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Consumer Acceptability of Muffin Fortified with Rice-Based Sagip Nutri-Powder

Joy Bata Cristobal[1], Martina Delos Reyes-Peñalber, EdD[2]
[1]Master of Arts in Education Major in Home Technology, Isabela State University, Echague Campus, Isabela, Philippines
[2]Professor, Isabela State University, Echague Campus, College of Education, Isabela, Philippines

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Email of Corresponding Author: joybatacristobal@gmail.com

Abstract

This experimental study aimed to develop and evaluate muffins fortified with Rice-Based Sagip Nutri-Powder as a nutritious snack alternative for learners. The research was conducted at Isabela State University during the School Year 2025–2026 using a product development approach. Five formulations (F0–F4) with varying levels of fortification (0g–80g) were assessed through sensory evaluation using a 9-point Hedonic Scale among seventy-five (75) randomly selected participants, including trained and untrained panelists. Data were analyzed using one-way Analysis of Variance (ANOVA), F-test, mean, and descriptive statistics. Results revealed that all formulations were generally acceptable, with ratings ranging from "Like Moderately" to "Like Very Much." Color and taste showed no significant differences, while aroma and texture were significantly improved in certain formulations. Formulation 4 (80g) obtained the highest Acceptability Consumer Index (7.82) and was identified as the most preferred. Nutritional analysis indicated that increasing levels of Rice-Based Sagip Nutri-Powder significantly enhanced protein, fiber, ash content, and energy, with Formulation 4 showing the highest nutritional values and improved shelf stability due to reduced moisture content. Cost analysis revealed that all formulations were profitable; however, higher fortification levels increased production costs and reduced return on expenses, with the control formulation yielding the highest profitability. The study concluded that Rice-Based Sagip Nutri-Powder is an effective fortificant for improving the nutritional quality and acceptability of muffins, particularly in Formulation 4, which offers the best balance between sensory appeal and nutrient density. The findings support its potential use in supplemental feeding programs. This study aligns with Sustainable Development Goal 3 (Good Health and Well-being) by promoting nutrient-dense food products to address malnutrition. It also contributes to sustainability by supporting local food innovation, enhancing community nutrition, and promoting the use of locally sourced agricultural resources.

Keywords: Acceptability Consumer Index, Cost Analysis, Muffin, Nutritional Value, Rice-Based Sagip Nutri-Powder, Sensory Evaluation, Shelf Life

1. Introduction

Malnutrition remains a persistent challenge in the Philippines, driven by poverty, food insecurity, and limited access to nutritious food. This has resulted in a dual burden of undernutrition and overnutrition, affecting both children and adults. In response, innovative food-based interventions have been explored to improve nutritional intake while maintaining affordability and acceptability. This study focuses on the development of muffins fortified with Rice-Based Sagip Nutri-Powder as a functional food product aimed at enhancing nutrition among learners while maintaining consumer acceptability.

Malnutrition continues to affect Filipino communities, particularly children, with high rates of stunting (23.6%), wasting (5.6%), and underweight (15.1%), alongside adult obesity (39.8%) and food insecurity (44.7%) (DOST-FNRI and UNICEF, 2023). Educational institutions, supported by initiatives such as CHED programs and university-based feeding efforts, have attempted to address these concerns through nutrition interventions. This study proposes the development of a fortified muffin using Rice-Based Sagip Nutri-Powder enriched with cacao pod husk, malunggay, mung beans, sesame, and turmeric. These ingredients provide essential macro- and micronutrients necessary for growth and health. Rice supplies energy and essential nutrients (Muthayya et al., 2014), while mung beans complement protein requirements (Hou et al., 2019; Tang et al., 2014). Sesame contributes healthy fats and minerals (Pathak et al., 2014; Rout et al., 2018), cacao pod husk offers fiber and antioxidants (Vargas-Arana et al., 2022; Valadez-Carmona et al., 2018), malunggay provides vitamins and minerals (Gopalakrishnan et al., 2016; Braganza, 2023), and turmeric contributes anti-inflammatory compounds (Hewlings & Kalman, 2017; Aggarwal et al., 2007).

Given the popularity of muffins as affordable and accessible snacks, fortifying them presents an opportunity to improve nutrition without altering dietary habits. Literature highlights the evolution of muffins as widely accepted food products and their adaptability for nutritional enhancement. The development of Rice-Based Sagip Nutri-Powder, initiated by DOST-ITDI, demonstrates its effectiveness in addressing malnutrition through locally sourced, nutrient-dense formulations (DOST-ITDI, 2014; GMA News, 2022; DOSTv, 2024).

Studies emphasize the nutritional synergy of rice and legumes, particularly mung beans, in forming complete proteins (EPRA Journals, 2024; MDPI, 2019). Malunggay enhances micronutrient density (NIH - PMC, 2021; MDPI, 2023), while cacao pod husk contributes fiber and antioxidants (MDPI, 2024; Cocoa Future Collaborative, 2024). Turmeric provides bioactive compounds beneficial for health (Frontiers in Nutrition, 2022). Previous research confirms that Sagip Nutri-Powder can be successfully incorporated into local food products such as bread and snacks without compromising acceptability (Journal of Chemistry and Nutritional Biochemistry, 2025; Viajar et al., 2020). However, most studies focus on porridge or bread products, with limited exploration of muffins as a delivery vehicle.

Globally, rice remains a staple food for more than half of the population, serving as a primary energy source (USA Rice Federation, 2024). In the Philippines, rice-based innovations such as Sagip Nutri-Packs are used in disaster relief and feeding programs to combat malnutrition (FAO AGRIS, 2023; DOST-TAPI, 2024). Locally, initiatives by Isabela State University and other institutions promote the use of indigenous ingredients to address food insecurity while supporting local agriculture. Nationally, programs align with food security strategies that emphasize sustainable, culturally acceptable, and affordable nutrition solutions. These efforts highlight the importance of integrating scientific food innovation with local practices to address nutritional challenges effectively.

This study is grounded in food fortification theory, which posits that commonly consumed foods can be enhanced with nutrient-dense ingredients to improve dietary intake without altering consumption patterns. It also draws on sensory evaluation theory, emphasizing that consumer acceptability is critical for the success of fortified products (Meilgaard et al., 2016). The concept of complementary proteins supports the combination of rice and legumes to achieve balanced amino acid profiles (EPRA Journals, 2024; MDPI, 2019). Additionally, functional food theory underpins the inclusion of bioactive compounds from ingredients such as turmeric and cacao pod husk, which provide health benefits beyond basic nutrition (Frontiers in Nutrition, 2022; Vargas-Arana et al., 2022).

Despite extensive research on Sagip Nutri-Powder, there is limited evidence on its application in muffin formulations tailored to Filipino taste preferences and institutional feeding contexts. Existing studies primarily focus on porridge or bread products, leaving a gap in bakery-based innovations. Furthermore, while the individual nutritional benefits of rice, mung beans, malunggay, cacao pod husk, sesame, and turmeric are well documented, their combined application in a standardized muffin recipe remains underexplored. This study addresses this gap by evaluating both nutritional value and consumer acceptability, ensuring that the product is both beneficial and acceptable.

This study aligns with several Sustainable Development Goals:
SDG 3 – Good Health and Well-Being, by addressing malnutrition through nutrient-dense food development.
SDG 2 – Zero Hunger, by promoting accessible and affordable fortified food products.
SDG 8 – Decent Work and Economic Growth, through support for local farmers and food producers using locally sourced ingredients.
SDG 12 – Responsible Consumption and Production, by utilizing sustainable and upcycled ingredients such as cacao pod husk. These alignments demonstrate the study's contribution to improving nutrition while supporting sustainable food systems.

This research contributes to multiple dimensions of sustainability. It supports public health sustainability by addressing nutrient deficiencies and improving dietary intake. It enhances economic sustainability by promoting local agriculture and creating value-added products for small enterprises. In terms of environmental sustainability, the use of byproducts like cacao pod husk reduces waste and promotes resource efficiency. The study also contributes to educational sustainability by supporting school feeding programs and improving student health and learning capacity. Finally, it advances innovation and technological sustainability by applying food science principles to develop functional, culturally acceptable products. Through this multidisciplinary approach, the study provides a sustainable solution to malnutrition while fostering local economic and community development.

2. Material and methods

2.1 Research Design

The study utilized an experimental research design involving five different formulations of muffins with varying proportions of Rice-Based Sagip Nutri-Powder. These formulations were randomly assigned to experimental units and coded to eliminate bias during evaluation.

2.2 Locale of the Study

The study was conducted at Isabela State University, Echague Campus, where the sensory evaluation took place. Laboratory analyses, including proximate and crude protein analysis, were performed at the Quirino State University–Diffun Campus College of Health Sciences Food Laboratory.

2.3 Respondents of the Study

The respondents consisted of seventy-five (75) individuals, including Food and Service Management students, Food Technology experts, and untrained panelists. Their ages ranged from 12 to 50 years old. All participants were screened to ensure they were non-smokers, not liquor drinkers, and in good health during the evaluation.

2.4 Sample and Sampling Procedure

Random sampling was employed in selecting the seventy-five panelists. The study utilized five muffin formulations with varying levels of Rice-Based Sagip Nutri-Powder substitution. Each sample was coded and randomly presented to the panelists to prevent bias during sensory evaluation.

2.5 Research Instrument

The primary instrument used in the study was the 9-point Hedonic Scale to assess consumer acceptability in terms of color/appearance, odor/aroma, taste/flavor, texture, and general acceptability. Panelists were provided with coded samples and instructed to evaluate each attribute carefully. Standard sensory procedures were followed, including rinsing the mouth with water before and after tasting each sample to ensure accuracy and reliability of responses.

2.6 Data Gathering Procedure

Materials, including Rice-Based Sagip Nutri-Powder fortified with cacao pod husk, malunggay, and turmeric, were collected from Isabela State University. Muffins were prepared by first organizing all materials and preheating the oven to 400°F (205°C). Dry ingredients were sifted and combined, while wet ingredients were mixed separately before being incorporated into the dry mixture. The batter was portioned into muffin cups, baked for 20–25 minutes until fully cooked, cooled, and prepared for evaluation. The finished products underwent proximate and crude protein analysis in a laboratory setting. Sensory evaluation was then conducted, where panelists assessed the samples using the Hedonic Scale under controlled conditions.

2.7 Data Analysis Techniques

Data gathered from sensory evaluation were analyzed using one-way Analysis of Variance (ANOVA) to determine significant differences among the formulations. Descriptive statistics, including mean and F-test, were applied to evaluate variations in color/appearance, odor/aroma, taste/flavor, texture, and general acceptability.

2.8 Ethical Considerations

The study adhered to proper food safety and sanitation practices during preparation, including the use of appropriate protective equipment and clean materials. Participants were informed about the study procedures and assured of the safety of the food samples. They were given the option to withdraw at any time and provided informed consent prior to participation.

3. Results and Discussion

3.1 Level of Acceptability

3.1.1 Color or Appearance

The muffins were generally well accepted in terms of color or appearance, with mean scores ranging from 7.41 to 7.79. Formulation 2 obtained the highest mean, while Formulation 1 obtained the lowest mean; the rest of the formulations were also rated positively, and the grand mean indicated that the products were liked very much. The differences in color or appearance were not statistically significant, as shown by the reported F-value and P-value. This means that adding Rice-Based Sagip Nutri-Powder did not materially change the visual acceptability of the muffin compared with the control, even if some formulations appeared slightly more appealing than others.

3.1.2 Odor or Aroma

All formulations were rated like very much in terms of odor or aroma, with Formulation 2 obtaining the highest mean score and Formulation 1 the lowest. The overall grand mean also reflected strong aromatic acceptability across the five

formulations. The differences in aroma were statistically significant, showing that the level of fortification affected the product's scent. This suggests that Rice-Based Sagip Nutri-Powder influenced the aromatic profile of the muffins, with Formulation 2 producing the most preferred aroma among panelists.

3.1.3 Taste or Flavor

The muffins were also generally liked in terms of taste or flavor, with mean scores ranging from 7.48 to 7.85. Formulation 4 received the highest score, while Formulation 3 received the lowest, although all formulations remained within the positive acceptability range. The difference in taste or flavor was not statistically significant. This indicates that fortification improved the nutritional content of the muffins without reducing their flavor acceptability, which is important for product development and consumer acceptance.

3.1.4 Texture

Texture results showed that the muffins were generally well accepted, with mean scores from 7.43 to 7.91. Formulation 4 had the highest score, while Formulation 3 had the lowest, and the remaining formulations were still rated very positively. The differences in texture were statistically significant, indicating that fortification level affected mouthfeel and structural quality. This suggests that the Rice-Based Sagip Nutri-Powder contributed to a texture that was more preferred at the highest formulation level, particularly in Formulation 4.

3.1.5 General Acceptability

All formulations were rated like very much in terms of general acceptability, with Formulation 4 obtaining the highest mean and Formulation 3 the lowest. The overall result showed that the muffins were broadly acceptable to the panelists. The statistical result showed no significant difference among formulations in general acceptability. This means that although some formulations performed better than others, all versions remained acceptable, and Formulation 4 had the strongest overall consumer appeal.

3.2 Proximate Analysis

The proximate analysis showed that moisture content decreased as the amount of Rice-Based Sagip Nutri-Powder increased, while ash, lipid, protein, fiber, carbohydrate, and metabolized energy generally increased. Formulation 4 had the lowest moisture content and the highest values for ash, lipid, protein, fiber, carbohydrate, and energy. These results indicate that fortification improved the nutritional profile of the muffin. The lower moisture content also suggests better shelf stability, while the higher protein, fiber, and mineral content make the product more suitable as a nutrient-dense supplemental food.

3.3 Acceptability Consumer Index

The Acceptability Consumer Index ranked Formulation 4 as the most acceptable, followed by Formulation 2, Formulation 0, Formulation 1, and Formulation 3. This ranking confirms that Formulation 4 had the strongest overall balance of sensory qualities. The ACI result shows that the best formulation was not simply the one with the highest fortification in every respect, but the one that achieved the most favorable combination of appearance, aroma, texture, and flavor. This supports the view that successful product development depends on balancing nutrition with consumer preference.

3.4 Shelf-Life Performance

Shelf-life observation showed that the control formulation spoiled earlier, while the fortified formulations stayed acceptable for a longer period. Formulations 3 and 4 remained edible up to seven days, with Formulation 4 showing the best stability. These results suggest that higher levels of Rice-Based Sagip Nutri-Powder helped reduce moisture buildup and delay spoilage. The improved shelf-life performance strengthens the practical value of the fortified muffins for storage, distribution, and feeding program use.

3.5 Cost and Return on Expenses

The cost analysis showed that production cost increased as more Rice-Based Sagip Nutri-Powder was added. Although all formulations were profitable, the control had the highest return on expenses, while Formulation 4 had the lowest. This means that nutritional improvement came with higher production cost. In practical terms, the results show a trade-off between profitability and nutrient density, with the fortified formulations offering better health value even if they are less cost-efficient to produce.

4. Conclusion & Recommendations

The study established that fortifying muffins with Rice-Based Sagip Nutri-Powder significantly enhances their nutritional value while maintaining high consumer acceptability. Among the formulations, Formulation 4 (80g fortification) demonstrated the best overall performance, yielding the highest protein, fiber, mineral content, and energy, along with improved shelf stability. Sensory evaluation revealed that fortification did not adversely affect color and taste, while aroma and texture were significantly improved in specific formulations. Although higher fortification levels increased production costs and reduced profitability, Formulation 4 achieved the highest Acceptability Consumer Index (7.82), confirming its effectiveness in balancing nutritional quality and consumer preference. Overall, the study confirms that Rice-Based Sagip

Nutri-Powder is a viable and effective ingredient for developing nutrient-dense bakery products suitable for supplemental feeding programs.

Based on the findings, Formulation 4 should be prioritized for implementation in community-based feeding programs due to its superior nutritional value and extended shelf life. The enhanced aroma and texture of fortified muffins should be emphasized in product promotion to improve consumer appeal. Further research is recommended to explore the application of Rice-Based Sagip Nutri-Powder in other baked products, particularly its potential to naturally extend shelf life through moisture reduction. Additionally, future evaluations should continue using standard sensory assessment procedures to ensure consistent product quality and acceptability.

Compliance with ethical standards

The authors declare no conflict of interest. This study complied with recognized ethical standards for human-participant research by ensuring voluntary participation with informed consent, the right to withdraw without penalty, and strict confidentiality through anonymous, secure, and aggregated data handling. Given the focus on psychological well-being, procedures were non-invasive, and safeguards were observed to minimize discomfort, with guidance to appropriate support services when needed, and required institutional permissions were secured for instrument use and access to academic records.

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