant differences among treatments in terms of sensory attributes. Tukey's HSD was applied as a post hoc test to identify differences between formulations. This statistical approach ensured that variations in sensory and nutritional outcomes were validated, consistent with established methods in food product studies (Abdul Lateef et al., 2025).

2.8 Ethical Considerations

The study ensured voluntary participation, informed consent, and confidentiality in compliance with the Data Privacy Act of 2012 (RA 10173). Proper hygiene, safety standards, and respect for cultural and dietary considerations were maintained (Shariati et al., 2025). No conflicts of interest were declared, and institutional approval was secured prior to the study. Artificial Intelligence (AI) tools were used only for language refinement, while all research processes were conducted independently by the researcher.

3. Results and Discussion

3.1 Sensory Acceptability of Saba Banana–Alugbati Soup Noodles

Table 1*: Acceptability of Saba Banana Flour-Based Soup Noodles Enriched with Alugbati Powder*

Sensory Attributes	F0	F1	F2	F3	F4	Results
Color/ Appearance	7.04b (*lm*)	7.79a (*lvm*)	7.29b (*lm*)	7.03b (*lm*)	7.15b (*lm*)	0.000*
Odor/Aroma	7.07b (lm)	7.71a (lvm)	7.24b (lm)	7.16b (lm)	7.25b (*lm*)	0.0029*
Taste/Flavor	7.13b (*lm*)	7.92a (*lvm*)	7.27b (*lm*)	7.05b (*lm*)	7.24b (*lm*)	0.000*
Firmness	7.15bc (*lm*)	7.92a (*lvm*)	7.29b (lm)	7.04bc (*lm*)	6.91c (*lm*)	0.000*
General Acceptability	7.24b (*lm*)	8.01a (*lvm*)	7.27b (*lm*)	7.24b (*lm*)	7.28b (*lm*)	0.000*

3.1.1 Color/Appearance Acceptability

The results showed that formulation F1 obtained the highest mean score (7.79), described as "like very much," indicating it was the most preferred in terms of color and appearance. The control formulation F0 (7.04), along with F2 (7.29), F3 (7.03), and F4 (7.15), were all rated "like moderately." Statistical analysis revealed a significant difference among formulations ($F = 6.80$, $p = 0.000$), indicating that variation in Saba banana flour and Alugbati levels significantly affected visual acceptability. The findings suggest that moderate substitution produced a more desirable color compared to higher levels. This supports studies indicating that appropriate incorporation of banana flour enhances visual appeal, while excessive substitution results in darker coloration due to browning and pigment concentration (Kusumasari et al., 2023; Rahman et al., 2024; Choo et al., 2022; Akonor et al., 2017). Thus, balanced formulation improves product attractiveness, which is critical for consumer preference and marketability.

3.1.2 Odor/Aroma Acceptability

The results revealed that F1 achieved the highest mean score (7.71), interpreted as "like very much," while all other formulations, including F0 (7.07), F2 (7.24), F3 (7.16), and F4 (7.25), were rated "like moderately." Statistical analysis showed a significant difference among treatments ($F = 4.11$, $p = 0.0029$), indicating that ingredient variation significantly influenced aroma. These results indicate that moderate levels of banana flour and Alugbati enhanced aroma, while higher levels slightly altered it. This aligns with findings that aroma strongly influences consumer perception and that moderate incorporation improves acceptability, whereas higher substitution intensifies plant-based odors (Yang et al., 2022; Pinto et al., 2023; Akonor et al., 2017). Therefore, optimal formulation is essential to maintain desirable aroma characteristics.

3.1.3 Taste/Flavor Acceptability

The findings showed that F1 obtained the highest mean score (7.92), described as "like very much," indicating the most preferred taste and flavor. Other formulations, including F0 (7.13), F2 (7.27), F3 (7.05), and F4 (7.24), were rated "like moderately." Statistical results confirmed a significant difference among treatments (F = 21.44, p = 0.000). This suggests that moderate substitution enhances flavor, while excessive inclusion may introduce undesirable starchy or earthy notes. These findings are consistent with studies emphasizing that balanced formulation is necessary to maintain desirable flavor in composite flour products (Okafor et al., 2023; Rahman et al., 2024; Hosain et al., 2024). Thus, optimal ingredient proportion is critical for consumer satisfaction and product acceptance.

3.1.4 Firmness Acceptability

The results indicated that F1 recorded the highest mean score (7.92), interpreted as "like very much," while F0 (7.15), F2 (7.29), F3 (7.04), and F4 (6.91) were all rated "like moderately." Statistical analysis showed a significant difference among formulations (F = 11.20, p = 0.000). These findings suggest that moderate substitution maintains desirable firmness, while higher substitution weakens the noodle structure. This supports studies showing that increased non-wheat flour reduces gluten strength, affecting texture and elasticity (Okaflor et al., 2023; Rahman et al., 2024; Shobha et al., 2015). Therefore, maintaining gluten balance is essential for achieving optimal texture.

3.1.5 General Acceptability

The results showed that F1 obtained the highest mean score (8.01), interpreted as "like very much," while all other formulations were rated "like moderately," with means ranging from 7.24 to 7.28. Statistical analysis confirmed a significant difference among treatments (F = 8.29, p = 0.000). This indicates that F1 achieved the best overall sensory balance. The findings align with studies showing that moderate substitution levels yield higher acceptability by balancing nutrition and sensory quality (Okafor et al., 2023; Rahman et al., 2024; Akonor et al., 2017). Thus, F1 demonstrates strong potential for commercialization due to its high consumer acceptance.

3.1.6 Summary of Acceptability

The sensory evaluation results showed that all formulations of Saba banana flour-based soup noodles enriched with Alugbati powder were generally acceptable, with ratings ranging from "like moderately" to "like very much." Among the treatments, formulation F1 consistently obtained the highest scores across all sensory attributes, including color/appearance, odor/aroma, taste/flavor, firmness, and general acceptability, indicating that it was the most preferred by the panelists. In contrast, the control (F0) and higher substitution levels (F2–F4) received lower but still acceptable ratings. The findings indicate that moderate substitution of Saba banana flour and Alugbati powder results in the most desirable sensory characteristics. This suggests that maintaining a balanced formulation preserves visual appeal, flavor, aroma, and texture, while excessive substitution may slightly affect overall sensory quality. The results support previous studies that emphasize the importance of optimizing ingredient proportions to achieve both nutritional enhancement and consumer acceptability, making F1 the most suitable formulation for potential commercialization.

3.2 Nutritional Composition of Saba Banana–Alugbati Soup Noodles

Table 2*: Nutritive Value of Saba Banana Flour-Based Soup Noodles Enriched with Alugbati Powder*

Nutritional Component	F1	F2	F3	F4
Moisture Content (%)	39.95	39.03	38.99	38.50
Total Ash (%)	1.68	1.80	2.11	2.40
Total Lipid (%)	1.44	1.39	1.07	1.14
Total Protein (%)	10.40	9.71	9.05	8.05
Total Fiber (%)	2.04	2.44	3.07	3.73
Total Carbohydrate (%)	45.00	45.67	45.67	46.33
Metabolizable Energy (kcal/3g)	7.32	7.25	7.11	7.03

The results showed that protein content decreased from 10.40% in F1 to 8.05% in F4, while dietary fiber increased from 2.04% to 3.73% as substitution levels increased. Ash content also increased (1.68% to 2.40%), indicating higher mineral content. Carbohydrates remained relatively stable (45.00%–46.33%), while lipid content remained low (1.07%–1.44%). Statistical analysis revealed significant differences in moisture, ash, protein, fiber, and energy, but not in lipid and carbohydrate content. These findings indicate that increasing Saba banana flour enhances fiber and mineral content but reduces protein levels due to lower gluten content. This is consistent with studies showing that banana flour increases fiber and ash while reducing protein (Yu et al., 2020; Zeqi Zheng et al., 2016; Ovando-Martinez et al., 2010; Choo & Aziz, 2010; Farzana et al., 2024). The results confirm that banana flour improves nutritional quality while maintaining stable fat and carbohydrate levels.

3.3 Acceptability Consumer Index

Table 3: *Acceptability Consumer Index of Saba Banana Flour-Based Soup Noodles Enriched with Alugbati Powder*

Formulation	22	19	19.5	39.5	ACI	Rank
F0	1.55	1.34	1.39	2.82	7.10	4
F1	1.71	1.46	1.54	3.13	7.84	1
F2	1.60	1.38	1.42	2.87	7.27	2
F3	1.55	1.36	1.37	2.78	7.06	5
F4	1.57	1.38	1.35	2.86	7.16	3

The Acceptability Consumer Index (ACI) results showed that formulation F1 obtained the highest score of 7.84, ranking first among all treatments, indicating the strongest overall consumer preference. This was followed by F2 (7.27), F4 (7.16), and F0 (7.10), while F3 recorded the lowest ACI of 7.06. The results indicate that F1 consistently performed best across sensory attributes, particularly in taste and firmness, contributing to its highest overall acceptability. The findings indicate that a balanced combination of Saba banana flour and Alugbati powder results in optimal sensory acceptance. As Kumar et al. (2021) emphasized, the ACI serves as a comprehensive measure of consumer preference by integrating multiple sensory attributes into a single value. The superior performance of F1 suggests that moderate substitution levels produce a more harmonious sensory profile, while higher or lower levels slightly reduce acceptability. This highlights the importance of proportion optimization in product development and confirms that F1 has the greatest potential for consumer acceptance and market success.

3.4 Shelf-Life Stability of the Developed Noodles

The results showed that all formulations remained acceptable for only two days under ambient storage, after which quality deteriorated and became unacceptable by the third day. This indicates that high moisture content accelerates microbial growth and spoilage. These findings are consistent with studies showing that fresh noodles have limited shelf life under ambient conditions due to microbial activity (Zhang et al., 2023; Li et al., 2018). Thus, improved storage or preservation methods are necessary to extend product shelf life.

3.5 Cost Efficiency and Return on Expenses

The results showed that production cost increased progressively from ₱104.86 in F0 to ₱204.66 in F4 due to higher Saba banana flour content. Despite all formulations generating positive income, F1 demonstrated the most favorable balance between cost and acceptability, while higher substitution levels resulted in increased cost and reduced return on expenses. This suggests that moderate substitution is economically optimal. The findings are supported by studies indicating that composite flour increases production cost but enhances product value, with moderate substitution offering the best balance (Yu et al., 2020; Falade and Akingbala, 2010; Adebowala et al., 2012). Therefore, F1 is the most practical formulation for commercialization and community-based enterprise.

4. Conclusion & Recommendations

The study concluded that Saba banana flour-based soup noodles enriched with Alugbati powder are nutritionally enhanced, generally acceptable to consumers, and economically viable. Among the formulations, F1 emerged as the most preferred, achieving the highest ratings in color/appearance, odor/aroma, taste/flavor, firmness, and general acceptability, indicating that moderate substitution of banana flour with minimal Alugbati powder provides the optimal balance of sensory quality and nutritional value. The product demonstrated increased dietary fiber and mineral content while maintaining stable carbohydrate levels and acceptable energy values, although moisture, protein, and lipid contents slightly decreased with higher substitution levels. Despite its favorable acceptability and economic potential, the product exhibited a short shelf life of approximately two days under ambient conditions.

It is recommended that food entrepreneurs adopt formulation F1 as the standard for production due to its high consumer acceptability, desirable sensory attributes, and cost efficiency, making it suitable for commercialization. The product may also be considered for inclusion in institutional feeding programs to support improved dietary intake due to its enhanced nutritional value. Furthermore, future studies should focus on improving the product's shelf life through appropriate preservation techniques and expanding the scope of evaluation by including a wider range of respondents and investigating long-term nutritional and health impacts to support broader application and commercialization.

The study was limited by the short shelf life of the developed noodles, which remained acceptable only for up to two days under ambient storage conditions, indicating high perishability and the need for improved preservation methods. Additionally, the evaluation was confined to a specific group of respondents within a single institution, which may limit the generalizability of the findings to other populations or settings.

Compliance with ethical standards

The authors declare no conflict of interest, and this study received no external funding. The research was conducted with the approval of Isabela State University – Echague Campus, and the authors acknowledge the participation of the respondents and the support of the institution. Participation was voluntary, informed consent was obtained, and data were collected using non-invasive sensory evaluation methods. All information was treated with strict confidentiality, and no identifying details of participants were disclosed.

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