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Rice Seasoning (*Furikake*) using Indigenous Vegetables

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Abstract

This study aimed to develop and evaluate rice seasoning (*furikake*) using indigenous vegetables to enhance nutritional quality, sensory acceptability, shelf-life stability, and economic feasibility. Grounded in the concept of functional foods, the study employed an experimental research design with five formulations (F0–F4) using varying proportions of malunggay, amaranth, violet sweet potato leaves, and blue ternate combined with other ingredients. Sensory evaluation was conducted using a 9-point Hedonic Scale among 75 panelists arranged in a Randomized Complete Block Design (RCBD), while proximate analysis determined nutritional composition. Data were analyzed using Analysis of Variance (ANOVA) and Tukey's Honestly Significant Difference (HSD) test, alongside cost and return analysis. Results showed that increasing indigenous vegetable content improved nutritional composition, with higher protein, dietary fiber, and mineral content, and reduced moisture, fat, carbohydrate, and caloric levels. All formulations were generally well accepted, with formulation F1 obtaining the highest ratings across sensory attributes and overall acceptability, while F4 exhibited the highest nutritional density. Shelf-life evaluation indicated stable product quality with no spoilage over the observation period. Economic analysis revealed decreasing production costs and increasing profitability with higher vegetable incorporation, although F1 provided the best balance between consumer preference and cost efficiency. The study concluded that indigenous vegetable-based rice seasoning is a nutrient-dense, low-calorie, and consumer-acceptable functional food with potential for commercialization, and recommended further testing on microbial stability, extended shelf life, and market feasibility. The study aligns with SDG 2 (Zero Hunger), SDG 3 (Good Health and Well-Being), SDG 12 (Responsible Consumption and Production), and SDG 15 (Life on Land) by promoting nutrient-enriched food products, improving dietary quality, and utilizing locally available resources. It contributes to socio-economic, agricultural, and public health sustainability by supporting local food systems, enhancing nutrition, and promoting affordable, community-based food innovations.

Keywords: Acceptability, Furikake, Indigenous Vegetables, Nutritional Composition, Rice Seasoning, Sensory Evaluation

1. Introduction

Rice remains a central component of Filipino diets, yet its dominance contributes to nutrient deficiencies and malnutrition due to limited dietary diversity. This study examines the development of an indigenous rice seasoning (*furikake*) using locally available nutrient-rich ingredients to enhance dietary quality, improve acceptability, and address malnutrition in rice-dependent populations.

1.1 Background of the Study on Nutrient Enhancement of Rice Diets among Filipinos

Rice is a staple food for millions of Filipinos and plays a vital role in culture and the economy. However, heavy reliance on rice has contributed to food insecurity and malnutrition, particularly among vulnerable groups such as children, women, and low-income households. Diets are often energy-dense but deficient in protein, vitamins, and minerals, increasing the risk of undernutrition and micronutrient deficiencies (DOST FNRI, 2024; DOST FNRI, 2025; PhilRice, 2025; Tribune, 2024). National data show that Filipino diets are characterized by high caloric intake from refined staples and low consumption of nutrient-rich foods such as fruits and vegetables, leading to deficiencies in iron, zinc, and vitamin A (Florento et al., 2025). This contributes to the "triple burden of malnutrition," which includes undernutrition, micronutrient deficiencies, and overnutrition. Iron and zinc deficiencies remain prevalent, affecting multiple population groups and increasing susceptibility to disease. Food-based interventions such as fortification and the use of indigenous nutrient-rich ingredients have been identified as sustainable approaches to improving dietary quality. Rice seasoning products like *furikake*, traditionally used in Japan, demonstrate potential as vehicles for nutrient delivery (Japanese Food Guide, 2023; Bando, Ogawa, & Bando, 2024).

1.2 Themes and Insights from Related Literature on Indigenous Rice Seasoning Development

Furikake originated as a functional rice topping designed to enhance both flavor and nutrition, with historical roots tracing back to traditional Japanese practices of adding dried fish, sesame seeds, and seaweed to rice (Japanese Food Guide, 2023). Its modern development during the Taishō era emphasized addressing calcium deficiencies through nutrient-enriched formulations (Bando, Ogawa, & Bando, 2024). Over time, *furikake* evolved into a versatile seasoning incorporating diverse ingredients and flavors, while maintaining its role as a convenient and functional food (Food in Japan, 2022; Slurrp, 2022; Kikkoman, 2023; Bunsiri et al., 2020; Food Network, 2023; Culinary Compendium, 2023). Studies confirm that such formulations can improve sensory acceptability and nutrient intake, particularly when adapted using locally available ingredients (Bunsiri et al., 2024). Research highlights the nutritional benefits of *furikake* components, including calcium, protein, antioxidants, and trace minerals, which support bone health, immune function, and disease prevention (Bunsiri, Tantipongarpa, & Teeparuksapun, 2020; Siripongvutikorn, Banphot, & Rampoei, 2024; JapanGov, 2025). Additionally, fortified rice seasonings have been shown to improve meal acceptance and reduce food waste in feeding programs (Siripongvutikorn et al., 2024). Indigenous vegetables such as malunggay, amaranth leaves, sweet potato leaves, and blue ternate are rich in essential nutrients and bioactive compounds, making them suitable for functional food development (Pareek et al., 2023; Tshilongo et al., 2024; Tripathi et al., 2022). These ingredients offer antioxidant, anti-inflammatory, and nutrient-enhancing properties, while processing methods like dehydration help preserve their quality (Siripongvutikorn et al., 2024; Tripathi et al., 2022).

1.3 Local, National, and Global Context of Indigenous Food-Based Nutrition Interventions

At the national level, the Philippines continues to face persistent malnutrition challenges driven by dietary imbalance and limited access to diverse foods. Indigenous vegetables, although nutrient-dense and environmentally resilient, remain underutilized due to changing consumption patterns and increased reliance on processed foods (Food and Agriculture Organization, 2020; Lara-Arevalo et al., 2024). Globally, functional foods and fortified products are increasingly promoted as strategies to improve nutrition and public health. Rice seasoning products like *furikake* have been successfully used in countries such as Japan and Cambodia to address nutrient deficiencies without altering dietary habits (JapanGov, 2025). Locally, the use of indigenous crops supports agricultural sustainability and strengthens local food systems. Incorporating locally sourced ingredients into food products aligns with efforts to promote food security, reduce dependency on imports, and support small-scale farmers (SEARCA, 2023).

1.4 Theoretical or Conceptual Basis for Indigenous Functional Food Development

This study is grounded in the concept of functional foods, which emphasizes the use of nutrient-rich ingredients to enhance health outcomes beyond basic nutrition. *Furikake* serves as a model for nutrient delivery through commonly consumed staples, demonstrating how food fortification can address dietary deficiencies (Bunsiri et al., 2020). The integration of indigenous vegetables into rice seasoning blends reflects principles of sustainable food systems, combining nutritional enhancement, local resource utilization, and cultural acceptability. Processing techniques such as dehydration and powdering further support product stability, shelf life, and nutrient retention (Siripongvutikorn et al., 2024; Tripathi et al., 2022).

1.5 Research Gaps and Rationale for Indigenous *Furikake* Development in the Philippines

Despite growing interest in functional foods, limited research exists on the formulation and acceptability of *furikake*-style rice seasonings using Philippine indigenous ingredients. Most existing products rely on imported components, making them less accessible to low-income populations (Bunsiri, Tantipongarpa, & Teeparuksapun, 2020; Siripongvutikorn et al., 2024). There is also a lack of studies integrating nutritional analysis, sensory evaluation, affordability, and local resource utilization in a single product. Indigenous vegetables, though widely available and nutrient-rich, remain underexplored in seasoning applications and food product innovation. This study addresses these gaps by developing and evaluating an indigenous rice seasoning using locally available ingredients, assessing its nutritional value, acceptability, shelf life, and economic feasibility.

1.6 Alignment with Relevant Sustainable Development Goals (SDGs)

This study aligns with several Sustainable Development Goals. It supports SDG 2 (Zero Hunger) by promoting food security and improving nutrition through nutrient-enriched rice seasoning. It contributes to SDG 3 (Good Health and Well-Being) by addressing micronutrient deficiencies and improving dietary quality. It also supports SDG 12 (Responsible Consumption and Production) by utilizing locally available indigenous ingredients and reducing reliance on imported products, and SDG 15 (Life on Land) by encouraging the use of biodiversity-friendly crops and sustainable agricultural practices (United Nations, 2023; FAO, 2022; SEARCA, 2023).

1.7 Importance of the Study to Multidisciplinary Sustainability

The study contributes to socio-economic sustainability by creating affordable, nutrient-rich food products that can improve household nutrition and support local livelihoods. It promotes agricultural sustainability by encouraging the use of indigenous crops that require fewer inputs and are resilient to environmental changes. It also supports public health

sustainability by addressing malnutrition through accessible dietary interventions, and food system sustainability by integrating local resources into innovative product development. Additionally, the study contributes to innovation and community sustainability by providing opportunities for small-scale food enterprises and strengthening local food systems.

2. Material and methods

2.1 Research Design

The study employed an experimental research design involving the formulation and evaluation of five rice seasoning variants (F0–F4) using varying proportions of indigenous ingredients. The design allowed comparison of formulations in terms of nutritional value, sensory acceptability, shelf stability, and economic viability. Sensory evaluation followed a Randomized Complete Block Design (RCBD) to minimize bias and ensure reliable comparisons among treatments.

2.2 Locale of the Study

The study was conducted at Isabela State University, Echague Campus, San Fabian, Echague, Isabela. Sensory evaluation was carried out within the same institution, while nutrient analysis was performed at the Quirino State University–Diffun Campus, College of Health Sciences and Food Laboratory.

2.3 Respondents of the Study

The respondents consisted of seventy-five (75) sensory panelists composed of untrained students, faculty, and staff, along with trained food technology experts from Isabela State University–Echague Campus. All participants were required to be in good health, non-smokers, and non-liquor drinkers during evaluation to ensure unbiased sensory assessment.

2.4 Sample and Sampling Procedure

Five formulations of rice seasoning were prepared using varying proportions of dried seaweed, blue ternate, violet sweet potato leaves, malunggay leaves, dried amaranth, corn-based Sagip Nutri Powder, bonito flakes, sesame seeds, and salt. As described in Table 1, the control formulation (F0) primarily consisted of seaweed, while experimental formulations (F1–F4) incorporated increasing proportions of indigenous vegetables and functional ingredients. All ingredients were carefully measured using a digital weighing scale after preparation and drying. Indigenous vegetables were sourced from local markets to ensure freshness and accessibility, while corn-based Sagip Nutri Powder was obtained from the BIDANI research output at Isabela State University.

2.5 Research Instrument

The primary instrument used in this study was the 9-point Hedonic Scale to evaluate sensory attributes, including color, aroma, taste, texture, and general acceptability. As shown in Table 3, the scale ranged from “Dislike Extremely” to “Like Extremely,” allowing panelists to quantitatively assess each formulation. Each sample was coded and presented with cooked rice to ensure uniform consumption. Panelists evaluated each formulation independently and rinsed their mouths between samples to eliminate carry-over effects.

2.6 Data Gathering Procedure

The preparation of rice seasoning followed a systematic process beginning with the collection and preparation of ingredients. Indigenous vegetables such as malunggay, amaranth, blue ternate, and sweet potato leaves were thoroughly washed, blanched, and dehydrated at controlled temperatures to preserve nutrients and ensure safety. As indicated in Table 2, drying conditions ranged from 50–60°C for 6–8 hours for leafy vegetables, while blue ternate required slightly lower temperatures. Sesame seeds were toasted, and seaweed was air-dried until crisp, while other ingredients were used in ready-to-use form. The preparation procedure is illustrated in Figure 1, which outlines a sequential process beginning with washing and blanching, followed by drying, cooling, and crushing of ingredients into flakes. The dried components were then mixed according to formulation proportions, optionally ground for texture, and packaged in airtight containers. Finally, the products were labeled and stored in a cool, dry place to maintain quality and shelf life. Proximate analysis was conducted to determine the nutritional composition of the formulations, including protein, fat, carbohydrates, fiber, and mineral content, using standard laboratory methods such as moisture analysis, biuret method, and Folch and Raghuramalu techniques. Sensory evaluation was then carried out using prepared rice samples with evenly distributed seasoning. Additionally, cost analysis and Return on Expenses (ROX) were computed by determining total production cost, unit cost, selling price, total sales, and income for each formulation to assess economic feasibility.

2.7 Data Analysis Techniques

Data from sensory evaluation were analyzed using Analysis of Variance (ANOVA) under a one-way classification to determine significant differences among formulations. Tukey’s Honestly Significant Difference (HSD) test was applied for pairwise comparisons to control family-wise error rates and ensure reliable interpretation of differences among treatment means. Economic analysis was performed using standard cost and return formulas, including computation of unit cost, selling price with markup, total sales, income, and ROX percentage to evaluate profitability.

2.8 Ethical Considerations

Ethical standards were strictly observed throughout the study. Participation in sensory evaluation was voluntary, and informed consent was obtained from all respondents. Participants were informed of the study's purpose and procedures and were allowed to withdraw at any time without penalty. All ingredients were handled following proper sanitation and food safety standards. Data confidentiality was maintained in accordance with the Data Privacy Act of 2012. The researcher declared no conflict of interest, and the study was conducted solely for academic purposes. Artificial intelligence tools were used only for improving grammar, clarity, and organization of the manuscript. All data collection, analysis, and interpretations were conducted independently by the researcher, ensuring originality and accuracy**.**

3. Results and Discussion

3.1 Nutritional and Sensory Evaluation of Rice Seasoning Formulations

3.1.1 Nutritional Composition of Indigenous Rice Seasoning

The results show that increasing the proportion of indigenous vegetables from F1 to F4 led to a decrease in moisture content from 11.11% to 9.64%, while ash, protein, and fiber content increased progressively. Fat, carbohydrates, and energy values slightly decreased across formulations, with F4 showing the highest protein (11.07%), fiber (8.10%), and ash (8.80%), and the lowest moisture and energy values. Statistical analysis revealed significant differences ($p < 0.05$) in moisture, ash, protein, fiber, carbohydrate, and energy, while lipid content showed no significant variation. These findings indicate that increasing indigenous vegetable content improves nutritional quality by enhancing protein, fiber, and mineral content while reducing caloric density. Lower moisture contributes to better shelf stability. This supports findings that leafy vegetables are rich in nutrients and improve food quality while maintaining low fat content (Raja et al., 2022; Lara-Arevalo et al., 2024; Gupta et al., 2019). Additionally, reduced moisture is associated with improved shelf stability in dried food products (FAO, 2020).

3.1.2 Nutritional Value per Serving

The results show that all formulations were low in calories (9.6–9.8 kcal), low in fat, free from trans fat, and contained minimal cholesterol. Protein and dietary fiber increased from F1 to F4, while carbohydrates and calories slightly decreased. Sodium levels increased moderately but remained within acceptable levels, and all formulations were rich in essential vitamins and minerals. These results suggest that the product is nutrient-dense while remaining low in calories and fat, making it suitable for health-conscious consumers. The increase in protein and fiber enhances digestion and overall health. This aligns with findings that vegetable-based foods improve nutritional value without significantly increasing caloric intake (Ying et al., 2021).

3.1.3 Acceptability in Terms of Color or Appearance

The results indicate that all formulations were highly accepted in terms of color, with an overall rating equivalent to "Like very much." F1 obtained the highest mean score, followed closely by F2, while F0, F3, and F4 received slightly lower but still favorable ratings. Statistical analysis showed a significant difference among formulations. This suggests that ingredient composition affects visual appeal, with balanced formulations producing more attractive colors. Visual quality is an important factor influencing consumer preference. These findings support studies showing that color strongly affects food perception and acceptance (Ares et al., 2021).

3.1.4 Acceptability in Terms of Odor or Aroma

The results show that all formulations were generally well accepted in terms of aroma, with an overall rating equivalent to "Like very much." F1 received the highest rating ("Like extremely"), followed by F2 and F3, while F0 and F4 were the least preferred. Statistical analysis revealed highly significant differences among formulations. These findings indicate that aroma is strongly influenced by ingredient composition, and balanced formulations enhance aromatic quality. Aroma plays a key role in food acceptability and overall liking. This is supported by studies emphasizing the importance of aroma and multisensory perception in consumer preference (Ares et al., 2021; Köster and Mojet, 2021).

3.1.5 Acceptability in Terms of Taste or Flavor

The results show that all formulations were well accepted in terms of taste, with an overall rating equivalent to "Like very much." F1 obtained the highest rating, followed by F2, while F0, F3, and F4 received lower but acceptable ratings. Statistical analysis indicated significant differences among formulations. These findings suggest that formulation significantly affects flavor quality, with balanced ingredient proportions improving taste acceptability. Taste is a major determinant of consumer preference and overall product acceptance. This is consistent with studies highlighting the importance of flavor in influencing sensory liking (Köster & Mojet, 2021; Lawless & Heymann, 2020).

3.1.6 Acceptability in Terms of Texture or Dryness

The results indicate that all formulations were well accepted in terms of texture, with an overall rating equivalent to "Like very much." F1 obtained the highest rating, followed by F2, while F3 and F4 showed similar results and F0 had the lowest rating. Statistical analysis showed highly significant differences among formulations.

These findings suggest that texture and dryness are critical factors in product acceptability. Proper moisture control enhances crispness, usability, and shelf stability. This supports research showing that texture significantly influences sensory perception and consumer satisfaction (Lawless and Heymann, 2020; Shafiee et al., 2022).

3.1.7 General Acceptability of Formulations

The results show that all formulations were generally well accepted, with an overall rating equivalent to "Like very much." F1 obtained the highest rating ("Like extremely"), followed by F2, while F3, F4, and F0 received lower but acceptable ratings. Statistical analysis revealed highly significant differences among formulations. These findings indicate that overall acceptability is strongly influenced by formulation, with F1 achieving the best balance of sensory attributes. This supports studies stating that overall food preference is determined by the integration of multiple sensory factors such as taste, aroma, texture, and appearance (Ares et al., 2021).

3.2 Most Acceptable Formulation Based on Sensory Evaluation

The results show that F1 obtained the highest acceptability index, ranking first overall, followed by F2, F3, F4, and F0. F1 consistently received the highest scores across all sensory attributes, particularly in aroma and texture. Statistical results confirmed significant differences among formulations. This indicates that F1 achieved the most balanced sensory quality and was the most preferred by consumers. The findings demonstrate that incorporating indigenous vegetables improves acceptability compared to the control formulation. This supports the view that sensory evaluation is essential in determining consumer preference and product success (Ruiz Capillas and Herrero, 2021).

3.3 Shelf-Life Stability of the Developed Product

The results show that all formulations maintained consistent color and dryness over a seven-day storage period, with no signs of spoilage. Aroma and taste gradually intensified from mild to more flavorful over time, while texture remained dry and stable. These findings suggest good short-term shelf stability due to low moisture content and proper processing. The absence of spoilage indicates product safety under proper storage conditions. This is supported by studies showing that moisture reduction inhibits microbial growth and improves shelf life in dried food products (FAO, 2020; Philippine Rice Research Institute, 2025).

3.4 Cost Efficiency and Economic Viability of Formulations

The results show that total production cost decreased from the control formulation to F4 as indigenous vegetable content increased. Ingredient substitution using local vegetables reduced costs, while operating expenses remained constant. F4 had the lowest cost, while F1 maintained moderate cost with high acceptability. These findings indicate that using indigenous vegetables reduces production costs and enhances economic feasibility. While F4 was the most cost-efficient, F1 provided the best balance between cost and consumer preference, making it the most viable option for commercialization.

3.5 Return on Investment and Profitability

The results show that return on investment increased from the control formulation to F4, with F4 generating the highest income and ROI, while F0 had the lowest. Unit cost decreased as vegetable content increased, while total sales remained constant across formulations. These findings suggest that higher incorporation of indigenous vegetables improves profitability and production efficiency. This aligns with studies emphasizing that cost efficiency and resource utilization are critical for sustainable food product development (Food and Agriculture Organization, 2020; Philippine Rice Research Institute, 2025).

4. Conclusion & Recommendations

The study demonstrated that incorporating indigenous vegetables such as malunggay, violet sweet potato leaves, blue ternate, and amaranth into rice seasoning significantly improved its nutritional composition, particularly in protein, dietary fiber, and mineral content, while reducing moisture, fat, carbohydrates, and caloric value. Among the formulations, F1 was identified as the most preferred due to its superior sensory attributes across color, aroma, taste, texture, and overall acceptability, whereas F4 exhibited the highest nutritional density. All formulations showed stable shelf-life characteristics with maintained quality and absence of spoilage, indicating suitability for storage and distribution. Additionally, economic analysis confirmed that production is feasible, with decreasing unit costs as vegetable incorporation increases, highlighting the potential of indigenous vegetable-based *furikake* as a nutrient-dense, low-calorie, and consumer-acceptable functional food.

Further studies should focus on conducting microbial analysis, extended shelf-life testing, and comprehensive physicochemical evaluation to ensure product safety, stability, and quality. Sensory optimization should be emphasized in scale-up trials to maintain the high level of acceptability observed in the preferred formulation. Additional indigenous vegetables may be explored to develop alternative formulations and expand the range of functional food products. Moreover, marketability and commercialization potential should be assessed through consumer studies, cost evaluation, and distribution analysis. Educational materials should also be developed to promote awareness of the product's preparation, nutritional value, and benefits, encouraging its adoption as a practical nutrition intervention.

The study was limited to selected indigenous vegetables and a specific number of formulations, with sensory evaluation conducted among a defined group of panelists, which may not fully represent broader consumer preferences. Shelf-life assessment was conducted over a short duration, and microbial and advanced physicochemical analyses were not included. Additionally, the economic evaluation was based on estimated production conditions, which may vary under large-scale commercialization.

Compliance with ethical standards

The authors declare no conflict of interest, and this study received no external funding as it was conducted solely for academic purposes. The researchers acknowledge the participation of the respondents and the support of Isabela State University–Echague Campus in facilitating the study. Participation was voluntary, with informed consent obtained from all participants, and data were collected using non-invasive sensory evaluation procedures. All information was treated with strict confidentiality, and no identifying personal data were disclosed.

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