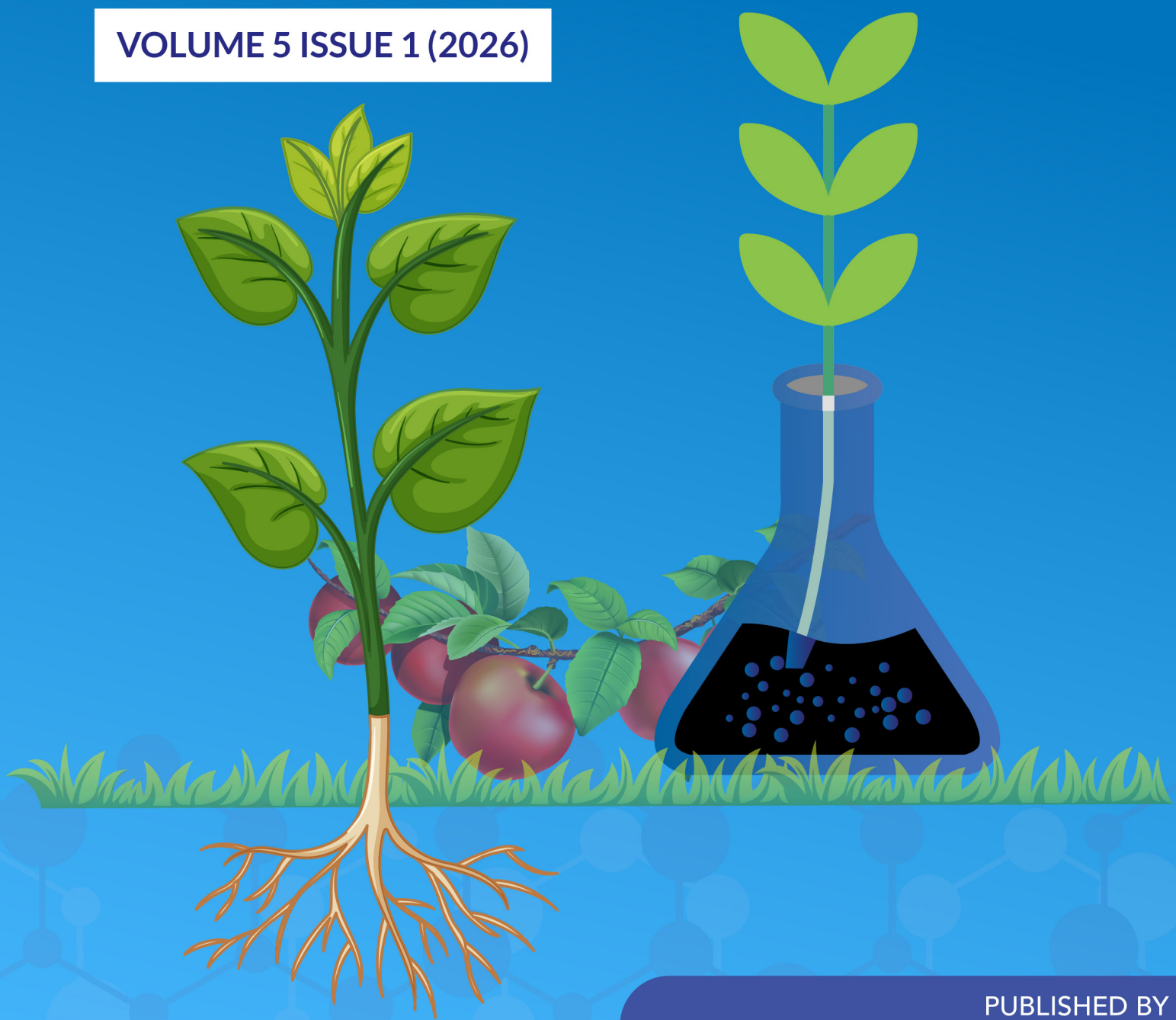




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From Garden to Table: Incorporating Organic Lettuce into Pandesal

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ABSTRACT

This experimental research investigates the acceptability of organic lettuce pandesal in different preparations, focusing on appearance, aroma, taste, texture, and general acceptability. The addition of organic lettuce to the traditional Filipino bread, pandesal, is an innovative approach to boost its nutritional content. With a growing emphasis on healthier food choices, this study aims to determine the significant differences in acceptability among different preparations and the potential benefits of incorporating organic lettuce into the pandesal recipe. The ultimate goal is to create a functional and appealing product while enhancing its nutritional value. This research provides an overview of pandesal, which is considered the classic bread roll of the Philippines. It explores the flavor of pandesal and investigates the incorporation of organic lettuce to enhance its nutritional content. The study analyzes micronutrients such as crude protein, total fat, carbohydrates, and energy to assess the potential health benefits for consumers. The study follows an experimental research process, incorporating organic lettuce into the pandesal and evaluating its acceptability in terms of appearance, aroma, taste, texture, and general acceptability. The findings reveal that pandesal with 40 grams of blended lettuce receives the highest evaluation, described as “liked extremely” by the evaluators. The results of this study support the diverse bakery products with enhanced nutritional profiles to appeal to health-conscious customers. By incorporating organic lettuce, this study aims to offer a healthier alternative to pandesal while preserving its original flavor and cultural significance. These findings have implications for customers seeking tasty and nutritious foods to include in their regular diets, as well as for the food business industry.

INTRODUCTION

Food plays an important role in maintaining good health, and dietary choices are influenced by factors like nutrition, health considerations, and food availability. In the Philippines, pandesal is one of the most widely consumed bread products, usually served for breakfast or as a snack. Its affordability and accessibility make it a staple food in Filipino households and a vital resource during emergencies, particularly in evacuation centers. Over time, its popularity has given rise to product innovations, including ube pandesal and malunggay pandesal, which incorporate additional flavors and nutrients (Food and Agriculture Organization [FAO], 2021).

Lettuce (*Lactuca sativa* L.), a leafy vegetable available year-round, is commonly included in the diets of health-conscious individuals. Rich in micronutrients and bioactive compounds, lettuce contributes to immune system support and overall wellness (USDA, 2023). To recognize its nutritional potential, the West Visayas State University–Pototan Campus, in partnership with the Department of Agriculture, established a Greenhouse Project for the organic cultivation of lettuce. Building on this initiative, the present study explored the incorporation of lettuce into pandesal to enhance its nutritional quality. This innovation not only supports institutional food production and income generation

but also offers consumers a fortified bread product with added health benefits.

In addition, this study supports the national nutrition initiatives. Republic Act No. 8976, known as the Philippine Food Fortification Act of 2000, which was enacted to address widespread micronutrient deficiencies, including those in energy, iron, vitamin A, iodine, thiamin, and riboflavin. Food fortification is recognized as an effective strategy to increase the intake of essential nutrients among Filipinos, in line with the Recommended Dietary Allowances (RDA) (Department of Health [DOH], 2020). By incorporating organically grown lettuce into pandesal, this research contributes to the wider goals of the government in combating malnutrition and promoting public health.

Moreover, this study supports the United Nations Sustainable Development Goals (SDGs), particularly SDG 2: Zero Hunger, by promoting access to nutritious and fortified food, and SDG 3: Good Health and Well-being, by contributing to healthier dietary practices and overall wellness (United Nations, 2023). By developing a nutritious bread product using organic ingredients that are produced locally, this research is the best example of sustainable approach to address both nutritional deficiencies and food security in the Philippines.

In light of these considerations, the study was conducted

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with the following objectives:

1. To determine the level of acceptability of organic lettuce pandesal in different preparations in terms of appearance, aroma, taste, texture, and general acceptability; and
2. To assess whether there is a significant difference in acceptability across different preparations and nutritional content.

LITERATURE REVIEW

The Department of Health (DOH) conceptualized the Philippine Food Fortification Program as a national strategy to address malnutrition. Its primary objective is to improve the nutritional status of the population by strengthening the availability and consumption of fortified foods (Department of Health, 2020). Food fortification is a national strategy in the Philippines to address micronutrient deficiencies. The Philippine Food Fortification Act of 2000 (RA 8976) mandates fortification of staple foods, complemented by behavior change and nutrition education programs to improve population health outcomes. Program briefs from the Department of Health (DOH) and the National Nutrition Council (NNC) emphasize integrating fortification with broader food-based interventions and public education to address persistent malnutrition linked to socioeconomic factors and caregiver knowledge. Additionally, the DepEd Order No. 39, s. 2017 or the Operational Guidelines on the Importance of the School-Based Feeding Program aims to improve beneficiaries' nutritional status by at least 70% after 120 feeding days. This order promotes nutritious food products like iron-fortified rice in school feeding programs to address malnutrition among undernourished learners (Severely Wasted and Wasted Kindergarten to Grade 6). Policies like these support and mandate the good health and well-being of the individual specially the learners.

Lettuce (*Lactuca sativa* L.) is consumed widely a leafy vegetable characterized by high water content and low energy value. According to the United States Department of Agriculture (USDA, 2019), it provides small amounts of protein, fat, carbohydrates, dietary fiber, and sugars, while serving as a source of minerals such as calcium, iron, magnesium, phosphorus, potassium, sodium, and zinc. Lettuce also contains B vitamins (thiamin, riboflavin, niacin, folate, and vitamin B6), along with vitamins C, A, E, and K.

Beyond its nutrient composition, lettuce is known to have various health benefits. Nagdeve (2020) reported its anti-inflammatory, cholesterol-lowering, sedative, antioxidant, and antimicrobial properties, as well as its potential role to reduce anxiety. Johnson (2019) also claimed the nutritional value of romaine lettuce, emphasizing its contributions to cardiovascular health through because of its high potassium, its antioxidant properties, and its richness in vitamin A.

Lettuce is also widely recognized not only for its culinary purpose but also for its medicinal applications. Different variety of lettuce exist, including crisphead (iceberg),

summer crisp (Batavian), butterhead (Boston or Bibb), romaine (cos), looseleaf, and oakleaf types (Ryder, 1999). Because of the various claims on the discovery of functional foods that promote good health and well-being, the idea of bread fortification was conceptualized. According to Rosell *et al.* (2016), bread can be a useful vehicle for adding phytochemicals, dietary fibers, and bioactive components. These findings are consistent with more recent assessments that emphasize the value of plant-based functional components in bread for enhancing its sensory qualities as well as for promoting long-term health advantages, such a lower risk of chronic illness (Plant Foods for Human Nutrition, 2022).

There are trends towards the innovation of various food products. These trends play an important role in enabling bakeries offer value-added varieties and compete in the market. Innovation is particularly important in the marketability of certain products, such as pandesal, considering their nutritional contribution and better-tasting choices. At present, there are popular pandesal flavors like malunggay pandesal, squash pandesal, and cheese pandesal, among many others. The COVID-19 pandemic has caused people to pause or even stop their regular activities, creating opportunities for many to discover new things, including new recipes. During the quarantine period, innovative Filipinos have created pandesal flavors such as chocolate pandesal (VCCI Bakeshop and Kimmy Bakes), bavarian pandesal (AMBOS Panaderia), caramel pandesal (Miss B's Infused Honey), pandan pandesal (Pan de Marino and Mrs. Pandesalan), ube and cheese pandesal (LaViestdale), matcha pandesal (Miss B's Infused Honey), red velvet pandesal (Baker n Better), blueberry cream cheese pandesal, and peanut butter pandesal (Flavors by Yna), strawberry cream cheese pandesal (Purple Dough), and mango pandesal (Bread Crumbs Bread shop). Bread is a globally consumed staple and a practical vehicle for nutrient delivery and functional ingredients. Contemporary reviews note accelerating efforts to fortify bread with vitamins, minerals, fibers, and phytochemicals to improve public health outcomes and align with consumer interest in "better-for-you" bakery products (Eres-Fernández *et al.*, 2024; Mannar & Hurrell, 2023). Within the Philippine context, pandesal a small, slightly sweet roll functions as an everyday carrier for fortification interventions. Studies have shown that fortified pandesal can improve micronutrient status among Filipino schoolchildren: vitamin A-fortified pandesal significantly increased serum retinol (Ocampo *et al.*, 2000), while iron-fortified variants improved hematologic indicators in anemic children after sustained daily intake (Uy *et al.*, 2010).

Due to its widespread popularity, pandesal has become a staple component of the typical Filipino breakfast and, in some cases, serves as a substitute for rice. It is traditionally consumed hot and freshly baked, with one distinctive cultural practice being its consumption when dipped in coffee. Over time, its availability has expanded, and many bakeries now offer pandesal not only for breakfast

but also as a snack throughout the day. According to Gabriel and Mollenhauer (2016), pandesal accounts for approximately 50% of total bakery production in the Philippines, underscoring its dominance in local bread consumption compared to other bakery products.

Several studies have explored the fortification and quality enhancement of pandesal and other bread products in the Philippines. Cabalda *et al.* (2011), in their study Efficacy of pandesal baked from wheat flour fortified with iron and vitamin A in improving the iron and anthropometric status of anemic school children in the Philippines, demonstrated that iron fortification of flour significantly reduced the prevalence of iron deficiency among anemic schoolchildren in non-malaria endemic areas. Moreover, double fortification with iron and vitamin A improved hemoglobin status, highlighting pandesal as a viable vehicle for addressing micronutrient deficiencies. Building on this premise, the present study aims to fortify pandesal with nutrients derived from lettuce (*Lactuca sativa*), thereby enhancing its functional value.

Other bread-based fortification efforts further support this approach. Ramos, Manaois, Morales, and Mamucod (2015), in their study Quality characteristics and consumer acceptability of salt bread supplemented with chili pepper (*Capsicum sp.*) leaves, found that supplementation with varying levels of crushed or powdered chili pepper leaves enhanced sensory attributes such as greenness, surface texture, leafy aroma, taste, and aftertaste, without negatively affecting the denseness, moistness, or tenderness of the bread. In terms of shelf life improvement, Azanza *et al.* (2016) reported that the combined use of antimicrobials such as calcium propionate and potassium sorbate effectively delayed mold spoilage in pandesal. Additionally, the incorporation of hydrocolloids and emulsifiers not only retarded staling but also inhibited microbial growth, thereby extending product stability.

These studies are proof of the adaptability of pandesal as a medium for fortification, functional ingredient incorporation, and shelf-life enhancement, further justifying its use in nutrition-focused product development. Considering the well-known benefits of vegetable fortification in bread, adding organic lettuce to pandesal, a popular and culturally significant bread in the Philippines, offers an additional opportunity to improve both the bread's nutritional value and attractiveness to consumers. Current study on lettuce fortification shows significant possibilities for improving antioxidant content and nutritional value, even though adjustment is necessary to preserve acceptable taste qualities. By developing organic lettuce pandesal, our work contributes to the growing body of evidence showing bread is a versatile medium for health-conscious innovation.

MATERIALS AND METHODS

The sources of data for this study were the responses of 35 evaluators composed of 10 teachers who are specialized in food, 15 students major in food-related courses, and

10 consumers from Pototan, Iloilo. These evaluators assessed the sensory characteristics of the organic lettuce pandesal. The selection of evaluators followed specific criteria to ensure the reliability and validity of the sensory assessment. Participants were selected based on their familiarity with bread products, sensitivity to variations in taste and texture, and willingness to participate in structured evaluations. Individuals with known allergies to bread or lettuce were excluded to minimize health risks. The evaluator pool included both trained panelists (teachers specializing in food) and untrained consumers (students and general consumers), thereby ensuring a balanced assessment of technical and consumer perspectives, consistent with recommended practices in sensory evaluation (Stone & Sidel, 2004; Lawless & Heymann, 2010).

Sensory characteristics were measured using a standardized Sensory Evaluation Score Sheet based on the Nine-Point Hedonic Scale. It uses a structured rating scale ranging from 1 ("dislike extremely") to 9 ("like extremely") to capture respondents' degree of liking or disliking for specific food attributes such as appearance, aroma, taste, texture, and overall acceptability. It is frequently used in product development studies, including those evaluating fortified or nutritionally enhanced foods, because it offers a straightforward, standardized, and statistically measurable indicator of customer preferences. This scale is frequently used to measure consumer preferences in sensory evaluations (Peryam & Pilgrim, 1957; Lim, 2011). Prior to the evaluation, the necessary tools, utensils, and equipment were prepared. Measuring tools included standard measuring spoons and cups, while utensils consisted of baking sheets, mixing bowls, and spatulas. Equipment such as a blender, weighing scale, and oven were also readied.

The formulation of lettuce pandesal underwent repeated testing and refinement until an acceptable blend of ingredients was achieved. To evaluate the influence of lettuce incorporation on product quality, samples with varying lettuce treatments were prepared and subjected to sensory evaluation. Special attention was given to texture and moisture content, with moisture levels measured at different time intervals to determine the extent of moisture migration and its impact on bread quality, following established food quality assessment methods (AOAC, 2019).

The most acceptable formulation was further subjected to proximate analysis conducted at the Department of Science and Technology (DOST), La Paz, Iloilo City, Philippines. This analysis provided an objective assessment of the nutritional composition of the optimized product in accordance with AOAC (2019) procedures.

Both descriptive and inferential statistics were used to analyze the information acquired from the sensory assessment of lettuce pandesal. The weighted mean for each sensory attribute appearance, aroma, taste, texture, and general acceptability was calculated using the respondents' responses as part of the descriptive

data. The 9-point hedonic scale, on which 9 denotes “like extremely” and 1 denotes “dislike extremely,” was used to interpret the weighted mean

Data collected from the sensory evaluation were tabulated and statistically analyzed. Frequency and percentage were computed to describe the sensory characteristics of the products. Mean and standard deviation were employed to determine the overall level of acceptability. To identify significant differences among treatments, Analysis of Variance (ANOVA) was applied at a 0.01 level of significance, consistent with statistical procedures used in sensory evaluation studies (Montgomery, 2017). Each sample was evaluated in three replications by the respondents for appearance, aroma, taste, texture, and general acceptability.

Furthermore, the results of the analysis indicated that the respondents provided high acceptability ratings for all sensory attributes, with no adverse effect attributed to the inclusion of lettuce in the formulation. The statistical treatment at the 0.01 level of significance ensured that the findings were highly reliable and minimized the likelihood of committing a Type I error.

RESULTS AND DISCUSSION

Level of Acceptability of Organic Lettuce Pandesal In Terms of Appearance, Aroma And Texture

The results revealed significant differences in the appearance of the pandesal samples across treatments, with Treatment C receiving the highest evaluation ($M = 8.38$, $SD = 0.81$) and Treatment A the lowest ($M = 7.24$, $SD = 0.85$). This suggests that the incorporation of organic lettuce positively influenced the visual appeal of the product. The distinctive light-green coloration and crusty texture of the lettuce-fortified pandesal were viewed as desirable by the evaluators, enhancing its overall acceptability in terms of appearance.

This result is in line with other research that highlighted how visual attributes influence consumers’ food preferences. Spence (2015) asserts that, as customers frequently use color and form to judge freshness and quality, appearance is a key sensory indicator that affects first impressions and overall product evaluation. In a similar vein, Delwiche (2004) pointed out that food color has a big impact on consumer expectations, which in turn influences how acceptable and tasty food is perceived. In the present study, the unique green color produced by the lettuce likely contributed to a perception of the pandesal as a healthier and more natural bread option, coinciding with increased consumer demand for functional and nutritional bakery items.

In addition, these results are supported by recent research on baked goods enhanced with vegetables. Ghoshal *et al.* (2021), for example, found that adding leafy greens to bread recipes increased consumers’ perceptions of the product’s healthfulness without compromising its sensory appeal. Similarly, Manohar and Haridas Rao (2018) discovered that because of their unique coloring and correlation with additional nutritional advantages,

vegetable-fortified bread samples were typically ranked higher in terms of attractiveness.

Treatment A had the lowest mean score ($M = 7.66$, $SD = 0.73$) in terms of aroma, while Treatment C once more received the highest ($M = 8.00$, $SD = 0.80$). On the hedonic scale, all treatments were assessed as “liked very much,” despite the fact that there were differences between them. This implies that 40 grams of organic lettuce helped create an aromatic profile that complemented customer tastes without dominating the classic pandesal aroma.

Due to its strong relationship to taste perception and the overall eating experience, aroma is a significant factor in customer acceptability of food. Delwiche (2004) asserts that olfactory indications have a substantial impact on food preference and can improve the sense of palatability and freshness. Aroma is frequently linked to the quality of bakery goods, and even little formulation adjustments can affect how customers perceive a product (Heenan *et al.*, 2008).

These findings imply that adding the right amount of lettuce to pandesal can improve its aromatic qualities while preserving the typical sensory qualities that consumers are accustomed to. Maintaining consumer approval of bread products that are both practical and health-conscious requires striking a balance between innovation and tradition.

The texture evaluation demonstrated that Treatment C was rated most favorably, receiving a mean score of 8.54 ($SD = 0.56$), classified as “liked extremely.” In contrast, Treatment D had the lowest evaluation ($M = 7.74$, $SD = 0.85$), while Treatments A and B were rated as “liked very much.” Results indicate that the addition of organic lettuce improved the textural quality of pandesal, producing bread that was soft, fluffy, and chewy with a slightly crunchy crust. These sensory characteristics are consistent with consumer expectations for high-quality bread products.

One of the most important factors influencing consumer preference is bread texture, which frequently affects product selection and recurring buy behavior (Guiné *et al.*, 2016). The sensory reactions noted in this study are consistent with freshness and good product quality, which are generally linked to a soft, fluffy crumb and a somewhat crispy crust. The ideal amount of lettuce integration in Treatment C may have contributed to its outstanding results by preserving moisture and maintaining structural homogeneity throughout baking. Gómez *et al.* (2019) assert that adding vegetable-based components to baked goods can improve their ability to absorb water and increase the elasticity of the crumb, both of which have a favorable impact on texture.

The results show that pandesal supplemented with organic lettuce, especially when prepared optimally, can satisfy customer demands for superior bread products while also offering functional dietary advantages. These findings lend support to the possibility of adding nutrient-dense veggies to classic baked items without sacrificing appetizing textures.

Table 1: Level of acceptability of organic lettuce pandesal in terms of appearance, aroma and texture

Treatment	Appearance			Aroma			Texture		
	Mean	SD	Description	Mean	SD	Description	Mean	SD	Description
Treatment A	7.94	0.73	Liked very much	7.66	0.73	Liked very much	7.91	0.51	Liked very much
Treatment B	8.14	0.65	Liked very much	7.86	0.85	Liked very much	8.11	0.58	Liked very much
Treatment C	8.60	0.55	Like extremely	8.00	0.80	Liked very much	8.54	0.56	Liked extremely
Treatment D	8.11	0.56	Liked very much	7.80	0.81	Liked very much	7.74	0.85	Liked very much

Level of Acceptability of Organic Lettuce Pandesal In Terms of Texture And General Acceptability

Treatment C received the highest evaluation (M = 8.77, SD = 0.42), categorized as “liked extremely” on the hedonic scale. In contrast, Treatment D obtained the lowest mean score (M = 7.78, SD = 0.87), though still classified as “liked very much.” Treatments A and B were similarly rated as “liked very much.” These findings suggest that the incorporation of organic lettuce enhanced the flavor profile of pandesal, contributing a subtle toasty note that was positively received by evaluators without compromising the product’s traditional taste.

Treatment C achieved the highest mean rating (M = 8.60, SD = 0.55), falling under the “liked extremely” category, while Treatment A received the lowest (M = 7.94, SD = 0.73), classified as “liked very much.” Overall, the data indicate that the addition of organic lettuce consistently improved the sensory attributes of pandesal including

appearance, aroma, texture, and taste culminating in greater overall acceptability. Moreover, the results suggest strong potential for consumer marketability, as the incorporation of natural, functional ingredients such as lettuce aligns with contemporary consumer trends favoring healthier and more sustainable food products.

Preliminary shelf-life observations indicated that organic lettuce pandesal maintained acceptable quality for 1–2 days at room temperature, 5–7 days under refrigeration, and up to 1 month when stored frozen. However, as shelf stability is influenced by factors such as moisture content, storage conditions, and microbial growth, these findings remain indicative rather than conclusive. A more rigorous shelf-life study is recommended in future research to determine precise stability parameters and optimal storage strategies, ensuring both product safety and quality retention.

Table 2: Level of acceptability of organic lettuce pandesal in terms of Texture and General Acceptability

Treatment	Taste			General Acceptability		
	Mean	SD	Description	Mean	SD	Description
Treatment A	8.14	0.65	Liked very much	7.94	0.73	Liked very much
Treatment B	8.23	0.77	Liked very much	8.05	0.68	Like very much
Treatment C	8.77	0.42	Liked extremely	8.60	0.55	Liked Extremely
Treatment D	7.78	0.87	Liked very much	8.02	0.75	Liked very much

Proximate Analysis of Organic Lettuce Pandesal

Based on the Department of Science and Technology (DOST) results, the proximate composition of 250 g of organic lettuce pandesal per 100 g serving was as follows: moisture content, 10.20 g; ash, 1.77 g; crude protein, 10.99 g; total fat, 12.80 g; carbohydrates, 64.24 g; and energy, 416 kcal.

Moisture content represents the amount of water present in the bread, which directly influences texture, freshness, and shelf life. The measured value of 10.20 g/100 g indicates that the organic lettuce pandesal maintains a desirable balance of softness and stability, consistent with quality standards in bread products. Ash content, on the other hand, reflects the total mineral composition after combustion of the sample, suggesting that the product retains essential micronutrients from both wheat flour

and lettuce.

Regarding protein, the organic lettuce pandesal contains 10.99 g per 100 g. According to the National Academy of Medicine (2023), adults require approximately 0.8 g of protein per kilogram of body weight daily. Thus, consumption of this product contributes substantially to daily protein requirements, offering a meaningful source of dietary protein.

Although bread is not typically thought of as a high-protein diet, its nutritional value can be increased by fortifying it with nutrient-dense ingredients (Gómez *et al.*, 2019). The addition of organic lettuce probably increased the amount of protein overall as well as the quantity of important amino acids, which are vital for sustaining muscle mass, assisting with metabolism, and enhancing general health (Wu, 2016). Furthermore, plant-

based protein sources like wheat flour and lettuce provide sustainable substitutes for animal-derived proteins, supporting international guidelines to diversify protein consumption for environmental and health reasons (FAO, 2021).

Organic lettuce pandesal's comparatively high protein content is especially pertinent to the fight against protein-energy malnutrition, a persistent public health issue in poor nations like the Philippines (Food & Nutrition Research Institute [FNRI], 2020). The product not only increases dietary protein intake by incorporating organic veggies into a staple food like pandesal, but it also advances the larger objective of enhancing nutritional security through familiar and culturally accepted foods.

In terms of energy contribution, the organic lettuce pandesal provides 416 kcal/100 g. The 2020–2025 Dietary Guidelines for Americans recommend daily energy intakes ranging from 1,600–2,400 kcal for adult females and 2,200–3,000 kcal for adult males, depending on age, body size, activity level, and health status. This indicates that a single serving of the product can significantly contribute to daily caloric needs, making it a potentially valuable energy source.

Comparatively, Murphy *et al.* (2014) examined the nutritional composition of 60 common bread variants in the United States and reported protein values ranging from 6.3 g/100 g to 15.2 g/100 g, and caloric values ranging from 232 kcal/100 g to 385 kcal/100 g, depending on grain type and ingredients used. The organic lettuce pandesal falls within this range, with slightly higher caloric content, thereby aligning with global bread standards while offering enhanced nutritional value through the incorporation of lettuce.

This finding aligns with studies that have shown functional and fortified breads, particularly those enriched with whole grains, legumes, or vegetables, often have altered macronutrient profiles compared to conventional white bread (Foschia *et al.*, 2017; Pasqualone *et al.*, 2018). It has been demonstrated that adding vegetables to bread products increases their protein and fiber content as well as their bioactive chemicals, which raises their overall nutritional value (Zhou *et al.*, 2022). In this case, the organic lettuce pandesal adds additional health-promoting qualities while remaining very close to the established bread nutrient ranges, making it nutritionally competitive with other fortified bakery products that are sold all over the world.

The potential of organic lettuce pandesal to be marketed as a functional food product is further highlighted by its compliance with international standards. Customers who require both palatability and nutritional benefits are becoming more interested in functional bread products (Martínez-Villaluenga *et al.*, 2020). The organic lettuce pandesal's potential to satisfy these two requirements offering palatable sensory attributes while maintaining nutritional parity with commercial bread underlines its feasibility in both domestic and international markets.

CONCLUSIONS

This study evaluated the sensory qualities and nutritional profile of organic lettuce pandesal, with specific focus on appearance, aroma, texture, taste, and overall acceptability. Findings revealed that the incorporation of 40 grams of blended organic lettuce produced the most favorable outcomes across all sensory attributes, indicating strong consumer preference and potential marketability. The enhanced sensory properties suggest that lettuce fortification not only maintains but elevates the traditional appeal of pandesal, aligning with consumer expectations for quality and innovation in bread products. Proximate analysis further demonstrated that organic lettuce pandesal is a rich source of energy, carbohydrates, crude protein, and fat. Its nutrient profile highlights its potential as a functional food product, contributing to daily nutritional requirements while offering additional health-promoting benefits from lettuce-derived bioactive compounds and dietary fiber. These attributes suggest that organic lettuce pandesal can serve as a nutritionally enhanced alternative to conventional bread, supporting both consumer satisfaction and public health objectives.

Generative AI Disclosure

The author used ChatGPT (GPT-4, OpenAI) to assist with drafting portions of the manuscript, including summarizing literature and refining phrasing in the introduction and discussion sections. All AI-generated content was carefully reviewed, verified, and edited by the authors to ensure accuracy, clarity, and originality.

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