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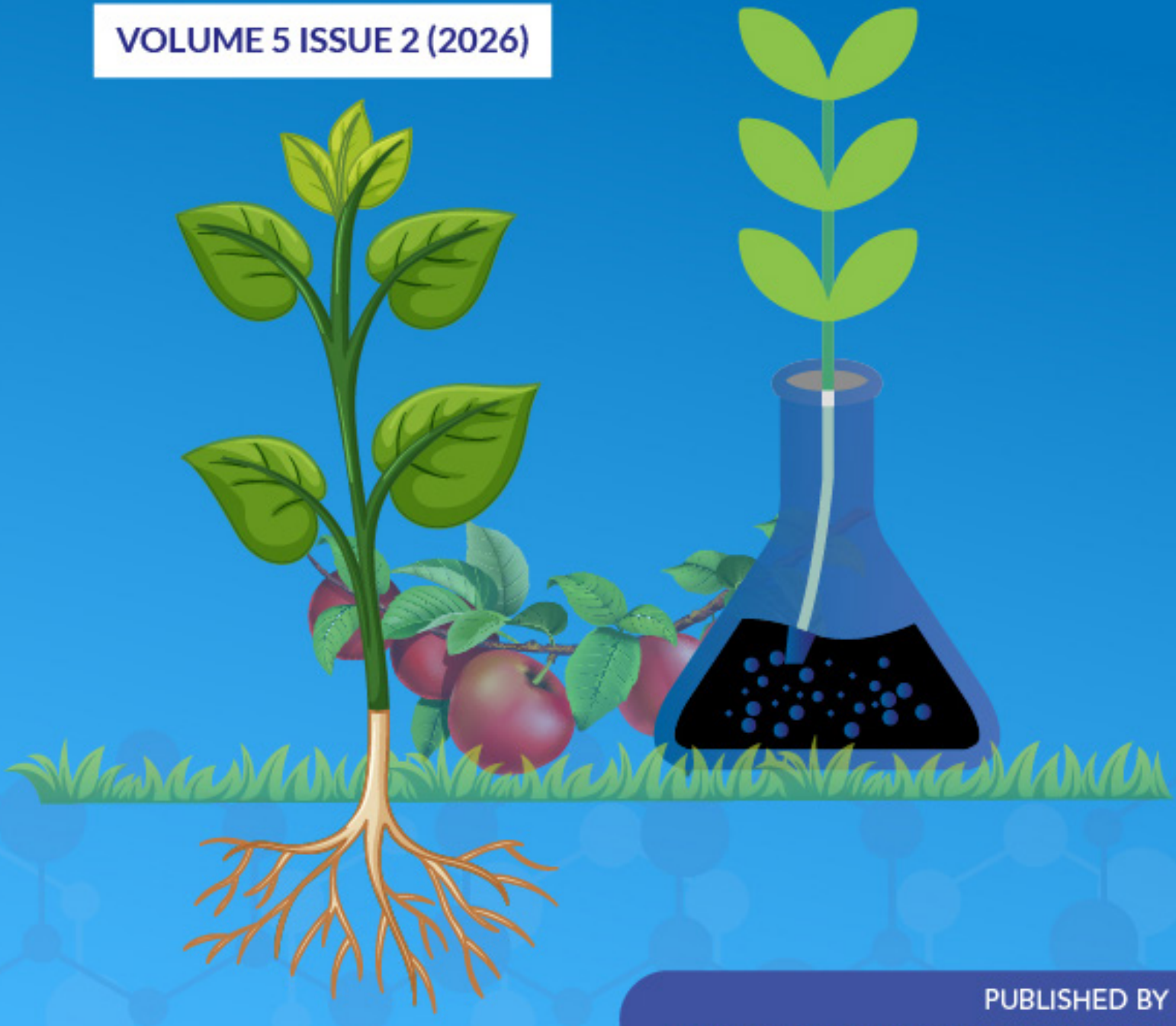

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Formulation and Acceptability of Bitter Gourd Savory Tart

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ABSTRACT

Bitter gourd (*Momordica charantia*) savory tart is a baked product developed by incorporating bitter gourd as a functional vegetable filling, transforming a traditionally bitter ingredient into a sensory-acceptable and nutritious snack. This study evaluated the product's acceptability by assessing its sensory qualities, overall acceptability, shelf life, microbial safety, and proximate composition. Three formulations containing varying amounts of bitter gourd (Treatment A-100g, Treatment B 75g, Treatment C 50g) were prepared and subjected to sensory evaluation in terms of appearance, aroma, taste, and texture. Statistical analyses were conducted to determine significant differences among treatments. Findings revealed that Treatment C, formulated with 50 grams of bitter gourd, achieved the highest level of sensory acceptability across all evaluated attributes, receiving strong ratings in taste and texture. Verbal sensory feedback supported these results, describing the product as having a more acceptable flavor profile and desirable texture aligned with consumer preferences, while acceptability testing demonstrated significant results in aroma, taste, and overall acceptability. Shelf life evaluation showed that refrigerated storage effectively extended product quality by delaying mold growth compared to room-temperature conditions. Microbial analysis confirmed that Treatment C complied with the National Food Safety Standards. Proximate analysis indicated a balanced nutritional composition, providing adequate amounts of protein, carbohydrates, fat, and energy suitable for snack consumption. Overall, the findings establish that a savory tart containing 50 grams of bitter gourd can be successfully developed as a safe, nutritionally adequate, and highly acceptable bakery product when stored under appropriate conditions, offering a healthier alternative for innovative bakery applications.

INTRODUCTION

Food culture around the world shows a strong preference for bite-sized foods. In many countries, small portions are valued because they are easy to eat and share, and they allow people to enjoy different flavors in one meal. Bite-sized foods are common in street food, snacks, and appetizers, reflecting creativity and practicality in global cuisines. These foods are often linked to social interaction, celebration, and cultural identity (Moments Log, 2023).

In the Philippines, bite-sized foods hold a special place in everyday life and traditions. Filipinos enjoy small, flavorful dishes not only for convenience but also because of the culture of sharing and togetherness. Even before foreign colonization, early Filipinos created various bite-sized foods using locally available ingredients such as rice, coconut, root crops, and tropical fruits. Traditional snacks like kakanin (such as suman and bibingka) and puso became integral to family gatherings, celebrations, and daily meals. These foods reflect Filipino creativity, resourcefulness, and strong communal values.

Historical events also shaped Filipino bite-sized cuisine. During the Japanese occupation, food shortages forced Filipinos to rely on local ingredients and simple cooking methods (Claudio, 2018). Despite limited resources, people continued to prepare small, filling, and flavorful foods, reflecting resilience and creativity (Fernandez, 1994). Today, this adaptability remains evident as Filipino cooks and bakers combine traditional recipes with modern techniques and international influences, keeping Filipino snacks diverse and appealing across generations (Fernandez & Zialcita, 2000).

One bite-sized food that has gained popularity in the Philippines is the tart. A tart is a small baked product with a crisp crust and shallow sides, traditionally made from pastry dough consisting of flour, butter, sugar, and water (Baclayon *et al.,* 2020).

Although tarts originated in Western cuisine, they became popular in the Philippines due to Spanish influence. Over time, Filipino bakers adapted tart recipes using local ingredients, resulting in well-known varieties such as buko tart, ube tart, and macapuno tart, as well as savory tarts made with meat, seafood, and vegetables (Fernandez & Zialcita, 2000).

Bitter gourd (*Momordica charantia*), commonly known as ampalaya, is widely grown and consumed in the Philippines. It is well known for its nutritional and medicinal benefits, despite its strong bitter taste. Bitter gourd is commonly used in soups, stir-fried dishes, and vegetable dishes; however, its use in baked products such as tarts remains limited and is rarely explored.

This study aims to introduce a new way of using bitter gourd by developing it as a savory tart and incorporating seafood to promote Roxas City, Capiz, the Seafood Capital of the Philippines. Doing so, the research seeks

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to change the common perception of bitter gourd as merely a traditional savory vegetable and demonstrate its potential in bakery products. The study also promotes the use of locally available ingredients, encouraging innovation among bakers, food entrepreneurs, and home cooks.

This experimental study was conducted to determine the acceptability of using bitter gourd as a tart. Specifically, the study sought to: determine the sensory qualities of bitter gourd as a savory tart in terms of appearance, aroma, taste, and texture; determine the general acceptability of bitter gourd as a savory tart among the three treatments; find out if there is a significant difference in the sensory qualities of bitter gourd as a savory tart in terms of appearance, aroma, taste, and texture among the three treatments; find out if there is a significant difference in the general acceptability of the bitter gourd as a savory tart among the three treatments; determine the shelf life of bitter gourd as a savory tart under room and chilling temperatures; and submit the best product to microbial and proximate analysis.

LITERATURE REVIEW

Kumar and Pal (2025) reported that bitter gourd is rich in dietary fiber, vitamins A, C, and E, and essential minerals such as iron and magnesium. In addition to its nutrient content, the vegetable contains bioactive compounds including phenolics, flavonoids, and saponins, which contribute to antioxidant activity and other health-promoting effects. These findings indicate that bitter gourd possesses both nutritional and functional value, supporting its utilization in product development aimed at enhancing health benefits while addressing dietary diversification.

Studies focusing on culinary applications and product innovation have demonstrated that bitter gourd can be successfully incorporated into non-traditional food forms when appropriate formulation strategies are employed. Singh *et al.* (2024) examined the development of bitter gourd soft candy and found that modifying formulation variables, particularly the level of citric acid, significantly influenced sensory attributes such as flavor, color, and overall acceptability. Their results suggest that bitterness, which is commonly perceived as a limiting factor, can be moderated through recipe adjustments, allowing bitter gourd to be adapted into processed food products that are more acceptable to consumers.

The study evaluates the practical use and consumer taste preference for bitter gourd in a savory tart. Kumar and Bidlan (2023) evaluated various pre-processing methods, including soaking, heat treatment, and frying, to reduce bitterness intensity. The study revealed that soaking combined with thermal processing was effective in decreasing bitterness-related compounds while maintaining desirable sensory characteristics. These findings are particularly relevant to food product development, as they highlight practical interventions that can enhance consumer acceptance without significantly compromising nutritional quality.

Consumer perception studies have emphasized the importance of formulation and presentation in determining the acceptability of bitter gourd–based products. Muzaffar and Wani (2025) investigated multigrain flatbreads fortified with bitter gourd juice powder and observed that higher concentrations of unprocessed bitter gourd negatively affected sensory acceptance. However, the use of encapsulation techniques improved flavor balance and overall liking among consumers. This study underscores the role of innovative processing technologies in aligning the health benefits of bitter gourd with consumer preferences, thereby increasing its potential for wider acceptance in functional and savory food products.

Recent studies have increasingly explored the utilization of vegetables as fillings and components in savory and baked products, emphasizing their role in improving nutritional quality while maintaining desirable sensory characteristics. Santamaria *et al.* (2024) demonstrated that incorporating vegetable powders such as tomato and beetroot into flatbread and baked formulations significantly enhanced dietary fiber and micronutrient content while also influencing visual appeal and texture. These findings indicate that vegetables can function not only as nutritional enhancers but also as structural and sensory modifiers in baked goods, supporting their suitability as filling ingredients in savory pastry products such as tarts and pies.

The effects of vegetable incorporation on sensory attributes have been widely examined, with studies consistently reporting changes in appearance, aroma, taste, and texture. Hidas *et al.* (2020) found that savory baked products containing vegetable-based fillings, such as spinach-enriched formulations, achieved favorable consumer ratings when sensory balance was carefully managed. Their results emphasized that color intensity, moisture retention, and mouthfeel play critical roles in consumer acceptance, suggesting that vegetable fillings can be well received provided that formulation adjustments are made to align sensory properties with consumer expectations.

In addition, industry-oriented and academic literature underscores the acceptability of savory vegetable-based fillings in international contexts. Malovany (2024) observed that global bakery markets have shifted toward upscale savory pies and tarts featuring vegetable-forward fillings, reflecting evolving consumer preferences for healthier, plant-based, and non-traditional savory options. Complementing this trend, a comprehensive review of functional bakery products reported that vegetable-enriched baked goods frequently achieved acceptable to high sensory scores when evaluated using standardized hedonic testing methods (Guiné & Florença, 2024). Collectively, these studies suggest that vegetable-based savory fillings are increasingly viable and acceptable in baked products, particularly when sensory quality and formulation balance are prioritized.

The effects of storage temperature, particularly room

versus chilling conditions, have been well-documented in international studies. For instance, Fernandes *et al.* (2020) reported that vegetable-based fillings stored at refrigeration temperatures (4–6°C) retained higher moisture content, texture, and flavor compared with products stored at ambient room temperature (25°C). In contrast, room temperature storage accelerated microbial growth and led to more rapid deterioration of sensory attributes, indicating that temperature control is critical for extending shelf life while preserving product acceptability.

According to Kumar *et al.* (2019), microbial testing is essential for detecting the presence of pathogenic bacteria, yeasts, and molds that can compromise product safety and shelf life. Their study highlighted the use of standardized microbiological protocols to monitor contamination during processing and storage, demonstrating that early detection of microbial hazards is pivotal for maintaining consumer safety and meeting regulatory standards. Furthermore, Oliveira *et al.* (2022) and Silva *et al.* (2020) emphasized that low temperatures inhibit enzymatic activity and microbial metabolism, thereby prolonging the shelf life of perishable, vegetable-enriched foods.

MATERIALS AND METHODS

Methods of Research

The study employed the experimental-developmental research method. Within the developmental research framework, various desserts were created using bitter gourd savory tart, each subjected to three different treatments. In this study, the experimental approach was utilized to explore the optimal proportions of bitter gourd in tart pastry preparation. In this developmental research, the product developed was a bitter gourd savory tart intended for potential commercialization.

Experimental Design

The study employed an experimental research design to determine the sensory quality, acceptability, and overall feasibility of bitter gourd as a savory tart filling. A Completely Randomized Design (CRD) was used to minimize bias and ensure that each treatment had an equal chance of being evaluated by the panelists. Three treatments were prepared based on varying amounts of bitter gourd incorporated into the savory tart, representing high, moderate, and low concentrations. These treatments served as the independent variable, while sensory attributes such as appearance, aroma, taste, texture, and overall acceptability were treated as the dependent variables.

Sensory evaluation was conducted using trained and semi-trained panelists who assessed each treatment under controlled conditions. All treatments were prepared using the same ingredients and procedures, except for the variation in bitter gourd content, to ensure consistency across treatments. The order of treatment presentation was randomized to reduce order effects and panelist bias. Data gathered from the sensory evaluation were subjected to appropriate statistical analyses to determine whether significant differences existed among the treatments. Analysis was performed at a 0.01 level of significance to ensure strict evaluation of treatment effects. The null hypothesis, which stated that there were no significant differences among treatments in terms of sensory quality and acceptability, was tested and interpreted accordingly.

Overall, the experimental design allowed for a systematic and objective assessment of the effects of varying bitter gourd concentrations on the sensory properties and acceptability of the savory tart, providing reliable results to support the study's conclusions

Tools and Equipment Used

The tools and equipment used in the study are the following: one (1) piece oven, one (1) piece working table, one (1) piece measuring cup, one (1) piece measuring spoon, one (1) piece wooden spoon, one (1) piece rubber scraper, ten (10) pieces tart molder, one (1) piece weighing scale.

Experimental Treatments

Table 1 presents the proportions of ingredients used in preparing three (3) formulations of bitter gourd savory tart. These formulations were evaluated for sensory attributes, including taste, texture, aroma, appearance, and overall acceptability. The proportions of ingredients vary across treatments (A, B, and C) within the same product type. Specifically, Treatment A contains 100g of bitter gourd, Treatment B contains 75g, and Treatment C contains 50g. The quantities of certain ingredients are adjusted accordingly across treatments to examine their influence on the product's sensory qualities.

By varying the proportions of bitter gourd while maintaining consistency in the other selected ingredients, the experiment aimed to determine how formulation differences influence the sensory characteristics of the savory tart. Each treatment was evaluated by sensory panelists in terms of appearance, aroma, taste, texture, and overall acceptability. To ensure reliability and to isolate the effect of the primary variable, several ingredients were kept constant in all treatments. These included 30g of mussels (tahong), 5g of onion, 2.5g of black pepper, one large egg, 14 ml of lemon juice, 10g of breadcrumbs, and 30g of pineapple tidbits.

Overall, the table clearly outlines the experimental design for evaluating the sensory attributes of the bitter gourd savory tart and facilitates systematic comparison among treatments to identify the most acceptable ingredient proportion.

Table 1: Product formulation, ingredients, and proportion per trial for sensory evaluation

Ingredients	Treatment A	Treatment B	Treatment C
Bittergourd Filling			

Bitter gourd	100 g	75 g	50g
Mussels (tahong)	30g	30g	30g
Onion	5g	5g	5g
Salted egg (yolk)	20g	20g	20g
Black pepper	2.5g	2.5g	2.5g
Egg	50 g	50 g	50 g
breadcrumbs	10g	10g	10g
Lemon juice	14 ml	14 ml	14 ml
Pineapple tidbits	30g	30g	30g
Cornstarch	11g	11g	11g
Tart Crust			
All-purpose flour	118g	118g	118g
Salt	1.5g	1.5g	1.5g
Unsalted Butter	114g	114g	114g
Iced Water	30 ml	30 ml	30 ml

Experimental Procedure

The product developed in the study was a savory tart made from bitter gourd. In preparing the different products and treatments, the researcher gathered and prepared all the ingredients.

Preparation of Raw Materials

The raw materials prepared in this study were tart crust and tart filling.

A. Preparation of Tart Crust.

In a large mixing bowl, combine the flour, sugar, and salt, stirring until well mixed. Cold cubed butter was incorporated into the flour mixture until a coarse crumb consistency was achieved. Gradually add ice water to the flour mixture, stirring with a fork or your hands until the dough comes together. If the dough seems too dry, add more ice water, 1 tablespoon at a time. Once the dough forms a cohesive ball, transfer it to a lightly floured surface, kneading it gently a few times to bring it together. Shape the dough into a disk, wrap it tightly in plastic wrap, and refrigerate for at least 30 minutes or up to 24 hours. When ready to use, remove the dough from the refrigerator and let it sit at room temperature for a few minutes to soften slightly. On a lightly floured surface, roll out the dough into a circle about 1/8 inch thick, large enough to fit your tart pan with some overhang. Carefully transfer the rolled-out dough to your tart pan, gently pressing it into the bottom and sides and trimming any excess dough from the edges. Prick the bottom of the crust all over with a fork to prevent air bubbles from forming during baking. At this point, you can either chill the crust again for about 15 minutes before baking, or proceed with your tart recipe according to its instructions.

B. Preparation of Bitter Gourd Savory Tart

All ingredients were carefully gathered and measured with precision. Begin by slicing the bitter gourd and blanching it to reduce its bitterness. Next, grind the onion and mussels (tahong) into small, uniform pieces. In a mixing bowl, combine the blanched bitter gourd, ground mussels (tahong), onion, salted egg, breadcrumbs, pineapple tidbits, and egg. Stir thoroughly until all ingredients are well incorporated, ensuring a balanced distribution of flavors and textures. Once mixed, cover the bowl with plastic wrap and allow the mixture to rest for a few minutes, letting the flavors meld together.

Collection of Data

The data collection instrument utilized was a Sensory Evaluation Scorecard. Ten (10) semi-trained panelists assessed the bitter gourd Tart across appearance, aroma, taste, and texture dimensions. The semi-trained panelists conducted sensory evaluations across three trials or replications. Conversely, the consumer's judgment of product acceptability relied on the final product's composition. A total of one hundred (100) random consumers of Jamindan, Capiz, participated. Following product evaluation, assessment sheets were collected, tallied, and analyzed using SPSS software, with the assistance of a statistician. Mean values were employed to ascertain the sensory attributes of the bitter gourd tart concerning appearance, aroma, taste, and texture, as well as its overall acceptability. ANOVA was utilized to analyze and interpret differences among the three treatments, with a significance level set at 0.01.

The process of data collection in developmental-experimental research begins with product formulation, undertaken by the researcher. After numerous trials and adjustments, a final product is established. Starting with Trial 1, the bitter gourd savory tart with a one-hundred percent (100%) proportion was made and presented to the ten (10) semi-trained panelists for sensory evaluation using the 9-Point Hedonic Rating Scale.

Trial 2 of the product formulation was conducted based on the comments, suggestions, and recommendations provided by the panel of evaluators during Trial 1 evaluation. The results of this second evaluation informed

further refinements, which were implemented in Trial 3 for the finalization of the product before its submission for consumer evaluation to determine its level of acceptability. The consumer's evaluation of the acceptability of the bitter gourd savory tart was based on the final product formulation during the sensory evaluation of the semi-trained panelists in the three trials or replications.

Scoring of Variables

The evaluation of the bitter gourd savory tart was conducted using the 9-Point Hedonic Rating Scale, a standard and widely accepted instrument in sensory evaluation studies. This scale enabled the respondents to indicate their degree of liking or disliking of the product based on its sensory attributes, namely appearance, aroma, taste, texture, and overall acceptability. Each attribute was assessed independently for the three treatments, and the mean scores were interpreted using corresponding adjectival descriptions to determine sensory quality and consumer preference.

Statistical Tools and Analysis

The Bitter Gourd and the treatments with the highest mean were evaluated by the consumer for the general acceptability of the product. The data were tabulated and statistically analyzed through the SPSS software using the Arithmetic Mean and the Analysis of Variance (ANOVA). The mean was used to describe the sensory qualities and acceptability of the bitter gourd savory tart. ANOVA is a statistical technique that is used to check if the means of two or more groups are significantly different from each other. This statistical tool was used to determine the significant difference in the sensory qualities of the product in terms of appearance, aroma, taste, and texture, as well as the differences among the three treatments. The level of significance was set at 0.01 ($\alpha = 0.01$).

RESULTS AND DISCUSSION

Sensory Qualities of Bitter Gourd as a Savory Tart in Terms of Appearance, Aroma, Taste, and Texture

Three treatments were tested during formulation of the product: Treatment A (100g), Treatment B (75g), and Treatment C (50g) of bitter gourd, across three evaluations to assess changes in sensory perception and consumer acceptance.

In the first evaluation of the product for the sensory quality, all treatments received "Very Much" ratings across all attributes, indicating positive initial acceptance. Treatment C (50g) had slightly higher mean scores for appearance (7.50) and aroma (7.50), suggesting that the lower bitter gourd content enhanced visual appeal and aroma, respectively. The mean scores for taste and texture showed minor variation among treatments, but the overall mean remained consistently favorable. These results align with research highlighting the influence of appearance and aroma on initial consumer perception and willingness to taste novel vegetable-based products (Zhu *et al.,* 2017; Dey *et al.,* 2018).

During the second evaluation, sensory scores improved, particularly for Treatment B (75g), which achieved the highest general mean (7.95). In the second trial, sensory scores improved, especially for Treatment B (75g), which achieved the highest overall mean (7.95), suggesting that this intermediate bitter gourd amount provided a harmonious balance of flavor and texture. This observation is consistent with studies indicating that careful optimization of ingredient proportions in functional food products can significantly enhance acceptability and sensory balance (Ribeiro *et al.,* 2019; Silva *et al.,* 2020).

The third evaluation yielded the highest overall scores, with Treatment C (50g) emerging as the most preferred formulation (general mean = 8.73). This treatment received the highest ratings for taste (8.90) and texture (8.80), while all treatments achieved "Extremely" ratings for appearance and aroma. These findings indicate that reducing the bitter gourd content improved taste quality without compromising visual and aromatic quality. This aligns with recent research indicating that moderate inclusion of bitter gourd or other unconventional vegetables in composite food products enhances sensory appeal while maintaining nutritional value (Mikstas, 2024). The results imply that iterative testing and formulation adjustment are critical for achieving optimal sensory qualities in vegetable-based food products. The progressive increase in scores across trials demonstrates the importance of product refinement based on panelist feedback to achieve a desirable balance between flavor intensity and texture. The sensory evaluation confirmed that taste and texture were the primary determinants of overall acceptability, while appearance and aroma contributed to initial positive perceptions. Treatment C, containing 50g of bitter gourd, was identified as the best-performing formulation, demonstrating the feasibility of producing a bitter gourd savory tart that is both nutritionally valuable and sensorially appealing.

General Acceptability of Bitter Gourd as a Savory Tart in terms of Appearance, Aroma, Taste, and Texture

The acceptability of bitter gourd as a savory tart filling was evaluated across three formulations: Treatment A (100g), Treatment B (75g), and Treatment C (50g). The assessment considered four sensory attributes: appearance, aroma, taste, and texture. A nine-point hedonic scale was used, where higher scores indicated greater liking, and results were interpreted according to adjectival descriptions ranging from "Liked Extremely" to "Liked Slightly."

All treatments were rated highly in terms of visual appeal, with Treatment B (75g) receiving the highest mean score (8.94), followed closely by Treatment A (8.91) and Treatment C (8.84). The small differences suggest that variations in bitter gourd content did not substantially affect the visual attractiveness of the tarts. These findings are consistent with studies indicating that moderate

incorporation of vegetables into pastry products does not compromise appearance when ingredients are evenly integrated, and the presentation is carefully managed (Pereira *et al.,* 2021).

Aroma evaluation revealed that Treatment C (50g) achieved the highest mean score (8.88), while Treatments A and B scored 8.71 and 8.59, respectively. This indicates that reducing the proportion of bitter gourd slightly enhanced the tart's aromatic appeal, likely by moderating the characteristic bitterness that can influence scent perception. Previous research has emphasized that balancing the natural aroma of bitter vegetables is key to increasing consumer acceptance in functional food formulations (Calín-Sánchez & Carbonell-Barrachina, 2021; Qiao *et al.,* 2024).

Taste was the most distinguishing attribute, with Treatment C (50g) receiving a perfect mean score of 9.00, followed by Treatment B (75g) at 8.65 and Treatment A (100g) at 7.76. This suggests that lower amounts of bitter gourd optimized flavor perception, balancing its inherent bitterness with other ingredients to produce a highly savory tart. These results are supported by recent studies highlighting that careful ingredient proportioning in vegetable-enriched foods improves overall taste and consumer satisfaction (Surhaini *et al.,* 2018).

All treatments demonstrated strong acceptability in texture, with Treatment C scoring 8.87, Treatment A 8.83, and Treatment B 8.75. These results indicate that textural attributes, such as firmness and flakiness, were consistently maintained across formulations, confirming that bitter gourd incorporation did not compromise texture quality. This aligns with previous findings showing that plant-based fillings can retain desirable pastry textures if properly formulated (Zhu *et al.,* 2017).

General acceptability, reflecting overall consumer preference, followed the same trend observed in individual sensory attributes. Treatment C (50g) achieved the highest mean score (8.90), followed by Treatment B (8.73) and Treatment A (8.55), respectively. The data suggest that reducing the proportion of bitter gourd (Momordica charantia) enhances overall liking, likely by improving the balance of taste and aroma while maintaining appearance and texture. These findings indicate that consumers prefer formulations that provide both sensory enjoyment and moderate exposure to bitter vegetable flavors (Pereira *et al.,* 2021; Ribeiro *et al.,* 2019). In the study of Sampson *et al.* (2026), sensory analysis revealed high consumer acceptability for gluten-free biscuits, particularly in taste, texture, and overall appeal, with scores averaging above 7 on a 9-point hedonic scale.

Treatment C (50g bitter gourd) was identified as the best-performing formulation across all evaluated attributes: appearance, aroma, taste, texture, and overall acceptability. These findings have important implications for product development, showing that bitter vegetables can be incorporated into savory pastries without reducing consumer appeal. Adjusting ingredient proportions and conducting iterative sensory testing are key strategies for optimizing the acceptability of functional food products, ensuring both nutritional benefits and market viability (Silva *et al.,* 2020).

Differences in the Sensory Quality of Bitter Gourd as a Savory Tart in terms of Appearance, Aroma, Taste, and Texture

Hypotheses were tested at an alpha level of 0.01, with p-values exceeding this threshold indicating no significant differences (ns) among treatments.

For Treatment A (100g), no statistically significant differences were observed across all sensory attributes: appearance ($z = 1.166$, $p = 0.558$), aroma ($z = 1.2$, $p = 0.549$), taste ($z = 0.982$, $p = 0.612$), and texture ($z = 2.993$, $p = 0.224$). Consequently, the null hypotheses were accepted for all attributes, indicating that variations within Treatment A did not produce noticeable changes in sensory perception. This suggests that Treatment A maintained a stable sensory profile across its formulations, indicating that changes in bitter gourd proportion did not significantly influence consumers' perception of appearance, aroma, taste, or texture. In practical terms, the sensory qualities remained uniform, demonstrating that Treatment A is resilient to formulation adjustments without compromising overall acceptability. Similar patterns have been reported in vegetable-based functional foods, where high inclusion of bitter ingredients stabilizes perceived sensory qualities across formulations (Appiani *et al.,* 2023).

Treatment B (75g) also showed no significant differences in appearance ($z = 1.006$, $p = 0.605$), aroma ($z = 0.009$, $p = 0.996$), taste ($z = 2.495$, $p = 0.287$), and texture ($z = 2.164$, $p = 0.339$). The null hypotheses were accepted for all attributes, indicating that Treatment B maintained consistent sensory qualities across formulations, with no statistically significant differences in appearance, aroma, taste, or texture. Formulation variations did not noticeably affect consumer perception, demonstrating that Treatment B is stable and uniform in its sensory profile regardless of bitter gourd proportion. The lack of significant differences may be attributed to the balanced formulation, where the bitterness of bitter gourd was sufficiently moderated by complementary ingredients, consistent with prior research suggesting that intermediate vegetable levels enhance sensory harmony without markedly altering panelist perception (Singh *et al.,* 2024).

For Treatment C (50g), all sensory attributes showed no significant differences except for taste ($z = 6.682$, $p = 0.035$). Appearance ($z = 0.731$, $p = 0.694$), aroma ($z = 0.401$, $p = 0.818$), and texture ($z = 0.412$, $p = 0.814$) remained statistically unchanged, while taste had a p-value below the alpha level, indicating a significant difference. Thus, the null hypothesis was rejected for taste but accepted for all other attributes. This suggests that Treatment C maintained consistent sensory qualities in appearance, aroma, and texture, while taste was significantly affected by formulation variations. In other words, although most

attributes remained stable, formulation changes led to noticeable differences in flavor perception, making taste the distinguishing attribute for Treatment C. This finding aligns with studies emphasizing that taste is the most sensitive sensory attribute in vegetable-enriched baked products, especially when functional ingredients with strong flavors are used (Zhu *et al.,* 2017).

Overall, the analysis indicates that high (100g) and moderate (75g) levels of bitter gourd did not produce significant differences in sensory attributes, whereas the lowest level (50g) notably affected taste, underscoring its critical role in overall acceptability. These results suggest that product developers should prioritize optimizing ingredient levels to improve taste, as other sensory attributes appear less sensitive to variations in bitter gourd content. These findings reinforce the importance of iterative testing in functional food development, where balancing health-promoting ingredients with sensory appeal is essential for consumer acceptance (Kumar & Pal, 2025; Silva *et al.,* 2020).

Differences in the Level of Acceptability of Bitter Gourd Savory Tart among Three (3) Treatments in terms of Appearance, Aroma, Taste, and Texture

Statistical analysis was conducted using ANOVA, with a significance threshold of $\alpha = 0.01$. A p-value below this threshold indicates a statistically significant difference among treatments, while p-values above it indicates no significant difference (ns).

The analysis of appearance showed no significant differences among treatments ($F = 2.868$, $p = .058$), indicating that consumers perceived the visual appeal of the tarts consistently across all formulations. Therefore, the null hypothesis for appearance was accepted, confirming uniform visual perception across formulations. This suggests that the inclusion level of bitter gourd did not meaningfully alter the color, uniformity, or overall presentation of the tart. Previous research supports this, showing that moderate to high incorporation of vegetables in bakery products does not significantly compromise visual attractiveness when ingredients are evenly distributed (Oliveira *et al.,* 2022; Pereira *et al.,* 2021).

For aroma, the results demonstrated a statistically significant difference among treatments ($F = 7.753$, $p = .001$), leading to the rejection of the null hypothesis. This indicates that the proportion of bitter gourd affected the aroma of the tart, with lower bitter gourd content likely producing a more pleasant aroma. This aligns with studies suggesting that the volatile compounds in bitter vegetables can influence aroma perception and that moderating bitter ingredients enhances acceptability (Zhu *et al.,* 2017; Silva *et al.,* 2020). The findings imply that careful adjustment of bitter gourd levels is necessary to optimize aroma while retaining functional benefits.

Taste showed the largest differences among treatments ($F = 220.738$, $p < .001$), leading to rejection of the null hypothesis. This result confirms that the quantity of bitter gourd substantially affected flavor perception. Treatment C (50g) likely contributed to the highest taste acceptability, as a reduced bitter proportion balanced the intrinsic bitterness with other filling ingredients, enhancing taste quality. This finding is consistent with research showing that taste is the most sensitive attribute in vegetable-enriched baked goods and is critical for determining overall acceptability (Santamaria *et al.,* 2024).

The analysis of texture revealed no significant differences among treatments ($F = 2.047$, $p = .131$), so the null hypothesis was accepted. This suggests that the mouthfeel, including crispiness and chewiness of the tart filling, was maintained across different bitter gourd levels. Previous studies indicate that proper formulation techniques allow the incorporation of functional vegetables into pastries without negatively affecting texture (Oliveira *et al.,* 2022; Zhu *et al.,* 2017).

Overall acceptability differed significantly among treatments ($F = 46.698$, $p < .001$), leading to the rejection of the null hypothesis. This finding indicates that variations in bitter gourd content influenced overall consumer preference. Treatment C (50g) likely achieved the highest overall acceptability due to its optimal balance of taste, aroma, appearance, and texture. These results reinforce the importance of proportioning functional ingredients to maximize sensory satisfaction and market viability (Silva *et al.,* 2020; Pereira *et al.,* 2021).

The results imply that while appearance and texture were less sensitive to bitter gourd content, aroma, taste, and overall acceptability were significantly influenced by bitter gourd proportions. For product development, these findings suggest that lowering bitter gourd content can enhance consumer liking without compromising visual appeal or mouthfeel. Iterative testing and refinement of functional food formulations are essential for balancing nutritional benefits and sensory satisfaction (Ribeiro *et al.,* 2019; Oliveira *et al.,* 2022). Specifically, Treatment C (50g) demonstrated the potential for developing bitter gourd savory tarts that are both healthful and highly acceptable to consumers.

Shelf Life of the Bitter Gourd as a Savory Tart Filling in Terms of Room and Chilling Temperature

Table 2 presents the shelf life assessment of the bitter gourd savory tart, which is essential for determining the period during which a food product maintains safety, quality, and acceptability for consumption (Oliveira *et al.,* 2022). In this study, the shelf-life of the bitter gourd savory tart filling was evaluated under two storage conditions: room temperature and chilled conditions. Observations were made at 7-day intervals up to 30 days, focusing on mold formation and edibility as indicators of product stability.

At room temperature, all treatments (A: 100g, B: 75g, C: 50g) showed no mold formation during the first 14 days, indicating that the tart filling was initially stable. By day 21, mild mold formation (+) was observed, accompanied

by unpleasant odor and minor spotting, signaling the onset of microbial degradation. By day 30, mold growth was significant (++) across all treatments, producing strong odors and visible colonies, indicating the product was no longer safe for consumption. The accelerated microbial growth at room temperature aligns with prior studies, which note that higher ambient temperatures increase water activity and promote mold proliferation in vegetable-based fillings (Guiné & Florença, 2024; Ribeiro *et al.,* 2019; Pereira *et al.,* 2021).

In contrast, storage under chilling conditions (approximately 4–7°C) demonstrated extended stability. Mold formation was negligible during the first 14 days, similar to room temperature. By day 21, minimal mold formation was observed, but the product remained edible. By day 30, only slight mold development (+) occurred across all treatments, indicating that refrigeration significantly delayed microbial growth. The protective effect of refrigeration is consistent with studies showing that low temperatures inhibit enzymatic activity and microbial metabolism, thereby prolonging the shelf-life of perishable, vegetable-enriched foods (Guiné & Florença, 2024).

Overall, the results indicate that chilling storage effectively extends the shelf-life of bitter gourd tart filling by at least 30 days, whereas room temperature storage limits safe consumption to approximately 14–21 days. No significant differences in mold formation were observed between treatments, suggesting that the proportion of bitter gourd did not substantially affect microbial stability within the tested range. These findings have practical implications for production and distribution, emphasizing the importance of refrigerated storage for extending product usability while maintaining safety and sensory quality. The data provide a scientific foundation for recommending cold-chain management in the commercial distribution of pastries enriched with bitter vegetables.

Table 2: Shelf life of the bitter gourd as a savory tart filling in terms of room and chilling temperature

Variant	7 Days	14 Days	20 Days	29 Days
Room Temperature				
Treatment A	0	0	+	++
Treatment B	0	0	+	++
Treatment C	0	0	+	++
Chilling Temperature				
Treatment A	0	0	0	+
Treatment B	0	0	0	+
Treatment C	0	0	0	+

Legend: 0 = No mold formation; + = Minimal mold formation (still edible); ++ = Significant mold formation (not safe for consumption)

Microbial Analysis of Bitter Gourd Savory Tart

Table 3 presents the microbiological assessment of the bitter gourd (ampalaya) savory tart, which is essential for ensuring that the product is safe for consumption, particularly because ready-to-eat (RTE) foods are susceptible to contamination during processing, handling, and storage. Microbial indicators, including total coliforms, fecal coliforms, Escherichia coli, yeasts, molds, and Salmonella, provide critical information about the sanitary quality of the food and potential health risks. Compliance with Philippine Food and Drug Administration (FDA) standards and DOST-ITDI reference limits serves as a benchmark for evaluating product safety and hygiene practices in food production (Philippine FDA Circular No. 2021-013; DOST-ITDI, 2024).

The total coliform count in the tart filling was recorded at < 3.0 MPN/100 g, which is well below the FDA maximum limit of 10 MPN/100 g. Total coliforms are used as general indicators of environmental contamination and hygiene quality, and low counts reflect effective sanitary controls in the preparation and handling of food. The result suggests that the production process of the tart maintained proper hygiene, minimizing the risk of contamination from environmental sources or raw ingredients (Tamiru *et al.,* 2024).

Fecal coliforms were also measured at <3.0 MPN/100 g, well below the allowable limit of 10 MPN/100 g. Fecal coliforms are a subset of coliform bacteria that indicate potential fecal contamination more directly. The low level observed confirms that the tart filling was likely produced under conditions that prevented fecal contamination, including proper handling of raw materials, personnel hygiene, and use of clean water. This result reinforces the overall microbial safety of the product (Tamiru *et al.,* 2024).

Escherichia coli was not detected at the detection limit of 10^1 CFU/g, indicating that the tart filling is free from this organism. E. coli is a key fecal indicator bacterium, and its absence is crucial for the safety of RTE products consumed without further cooking. This finding confirms the implementation of proper sanitary measures during production and handling, ensuring consumer safety and regulatory compliance (FDA, 2021).

Yeasts were not detected at the detection limit of 10^1 CFU/100 cm^2, well below the DOST-ITDI reference limit of 100 CFU/100 cm^2. Yeasts are common contaminants that can lead to spoilage and reduced shelf life in bakery

products, and their absence indicates effective control of fungal contamination during ingredient storage and tart preparation. The result also suggests that the tart filling is microbiologically stable and suitable for consumption over the intended shelf life (Nguessan *et al.,* 2017).

Molds were not detected at the detection limit of 10^1 CFU/100 cm^2, well below the Negros Prawn Producers Cooperative Analytical and Diagnostic Laboratory standard of 100 CFU/100 cm^2. Mold contamination in bakery and RTE products can lead to spoilage, off-flavors, and potential mycotoxin production. The absence of molds in the tart filling reflects high standards of cleanliness and proper storage conditions, which collectively contribute to product quality and safety (Paloma and Israel, 2025).

Salmonella was not detected at 10^1 CFU/100 cm^2, meeting the zero-tolerance standard for this pathogen in RTE foods. Salmonella is a major foodborne pathogen responsible for serious gastrointestinal illnesses, and its absence confirms that the tart filling poses minimal health risk. This result demonstrates adherence to strict microbial safety protocols and underscores the effectiveness of good manufacturing practices (EFSA, 2024).

Overall, the microbial analysis of the bitter gourd savory tart filling demonstrates that all tested parameters are within acceptable limits set by the FDA and DOST-ITDI. These results indicate effective sanitation, safe ingredient sourcing, and hygienic handling during production. The absence or low levels of microbial indicators and pathogens suggest that the tart filling is safe for consumption and aligns with best practices for RTE foods, thereby reducing the risk of foodborne illness.

Table 3: Microbial analysis of the bitter gourd savory tart filling

Sample Description	Parameter	Laboratory Result	FDA Maximum (M)	Remarks
Savory Ampalaya Tart	Total Coliform Count (MPN/100g)	< 3.0	10	Within acceptable limit
	Fecal Coliform Count (MPN/100g)	< 3.0	10	Within acceptable limit
	Escherichia coli (CFU/g)	Not detected at 10^1	10	Safe
	Yeasts (CFU/100cm^2)	Not detected at 10^1	100	Safe
	Molds (CFU/100cm^2)	Not detected at 10^1	100	Safe
	Salmonella (CFU/100cm^2)	Not detected at 10^1	0	Safe

Legend:

- *FDA M = Maximum acceptable limit before the product may pose a hazard*
- *DOST = Department of Science and Technology Laboratory Standards*
- *M = Unsafe or unsatisfactory threshold per microbiological standards*

References for Standards:

- *Philippine FDA Circular No. 2021-013: Microbiological Criteria for Processed Food*
- *PNS/BAFPS 2006: Standards for Dried Fruit-Based Products*

Proximate Analysis of the Best Product of Bitter Gourd Savory Tart

Table 4 presents the proximate analysis, a fundamental approach in food science that quantifies the macronutrient composition of food products, including moisture, ash, protein, fat, carbohydrates, and energy. This analysis is essential for evaluating nutritional quality, guiding product formulation, and ensuring compliance with regulatory standards such as those of the Food and Nutrition Research Institute (FNRI) and the Food and Drug Administration (FDA) in the Philippines (FNRI, 2017–2023; FDA, 2021). The results of proximate analysis for the bitter gourd savory tart filling provide insights into both its nutritional contribution and functional properties in bakery products.

The moisture content of the tart filling was 31.41%, which falls within the recommended range of 10–35% for ready-to-eat bakery products. Maintaining moisture within this range also helps control water activity, which is critical for preserving quality during storage.

The ash content was measured at 1.85%, indicating a normal mineral content consistent with typical bakery products. Ash content serves as an overall indicator of inorganic nutrient availability, supporting the nutritional value of the product as a functional snack option.

Protein content in the tart filling was 8.73%, which is within the standard range of 5–10% for similar bakery products. The inclusion of bitter gourd may slightly enhance protein bioavailability compared with conventional tarts.

Total fat content was 9.89%, which aligns with the typical range of 5–15% in bakery products. Fat contributes to the product's energy density, texture, and flavor, enhancing palatability and consumer acceptance. In this product, fat levels are adequate for sensory quality without exceeding standard limits.

Carbohydrates comprised 62.83% of the tart filling, serving as the primary energy source. The high carbohydrate content ensures sufficient energy provision for consumers while highlighting the role of the tart as a snack that supports daily caloric needs. Adjustments to carbohydrate composition could be explored for targeting low-glycemic formulations.

Finally, the energy value of 81 kcal per 25 g serving falls within the 80–100 kcal range recommended for snack portions, confirming that the tart provides moderate caloric intake appropriate for consumption between meals.

In summary, the proximate composition of the bitter gourd savory tart aligns with established bakery product standards, validating its nutritional quality and functional properties. Moisture, ash, protein, fat, carbohydrates, and energy values all fall within acceptable ranges, supporting both consumer health benefits and product stability. These findings demonstrate the potential of incorporating bitter gourd into bakery products to create nutritionally balanced, functional snacks that meet regulatory and dietary guidelines.

The proximate analysis of the squash-vegetable biscuit (Table 4) containing beans showed that it had a high carbohydrate content, which comprised 78.5% of its weight. This implies that the product is mainly meant to be an energy source. Fats made up 12.4% of the product's weight, implying that there is an intermediate amount of fats in the product. However, there were lower amounts of proteins (4.7%), fibers (1.1%), moisture (2.1%), sugars (5.8%), ashes (1.3%), and sodium (0.05%).

Table 4: Proximate analysis of the best product of bitter gourd savory tart

Nutrient	Result	Reference Value (FNRI/FDA)	Interpretation
Moisture	31.41	10–35 (FNRI, bakery RTE products)	Within acceptable range; indicates moderate water content suitable for shelf stability
Ash	1.85	1–5 (FNRI, bakery products)	Within normal range; reflects adequate mineral content
Protein	8.73	5–10 (FNRI, similar tarts)	Satisfactory; provides moderate nutritional protein
Total Fat	9.89	5–15 (FNRI/FDA, bakery RTE products)	Within standard range; contributes to texture and energy
Carbohydrates	62.83	50–75 (FNRI/FDA)	High; provides the main energy source for the product
Energy/ Calories	81 kcal/25 g	80–100 kcal/25 g (FNRI/FDA)	Acceptable; energy content suitable for snack portions

Legend:

- *FNRI: Food and Nutrition Research Institute of the Philippines. Provides standard nutrient composition for bakery and RTE foods (FNRI, 2017–2023).*
- *FDA: Food and Drug Administration, Philippines. Sets general nutritional reference ranges for processed foods (FDA, 2021).*
- *Values in Result (%) are from laboratory analysis of the Savory Ampalaya Tart using standard AOAC methods: Soxhlet extraction (fat), phenol-sulfuric acid (carbohydrates), Kjeldahl (protein), gravimetric oven drying (moisture), and oxidation (ash).*
- *Interpretation is based on comparison with typical nutrient ranges for similar processed bakery products.*

CONCLUSIONS

Based on the findings of the study, it can be concluded that bitter gourd (Momordica charantia) can be successfully developed as a savory tart with acceptable sensory qualities, high consumer acceptability, and satisfactory safety and nutritional characteristics. Bitter gourd can be incorporated into a savory pastry without negatively affecting its overall quality. The development of a savory tart using bitter gourd successfully demonstrates its potential as a nutritious and acceptable alternative ingredient in food innovation. Across the three formulations tested, Treatment A (100 g), Treatment B (75 g), and Treatment C (50 g), all products achieve high consumer ratings. Among these, Treatment C (50g bitter gourd) consistently emerge as the most preferred formulation, attaining the highest mean acceptability score and excelling particularly in appearance and taste. The product maintains consistent attributes of appearance, aroma, taste, and texture across treatments. Additionally, while the tart is suitable for short-term storage at room temperature, refrigeration effectively extended its stability and safety, underscoring the importance of proper cold storage for maintaining product quality. All treatments meet food safety standards, with no harmful microorganisms detected, while proximate analysis highlights a balanced nutritional profile, with carbohydrates as the primary energy source complemented by adequate protein, fat, and ash content. Bitter gourd can be successfully utilized as a savory tart, offering both nutritional benefits and high consumer acceptability. Treatment C (50 g) stands out as the optimal formulation, combining favorable sensory qualities, safety, and nutritional value. This product innovation not only enhances vegetable utilization but also contributes to promoting healthier food choices among consumers. The results of this study aligned with that of Gonzales *et al.* (2026), which support the diverse bakery products with enhanced nutritional profiles to appeal to health-conscious customers.

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