

Proximate Composition and Sensory Properties Evaluation of Pandesal Produced from Squash (*Cucurbita maxima*)

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Abstract

This study aimed to develop and evaluate pandesal produced from squash (*Cucurbita maxima*) fortified with Corn-Based Sagip Nutri Pack, focusing on its proximate composition, sensory properties, and economic feasibility. Anchored on nutrition improvement and food product innovation concepts, the study employed a quantitative true experimental research design. Four formulations were prepared, with three treatments (F2, F3, F4) subjected to nutrient analysis and sensory evaluation. Seventy-five purposively selected respondents assessed the product using a 9-point Hedonic Scale based on color/appearance, odor/aroma, taste/texture, and general acceptability, while statistical treatments included weighted mean, Analysis of Variance (ANOVA), and Tukey's HSD test. Results revealed that increasing levels of Corn-Based Sagip Nutri Pack significantly enhanced protein, fiber, lipid, ash, and energy content while reducing moisture, with F4 yielding the highest nutritional values. However, F2 obtained the highest acceptability ratings across all sensory attributes. Economic analysis showed that F1 and F2 achieved the highest return on expenses, indicating better financial feasibility compared to higher fortification levels. The study concluded that squash pandesal fortified with Corn-Based Sagip Nutri Pack is a viable and nutritionally beneficial alternative to conventional bread, with F2 providing the most balanced outcome in terms of acceptability, nutrition, and cost efficiency. It is recommended for use in school feeding programs and as a nutritious snack option. The study aligns with Sustainable Development Goals such as SDG 2 (Zero Hunger) and SDG 3 (Good Health and Well-being), as it promotes improved nutrition and accessible healthy food options. Its sustainability impact lies in supporting community nutrition interventions, enhancing food innovation using local resources, and contributing to efforts in reducing malnutrition among school-aged children.

Keywords: Acceptability, Corn-Based Sagip Nutri Pack, Pandesal, Proximate Composition, Sensory Evaluation, Squash, Sustainable Nutrition

1. Introduction

Academic success is closely linked to health, yet malnutrition continues to threaten this relationship by depriving individuals of essential nutrients required for proper physiological function (Johns Hopkins Medicine, 2025). The World Health Organization (2022) defines malnutrition as encompassing both undernutrition and overnutrition, both of which contribute to serious health risks. Globally, nutrition is recognized as fundamental to human development and dignity, as emphasized by the United Nations' Sustainable Development Goals (Grosso et al., 2020). Early-life nutrition, particularly within the first 1,000 days, is critical to preventing irreversible health consequences (Martorell, 2017). In the Philippines, malnutrition persists as a major public health concern, with 26% of children aged 5–10 stunted and 8.2% wasted (Department of Science and Technology - Food and Nutrition Research Institute (DOST-FNRI, 2021). The issue reflects a “triple burden” of undernutrition, micronutrient deficiencies, and overnutrition (EDCOM 2, 2024). Despite school-based feeding programs, malnutrition remains evident, as shown by cases of wasting, severe wasting, overweight, and obesity among students in Pinoma National High School. These challenges highlight the need for sustainable, acceptable, and nutrient-dense food innovations that can complement existing nutrition programs.

Existing literature emphasizes the nutritional importance of food-based interventions using locally available crops. Pandesal, a staple Filipino bread, primarily provides carbohydrates but lacks essential micronutrients (Martinez, 2017). Efforts to fortify pandesal with nutrient-rich ingredients, such as iron and vitamin A, have been explored (Dizon & Caballes, 2022). Squash (*Cucurbita maxima*) is widely recognized for its high content of vitamins A and C, fiber, and antioxidants (Smith, 2018). Similarly, corn, mung beans, malunggay, turmeric, sesame seeds, and cacao by-products offer significant nutritional benefits, including protein, fiber, essential minerals, and bioactive compounds that support overall health. Research also shows that incorporating nutrient-dense ingredients into baked goods can enhance both nutritional value and sensory acceptability (Gonzales et al., 2026; Mallillin et al., 2025). However, studies focusing on combining multiple fortifiers in a commonly consumed product like pandesal remain limited.

Globally, malnutrition is a major barrier to achieving sustainable development, particularly in health and education sectors. Nationally, the Philippines continues to face persistent malnutrition despite government interventions such as school feeding programs. At the local level, community-based initiatives like the Barangay Integrated Development Approach for Nutrition Improvement (BIDANI) demonstrate efforts to address malnutrition through integrated development strategies. However, data from adopted barangays show ongoing issues, including underweight, stunting, wasting, overweight, and obesity among children. These findings indicate that malnutrition remains widespread across different contexts, reinforcing the need for innovative, community-based, and food-centered solutions. This study is anchored on the concept that food fortification and dietary diversification can improve nutritional outcomes and support human development. Nutritional science suggests that incorporating nutrient-rich, plant-based ingredients into commonly consumed foods can enhance dietary intake without drastically altering eating habits. The integration of squash and corn-based Sagip Nutri Pack into pandesal aligns with functional food theory, where food products are enhanced to provide additional health benefits beyond basic nutrition. Furthermore, sensory evaluation principles (Lim, 2009; Sensory Society, 2021) support the importance of consumer acceptability in ensuring the success of food innovations.

Although school feeding programs and conventional nutritional interventions exist, literature indicates limited research on innovative, nutrient-enriched baked products tailored for school-based feeding (Gelli et al., 2021). Existing studies focus primarily on traditional interventions and do not sufficiently explore food products that combine nutritional enhancement with sensory acceptability. Moreover, despite ongoing programs, malnutrition persists in school communities, indicating gaps in sustainability and effectiveness. This study addresses these gaps by developing and evaluating squash-based pandesal fortified with corn-based Sagip Nutri Pack, aiming to provide a practical, acceptable, and nutrient-dense alternative for school feeding initiatives.

This study aligns with several Sustainable Development Goals:

SDG 2 – Zero Hunger: By developing nutrient-enriched food products to address malnutrition.

SDG 3 – Good Health and Well-Being: Through improving nutritional intake and supporting overall health.

SDG 12 – Responsible Consumption and Production: By promoting the use of locally available, nutrient-rich ingredients and reducing reliance on less nutritious processed foods. The research supports these goals by offering a sustainable, food-based solution to improve dietary quality and health outcomes.

This study contributes to multiple dimensions of sustainability:

Public Health Sustainability: Enhances nutrition and addresses malnutrition among schoolchildren.

Educational Sustainability: Supports improved learning outcomes through better health and nutrition.

Socio-economic Sustainability: Provides opportunities for local farmers to increase squash production and income.

Technological and Innovation Sustainability: Promotes food innovation through nutrient fortification and product development. Community Sustainability: Supports school feeding programs and community-based nutrition initiatives. By integrating nutrition, education, agriculture, and food technology, the study offers a multidisciplinary approach to sustainable development and community well-being.

2. Material and methods

2.1 Research Design

The study employed a quantitative approach using a true experimental research design to examine the chemical and sensory properties of squash pandesal. Different formulations were prepared under controlled conditions, with each formulation serving as a treatment group. Their properties were measured and compared using standardized procedures to ensure objective, reliable, and valid results in determining the effects of squash and Corn-Based Sagip Nutri Pack on product quality and acceptability.

2.2 Locale of the Study

The study was conducted at Pinoma National High School in Pinoma, Cauayan City, Isabela. The sensory evaluation and related activities were carried out within the school setting during April 2026 to ensure accessibility of respondents and proper implementation of the research procedures.

2.3 Respondents of the Study

The respondents consisted of seventy-five (75) purposively selected individuals composed of faculty, staff, and Senior High School students of Pinoma National High School. Participants were screened to ensure they were non-smokers, non-liquor drinkers, and in good health. Each respondent evaluated one sample of squash pandesal based on color/appearance, odor/aroma, taste/texture, and general acceptability using the 9-point Hedonic Scale. Standard sensory evaluation procedures were followed, including palate cleansing before and after tasting, to ensure reliability and validity of responses.

2.4 Sample and Sampling Procedure

Purposive sampling was used to select respondents who met the study criteria. The study involved four formulations of pandesal: a control formulation and three experimental treatments with varying proportions of Corn-Based Sagip Nutri Pack and squash. Each formulation maintained consistent ingredient quantities except for the substitution levels of the main ingredients. The treatments were systematically prepared and distributed for evaluation, ensuring controlled comparison among samples.

2.5 Research Instrument

The study utilized structured survey instruments based on Hedonic Scales to assess sensory attributes and acceptability. The 9-point Hedonic Scale was used to evaluate color/appearance, odor/aroma, taste/flavor, texture, and general acceptability, with responses ranging from “dislike extremely” to “like extremely.” A 5-point Hedonic Scale was also used for market analysis to measure respondents’ preferences. These instruments provided standardized quantitative data, ensuring consistency, objectivity, and reliability in evaluating the sensory characteristics of the product.

2.6 Data Gathering Procedure

Data collection followed a systematic and standardized process. Ingredients, including squash and Corn-Based Sagip Nutri Pack, were selected and prepared alongside other materials required for pandesal production. Equipment and utensils were properly sanitized to ensure food safety and hygiene. The preparation process involved measuring, mixing, kneading, fermenting, shaping, proofing, and baking the pandesal according to predetermined formulations. Squash was washed, peeled, cooked, and blended into a smooth mixture before incorporation into the dough. The dough was kneaded until elastic, fermented, shaped into equal portions, coated with breadcrumbs, and baked under controlled conditions. After preparation, the samples were subjected to nutrient analysis conducted at Quirino State University to determine their proximate composition. Sensory evaluation was then conducted using Hedonic Scales, where respondents assessed the product based on specified attributes. All procedures were carefully followed to ensure consistency, accuracy, and reliability of results.

2.7 Data Analysis Techniques

The collected data were organized, tallied, and analyzed using appropriate statistical methods. Frequency and percentage were used to summarize acceptability and marketability results. Weighted mean was applied to determine the level of sensory evaluation and overall acceptability. Analysis of Variance (ANOVA) was used to identify significant differences among the formulations in terms of sensory attributes. Tukey’s HSD post hoc test was conducted to determine pairwise differences among treatment groups. The study also included cost and return analysis to evaluate economic feasibility, computing production cost, selling price, total sales, income, and return on expenses. These statistical techniques ensured objective interpretation of results and valid comparison among treatments.

2.8 Ethical Considerations

The study adhered to ethical standards to protect the rights and welfare of all participants. Participation was voluntary, and respondents were fully informed about the purpose, procedures, and potential risks of the study. Consent and assent forms were secured, particularly for participants below 18 years old, with authorization from parents or guardians. Confidentiality and anonymity were strictly maintained, and respondents were allowed to withdraw at any time without penalty. All collected data were used solely for research purposes, ensuring integrity and ethical compliance throughout the study.

3. Results and Discussion

3.1 Product Development and Nutritional Composition

3.1.1 Product Development Process

The developed squash pandesal was prepared using a standardized formulation combining squash, flour, and Corn-Based Sagip Nutri Pack. The process involved ingredient preparation, blending of squash, mixing, kneading, fermentation, shaping, and baking, ensuring uniform quality and yield. The formulation emphasized squash as a major component, contributing to improved nutritional value and product consistency. This development approach aligns with enrichment strategies in bread products, where nutrient-dense ingredients are incorporated to enhance health benefits without compromising acceptability, as supported by Lang-ayan et al. (2022). The balance of ingredients ensured desirable texture, flavor, and nutritional enhancement, demonstrating that traditional bread products can be effectively modified into functional foods.

3.1.2 Proximate Composition and Energy Content

The proximate analysis showed that increasing the level of Corn-Based Sagip Nutri Pack resulted in decreasing moisture content from 27.48% to 17.66%, while ash, lipid, protein, fiber, carbohydrate content, and metabolized energy consistently increased across formulations. The highest values were observed in the formulation with the greatest level of fortification, indicating improved nutrient density and energy contribution. These results indicate that fortification enhances the

nutritional profile of pandesal, particularly in protein, fiber, and energy content. The reduction in moisture suggests improved shelf stability, while increased ash content reflects enhanced mineral composition. The findings confirm that higher substitution levels produce greater nutritional benefits, making the fortified pandesal a viable option for addressing nutritional deficiencies.

3.1.3 Statistical Differences Among Formulations

Statistical analysis revealed significant differences among formulations in most nutritional components. Moisture, protein, fiber, and energy showed significant differences across all comparisons, while ash and lipid exhibited significance only at higher substitution levels. Carbohydrates showed minimal differences except at the highest level of fortification. These findings confirm a dose-dependent effect of the Corn-Based Sagip Nutri Pack, where increasing levels significantly influence nutritional composition. The consistent improvement in protein and fiber highlights the effectiveness of fortification, supporting its role in enhancing the functional value of baked products.

3.2 Sensory Acceptability of the Product

3.2.1 Color and Appearance

The results showed that the formulation with moderate fortification obtained the highest acceptability rating for color and appearance, described as “like very much,” while the control formulation received the lowest rating. Other fortified formulations were rated as “like moderately,” indicating overall positive acceptance. This suggests that the addition of squash and fortifier improves visual appeal without negatively affecting product quality. The findings support Gonzales et al. (2026), who reported that ingredient enrichment can influence crumb structure and overall appearance, contributing to consumer preference.

3.2.2 Odor or Aroma

The results indicated that the moderately fortified formulation received the highest rating for aroma, followed by higher-level formulations, while the control obtained the lowest rating. Overall, the product was rated from “like moderately” to “like very much.” This demonstrates that squash and the fortifier enhance the aroma of the product. The findings are consistent with Mercadal et al. (2022), which showed that squash contributes a pleasant natural aroma that improves sensory appeal and consumer acceptance.

3.2.3 Taste or Flavor

The findings revealed that the moderately fortified formulation achieved the highest rating in taste, described as “like very much,” while other fortified samples were rated “like moderately,” and the control received the lowest score. This indicates that squash incorporation does not negatively affect taste and may enhance flavor when used in appropriate proportions. This supports the findings of Mallillin et al. (2025), which emphasized that squash-enriched products generally achieve favorable taste acceptability.

3.2.4 Texture

The results showed that the moderately fortified formulation obtained the highest texture rating, while other formulations were rated moderately acceptable and the control received the lowest score. This suggests that the addition of squash maintains desirable texture characteristics of pandesal. The findings align with Adebayo et al. (2025), which highlighted that texture significantly influences overall product acceptability and consumer preference.

3.2.5 General Acceptability

The results demonstrated that the moderately fortified formulation achieved the highest overall acceptability, while other fortified formulations were moderately accepted and the control had the lowest rating. This indicates that the product is generally acceptable to consumers and that moderate fortification provides the best balance between sensory quality and nutritional enhancement. As noted by Lim (2009) and Sensory Society (2021), higher hedonic scores reflect stronger consumer preference and satisfaction, confirming the product’s potential for market acceptance.

3.3 Economic Feasibility and Return on Expenses

The results showed that production cost increased with higher levels of fortification, with the control having the lowest cost and the most fortified formulation having the highest cost. However, despite higher costs, the moderately fortified formulation achieved the highest total sales and income, while the most fortified formulation generated the lowest profit. Return on expenses was highest for the control and moderately fortified formulations, and lowest for the highly fortified formulation. These findings indicate that increasing fortification improves nutritional value but also raises production costs, which may reduce profitability. The results support Vicky (2025), emphasizing that cost management is essential in ensuring sustainability and profitability in food production. The moderately fortified formulation provides the best balance between cost, acceptability, and profit, making it the most practical and marketable option.

4. Conclusion & Recommendations

The study demonstrated that the incorporation of Corn-Based Sagip Nutri Pack into squash pandesal significantly improved its nutritional composition, as evidenced by increased protein, fiber, lipid, mineral content, and metabolized energy, alongside decreased moisture content. Among the formulations, the highest level of fortification exhibited the greatest

nutritional enhancement, while the moderately fortified formulation showed the highest sensory acceptability in terms of color/appearance, odor/aroma, taste/texture, and general acceptability. Furthermore, economic analysis revealed that lower to moderate fortification levels yielded higher return on expenses, indicating better financial feasibility. Overall, squash pandesal fortified with Corn-Based Sagip Nutri Pack is a viable, nutritionally beneficial, and acceptable alternative to conventional bread products, with optimal results achieved when balancing nutritional improvement, sensory quality, and cost efficiency.

Based on the findings, it is recommended that food manufacturers and business owners consider adopting the moderately fortified formulation as a viable alternative to commercial pandesal due to its balance of acceptability, nutritional value, and cost efficiency. School canteen operators and feeding program coordinators may incorporate the product into their offerings and nutrition interventions to help address malnutrition among learners. Nutritionists and dietitians may also recommend the product as a nutritious snack option, particularly for individuals requiring increased energy and nutrient intake. Additionally, future researchers are encouraged to further investigate the product's potential health benefits and explore its micronutrient composition to strengthen its nutritional profile and applicability.

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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