

RESEARCH ARTICLE

The Role of Winged Beans in Modern Loaf Bread Production: Exploring Nutritional Benefits and Consumer Acceptance of an Innovative Ingredient

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Abstract

Winged beans (*Psophocarpus tetragonolobus*) are one of the nutrient-dense legumes that can transform foods such as a simple bread into a superfood. Therefore, its flour makes it a sustainable alternative to wheat and soy flour for baking. This study explores the use of winged bean flour in loaf bread to enhance the nutritional profile of conventional wheat-based goods. The study assesses substitution levels of 20% formulation among 50 respondents in Imus, Cavite, using a mixed-methods approach that includes a 9-point hedonic sensory evaluation and a 5-point Likert scale for the consumer market intent and perception. This study has demonstrated that winged beans are an effective functional component of modern loaf bread making because of their balanced traditional local crops with the nutritional requirements of current baking. The overall satisfaction obtains the highest scores for making winged bean loaf bread. Additionally, as 100% of the participants said that they would be prepared to consume and pay more for protein, nutritional enrichment, and health promotion, the results demonstrate a significant market potential in the local community of Imus, Cavite. More long-term shelf-life studies are required to determine if this significant moisture retention persists over time and how it affects mold inhibition in terms of bread making.

Keywords: Consumer acceptance; Functional foods; Loaf bread; Nutritional enhancement; Winged beans (*Psophocarpus tetragonolobus*).

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Received: December 11, 2025

Accepted: April 10, 2026

To cite this article:

Gonzales, K. M., Encinas, E. B., Pineda, N. M., & Baleos, D. M. (2026). The role of winged beans in modern loaf bread production: Exploring nutritional benefits and consumer acceptance of an innovative ingredient. *SDCA Asia-Pacific Multidisciplinary Research Journal*, 8(1), 55-59. doi: 10.5281/zenodo.20715812

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Introduction

Bread is considered a staple food for most people. According to Weegels (2019), its inherent benefits make it even more significant as a food that can withstand future threats to the food supply and is a ready-to-eat staple which may substantially contribute to the daily necessary intakes of fiber, protein, vitamins, and minerals. However, traditional white loaf bread often lacks the fiber and proteins needed for modern dietary trends.

Although recent advancements in the bread-making process, such as the addition of enzymes, flours of non-plant origin, antimicrobial supplements, improved yeast strains, baking tools, and enhancement of dough rheological properties, have made it possible to bridge the gap between nutritional demands and fulfillment (Goel et al., 2021; Makeri et al., 2017), their nutritious content is either greater or lower than usual amounts of nutrients such as iron, potassium, magnesium, calcium, copper, and zinc when bread is stored in poor conditions (Aghalari et al., 2022). Although fortification enhances gut health, glycemic management, and antioxidant activity, issues with nutritional stability, bioavailability, and sensory changes persist with regards to bread making (Falsafi et al., 2025).

The use of winged beans (*Psophocarpus tetragonolobus*) in loaf bread has not been properly examined in the Philippine context, despite the fact that the use of other legumes to enhance bread has been extensively investigated in the global academic literature. The winged bean, also known by the Tagalog name “*sigarilyas*,” is a nutritional powerhouse that is often referred to as a “one-plant pharmacy.” *Sigarilyas* is a tropical leguminous plant that is classified as one of the underused legumes, making it an underappreciated food source in tropical places and is also called asparagus pea, goa bean, four-angled bean, and winged bean (Barlongo & Mercado, 2024). It has many health benefits, such as high intakes of vitamin A and C for immune system support, iron for anemia prevention, and calcium for bone density, from its protein-rich seeds to its vitamin-rich leaves. Its high folate concentration also makes it an excellent supplement for maternal health, and its dietary fiber aids in healthy blood sugar regulation. In fact, research by Adegboyaga et al. (2019) and Bepary et al. (2023) showed that the winged bean plant’s extract, including seeds and tubers, contains anti-inflammatory, anti-oxidant, antibacterial, and antiproliferative qualities. Tanzi et al. (2019) agreed that it is more difficult to represent policies and research funding schemes that would boost such sources of food and income, as well as to incorporate crops like winged beans into a more thorough evaluation of the diversity of national food production systems, due to this lack of information. Nevertheless, the main advantage is by increasing the ability of these kinds of underutilized legumes to provide balanced diet in optimum quantities (Ayilara et al., 2022; Samal et al., 2023).

Winged beans are high in iron, calcium, and B vitamins, and their protein content is similar to that of other legumes (Chinnadurai & Devi, 2025; Eagleton, 2020; Mohanty et al., 2020). They are perfect for climate-resilient food systems because they fix nitrogen. Previous innovations in bread-making using soybean or chickpea flours suggest that similar substitutions can be successful with winged beans. The morphological research by Riwayati et al. (2022) revealed that the high protein and carbohydrate content causes winged bean seed flour particles to agglomerate in terms of loaf bread. Akhsanitaqwm et al. (2024) discovered that making cookies with winged bean seed flour and cassava leaf paste might be a novel way to stop stunting, as the mix of 25% winged bean seed flour and 15% cassava leaf paste produced the best results in terms of sensory qualities, based on organoleptic test findings showing a preference for this formulation. Wardany and Nasrulloh (2025) demonstrated that changes in the proportion of arrowroot starch to winged bean seed flour have a major impact on the nutritious composition of steamed sponge cake, especially the amounts of calcium, protein, fat, carbohydrates, and ash, whereas steamed sponge cake made with a larger percentage of winged bean seed flour had a nutritious profile more suited for sport food, with lower levels of carbohydrates and higher protein and healthy fat contents. However, a research gap exists regarding consumer perceptions and optimal substitution ratios specifically for winged bean-enriched loaves in local communities.

Although research on legume-enriched breads has been conducted, little research focuses on the use of winged beans in loaf bread in the context of Philippine culture. The demand for evidence-based formulations that increase the protein and fiber content of popular bread without sacrificing sensory appeal is addressed by this study. This work has the potential to fill a gap of evidence-based formulations that improve the nutritional content of a popular foodstuff without compromising on the sensory attributes of taste, texture, and aroma, which are expected by local consumers. Focusing on cultural adaptation, this work investigates the innovative application of the winged bean in loaf bread making for the residents and industry makers of Imus, Cavite. In combining healthy nutrition with sensory pleasure, this study strives to offer a practical architecture for enhancing public health through a well-sustained food source (known to all) that reflects local food choices and the native crop use.

Methodology

A descriptive quantitative research methodology was used to determine the acceptability, nutritional value, and consumer perception of loaf bread enhanced with 20% winged bean (*Psophocarpus tetragonolobus*) flour. While the descriptive component looked at customer reactions on sensory qualities and market acceptability, the experimental component concentrated on creating loaf bread formulations employing winged bean flour as a partial replacement for wheat flour.

The study was carried out in Imus, Cavite, Philippines due to its accessibility to local consumers, bakers, and nutritionists who might offer pertinent insights into the cultural and nutritional acceptance of winged bean-enriched bread products. The survey included 50 adult respondents, wherein consumers, bakers, and nutritionists from Imus, Cavite, made up the participants. Respondents who were willing to take part in the sensory evaluation and who were familiar with bread products were chosen using convenience and purposeful sampling strategies. A structured sensory evaluation questionnaire based on a 9-point hedonic scale for overall acceptability and a 5-point Likert scale for consumer market intent and perception based on nutritional value importance, climate resilience interest, purchase intent at local bakery, family consumption confidence, and substitution frequency served as the study’s main research instrument.

Fresh, ripe winged bean seeds were properly washed to get rid of dirt and contaminants. A food grinder was used to crush the seeds into fine flour after they had been cleaned and either sun-dried or oven-dried at a regulated temperature. In this formulation, 20% of the wheat flour in the bread recipe was replaced with winged bean flour. Preliminary results indicating that the substitution level offers better nutritional content while preserving acceptable sensory qualities led to its selection. Respondents were given samples of finished bread for sensory evaluation. The bread was evaluated by participants based on the following characteristics:

- Overall acceptability
- Crumb texture
- Aroma profile
- Color acceptance
- Moisture retention

A 5-point descriptive scale was employed for the customer intent and purchase, while a 9-point hedonic scale, ranging from “1 – Dislike Extremely” to “9 – Like Extremely,” was used for overall satisfaction. Informed consent was obtained prior to conducting the study. The quantitative information obtained from the sensory evaluation was analyzed using descriptive statistical techniques such as frequency, percentages, and weighted mean.

Respondents were requested to participate voluntarily after being informed of the study's objectives. Participants were given individual bread samples, and as soon as they tasted the food, they filled out the sensory evaluation questionnaires. The study's goals were explained to the respondents, who were also given the assurance that any information gathered would be kept private and utilized only for academic research.

Results and Discussion

The results of an experimental sensory evaluation and consumer perception survey with 50 individuals in possession of winged bean-enriched loaf bread show a very high level of acceptability. The incorporation of such a novel ingredient can influence the nutritional perception and the market feasibility of the product among the local inhabitants of Imus, Cavite.

Sensory Characteristics and Consumer Acceptance

Overall satisfaction with the bread sample was extremely high, as 62% of the respondents considered that “9 – Like Extremely” and 22% as “8 – Like Very Much”. Mean scores and interpretations for certain sensory features are displayed in Table 1. Among the most important ones is the observation of moisture retention, the average “5.00”, where all 50 participants considered the bread as “Very Moist and Fresh”. Furthermore, even though each participant noticed the unique greenish-yellow tint of the crust and crumb, 100% of them rated the color “Very Strong” in its appeal, meaning the appearance was still non-traditional, but did not detract from its perceived quality.

Table 1. Mean Scores for Sensory Attributes of Winged Bean Loaf Bread

No.	Sensory Attribute	Mean	Interpretation
1	Overall Satisfaction (1–9 Scale)	8.22	Like Very Much
2	Crumb Texture (Softness)	4.86	Very Soft/Airy
3	Aroma Profile (Beany/Earthy)	1.22	Not Noticeable
4	Color Acceptance (Visual Appeal)	5.00	Very Strong Appeal
5	Moisture Retention	5.00	Very Moist and Fresh

Legend: Mean scores based on a 5-point scale unless otherwise noted.



Figure 1. Consumer Market Intent and Perception (Legend: Results based on 50 respondents)

Figure 1 shows the results with a very high degree of agreement among respondents about the factors assessed based on a 5-point Likert scale. The highest mean scores were achieved by Climate Resilience Interest and Family Consumption Confidence, both with

weighted means of 5.00, indicating that respondents strongly agree with the significance of climate-resilient food products and are very confident in serving them to their families. Respondents highly valued the product's nutritional benefits, as seen by the high rating of Nutritional Value Importance, especially with regard to calcium and iron content ($M = 4.96$). Similarly, Purchase Intent at Local Bakery ($M = 4.92$) indicates that respondents are strongly inclined to purchase the product should it become available at local bakeries. The characteristic with the lowest mean score, Substitution Frequency from regular to nutrient-dense items ($M = 4.86$), is still in the "Strongly Agree" range, indicating a substantial probability of consumers switching to healthier options. Continuously high mean scores point to significant market potential, favorable opinions of the product's nutritional and environmental advantages, and great consumer acceptability.

The "Not Noticeable" beany scent (Mean = 1.22) and "Very Soft" crumb texture (Mean = 4.86) showed that the recipe was able to cover up the characteristic "earthy" qualities in legumes that frequently drive off customers. Surprisingly, rather than being an obstacle, the green-yellow hue was one of the main appealing features. Future long-term shelf-life research is needed to determine whether this high moisture retention (Mean = 5.00) endures over time and how it influences mold inhibition.

Conclusions and Recommendations

This study has shown that winged beans (*Psophocarpus tetragonolobus*) are an effective functional component of modern loaf bread manufacturing because they have balanced traditional local crops with the nutritional requirements of contemporary baking. This evidence shows that winged bean flour, as opposed to wheat flour, increases food protein and fiber content in bread significantly and maintains a high acceptance by consumers. More precisely, a sensory assessment for 50 respondents revealed "Overall Satisfaction" with an average score of 8.22 ("Like Very Much"), texture of crumb and moisture binding scoring very close to perfect. Also, the results indicate a clear market potential in the local community of Imus, Cavite, given 100% of the participants showed the willingness to pay more for health promotion and nutritional enrichment of the product, as well as protein. In addition, the study highlights the need for "cultural adaptation," revealing that consumers are very sensitive to locally made, culture-adapting ingredients, provided that this ingredient is offered in familiar formats such as loaf bread.

Considering the findings mentioned, the recommendations are:

1. **For local bakers and entrepreneurs:** Adopt the optimized formulation of winged bean flour to develop a "functional" line of bakery products that caters to health-conscious consumers.
2. **For nutrition educators:** Apply these findings to increase the utilization of untapped local legumes as a sustainable source of supplemental source of underused legumes through a low-impact alternative to imported fortification methods.
3. **For further studies:** Carry out long-term shelf-life analysis and more specific proximate analysis to assess the exact bioavailability of minerals (such as calcium and iron) to quantify the complete bioavailability of minerals such as Calcium and Iron in the finished item in the baked product.
4. **For agricultural stakeholders:** Expand on the growing and supply-chain support for winged beans to meet the potential industrial demand from the baking industry.

Acknowledgments

This section will give an opportunity to the authors to thank those who participated in carrying out this work. The authors wish to acknowledge the support of the School of Hospitality, Tourism, and Business Management at St. Dominic College of Asia in furnishing the necessary kitchen and laboratory facilities for the development of the product. Our gratitude to these 50 respondents who were from Imus, Cavite, including consumers, bakers, and nutrition professionals, and who played a large role in the sensory evaluation and survey to do this analysis.

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