

Utilization of Squash Flour in Making Piaya: Consumer Acceptability, Preference and Quality Assessment

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Abstract

This quantitative-experimental study examined the utilization of squash flour as a substitute for all-purpose flour in the production of *piaya*, a traditional Filipino pastry. A total of 60 respondents composed of students, faculty members, local residents, and bakers from Himamaylan City participated in the sensory evaluation. Five formulations with varying proportions of squash flour substitution (0%, 25%, 50%, 75%, and 100%) were assessed using a 9-point hedonic scale for appearance, aroma, taste, texture, and overall acceptability. Consumer willingness to purchase was evaluated using a 5-point Likert scale. Results indicated that *piaya* samples with up to

75% squash flour substitution were rated as “very acceptable” across all sensory attributes, while the 100% substitution showed reduced scores, particularly in aroma and texture. Physico-chemical analysis revealed higher moisture content and enhanced yellow-orange coloration in squash-based formulations, with sweetness levels remaining consistent across treatments. Respondents also expressed strong willingness to purchase squash flour-based *piaya*, citing its appealing appearance and perceived health benefits. Statistical analysis confirmed significant differences among the treatments, particularly between the 100% formulation and the other groups. The findings suggest that squash flour is a viable alternative to all-purpose flour for up to 75% substitution without compromising sensory quality. Its integration in *piaya* production presents opportunities for nutritional innovation, entrepreneurship, and the promotion of sustainable food practices within local communities.

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Keywords: Squash Flour, Piaya, Sensory Evaluation, Consumer Preference, Product Development

1. Introduction

Background of the Study

Squash, a term encompassing pumpkins, zucchinis, and marrows under the genus *Cucurbita*, is widely cultivated across different regions and valued for its nutritional and culinary applications. It contains essential nutrients such as vitamins A and C, dietary fiber, and bioactive compounds that contribute to health benefits including cardiovascular support, blood sugar regulation, and cancer prevention (Mahmoud & Mehder, 2022; Staughton, 2024). Beyond its nutritional role, squash also holds traditional medicinal value and is incorporated into diverse cuisines worldwide (Enneb et al., 2020). In many parts of Asia, squash is a staple vegetable cultivated year-round, particularly in hilly regions. However, nutrient-rich parts such as the peel are often discarded, contributing to food waste (Mukherjee et al., 2022). In the Philippines, locally known as *kalabasa*, squash is abundant and affordable. It plays a central role in Filipino cuisine and is especially noted for its high vitamin content and versatility in dishes ranging from stews to side dishes (Mercadal et al., 2022; Negros Season of Culture, 2021). In Negros province, squash is commonly paired with coconut milk or incorporated into local delicacies, highlighting its importance in regional culinary traditions. Despite these recognized benefits, the potential of squash as a functional food ingredient remains underutilized. One emerging innovation is the production of squash flour, which is prepared by drying and milling squash into a powder form. Squash flour not only preserves nutrients but also provides a sustainable means of utilizing surplus squash and its by-products. Such flour can be incorporated into baked goods and traditional delicacies, making it suitable for urban communities where access to fresh produce may be limited due to fast-paced lifestyles (Joshi et al., 2015).

Rationale of the Study

The growing demand for healthier food options has created opportunities for product innovation through the use of alternative flours. Substituting all-purpose flour with vegetable-based flours such as squash flour enhances both the nutritional value and visual appeal of baked goods without significantly compromising sensory qualities when applied in optimal proportions (Poliszko et al., 2019; Wongsagonsup et al., 2015). In addition, the natural pigments in squash, particularly β -carotene, provide attractive color enhancement, which can positively influence consumer preference (Adelerin et al., 2024). In the Philippines, *piaya*, a traditional muscovado-filled flatbread, is one of the most recognized delicacies, especially in Negros. Enhancing this local delicacy with squash flour provides dual benefits: promoting nutrition and sustaining cultural heritage through innovation. Prior studies have shown that incorporating squash into familiar foods such as cupcakes, ice cream, and polvoron increases consumer

acceptability and health value (Mercadal et al., 2022; Moreno, 2015; Bayogos, 2024). Given these insights, the present study seeks to evaluate the utilization of squash flour in making *piaya*. It investigates its sensory qualities, nutritional implications, and consumer willingness to purchase. This research not only supports the development of healthier and sustainable food options but also contributes to local entrepreneurship and culinary tourism in Himamaylan City.

Theoretical Framework

This study was anchored on two theoretical perspectives that explain consumer behavior and product evaluation: the Theory of Planned Behavior and the Sensory Evaluation Theory. The Theory of Planned Behavior (TPB), developed by Ajzen (1991), posits that an individual's intention to engage in a behavior is shaped by attitudes, subjective norms, and perceived behavioral control. In the context of food innovation, TPB has been widely applied to explain consumers' willingness to purchase healthier and alternative food products. Attitudes reflect consumer evaluations of squash flour-based *piaya* in terms of taste, texture, and overall appeal; subjective norms represent the influence of peers and community on consumer choices; and perceived behavioral control refers to the ease or difficulty of purchasing and consuming the product. This framework provides theoretical support for examining consumer willingness to purchase *piaya* formulated with squash flour. The Sensory Evaluation Theory supports the use of systematic methods to assess consumer acceptability of food products. Peryam and Pilgrim (1957) established the hedonic scaling method, which remains a widely recognized approach for measuring consumer preference and product acceptability in terms of appearance, aroma, taste, and texture. Sensory evaluation theory posits that consumer perceptions of food are multidimensional, and the integration of these sensory cues shapes overall product acceptability (Lawless & Heymann, 2010). In this study, sensory evaluation provided a structured way to determine the acceptability of different squash flour formulations of *piaya*. Together, these two theoretical perspectives justify the dual focus of this study: assessing sensory qualities through structured hedonic scaling and understanding consumer willingness to purchase through behavioral constructs. Anchoring the research on TPB and sensory evaluation principles strengthens the rationale for evaluating squash flour as a sustainable and nutritious ingredient for product development.

Conceptual Framework



Figure 1. Schematic Diagram of Conceptual Framework

The framework in figure 1 illustrates the logical flow of the study. The input highlights the primary variables, including squash flour as the main ingredient, sensory qualities (taste, texture, aroma, color, and appearance), and physico-chemical properties such as moisture content and soluble solids. The process outlines the key stages undertaken in the research, namely product development, laboratory analysis, sensory evaluation, and data

analysis. The output reflects the expected outcomes, which include sensory ratings of squash-based *piaya*, a nutritional comparison with traditional *piaya*, the identification of the most acceptable formulation, and insights into market potential and consumer interest. This framework guided the conduct of the study and served as the basis for interpreting its results.

Research Questions

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This study aimed to evaluate the utilization of squash flour in making *piaya*. Specifically, it sought to answer the following questions:

1. What is the level of sensory acceptability of squash flour-based *piaya* in terms of:
 - a. Taste
 - b. Texture
 - c. Aroma
 - d. Color
 - e. Overall appearance
2. How do the following qualities of squash flour-based *piaya* compare with those of traditional *piaya*?
 - a. Moisture content
 - b. Color and appearance
 - c. Total soluble solids
3. What is the level of consumers' willingness to purchase squash flour-based *piaya* in terms of:
 - a. Product appeal
 - b. Perceived value
 - c. Purchase intention
 - d. Social influence
4. Is there a significant difference in the sensory acceptability of squash flour-based *piaya* among the five treatment groups?

Hypotheses

The study tested the following null hypothesis:

- **H₀:** There is no significant difference in the sensory acceptability of squash flour-based *piaya* across the five treatments in terms of appearance, aroma, taste, and texture.

2. Review of Related Literature

Sensory acceptability is a critical factor in evaluating food innovations. Previous studies have shown that incorporating squash or pumpkin flour into staple food products enhances both nutritional value and consumer preference. For example, Liubych et al. (2023) found that pasta enriched with squash flour achieved a balanced flavor and was highly rated for taste at moderate substitution levels. Similarly, Waryat et al. (2023) reported that cakes containing a 50:50 ratio of wheat and squash flour attained optimal sensory scores, particularly in taste and

texture. These findings suggest that partial substitution with squash flour can improve the sensory characteristics of food products without compromising consumer satisfaction.

In terms of nutritional composition, squash is recognized as a rich source of vitamins, minerals, fiber, and bioactive compounds. Research has highlighted its potential to manage diabetes, reduce blood pressure, and act as an antioxidant due to the presence of carotenoids and polyphenols (Kaur et al., 2020; Batool et al., 2022). Furthermore, squash flour has been identified as a viable gluten-free alternative that enhances protein and fiber content in baked goods (Mukherjee et al., 2022). These properties make squash flour a functional ingredient that not only improves the nutrient profile of traditional foods but also caters to health-conscious consumers seeking natural alternatives.

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Consumer preference and willingness to purchase are equally important in determining the marketability of squash-based products. Studies in Thailand and the Philippines have shown that consumers value health benefits, appearance, and affordability when choosing innovative food products (Srisuwan et al., 2023; Lomeda-Junio, 2025). Moreover, research by Alsubhi et al. (2022) demonstrated that consumers are often willing to pay more for healthier options, especially those rich in fruits and vegetables. These findings highlight the strong potential for squash flour-based *piaya* to succeed in the market by combining nutritional benefits with sensory appeal and cultural familiarity.

3. Methodology

Research Design

This study employed a quantitative experimental design to evaluate the sensory acceptability, physico-chemical properties, and consumer willingness to purchase squash flour-based *piaya*. Five treatments were prepared using varying levels of squash flour substitution: 0%, 25%, 50%, 75%, and 100%.

Respondents

The study employed a purposive sampling technique to select respondents who were knowledgeable and capable of evaluating the sensory qualities of squash flour-based *piaya*. A total of 60 individuals from Himamaylan City participated in the study. The sample was composed of 32 Hospitality Management students, 8 faculty members, 10 local residents, and 10 local bakers. This composition was chosen to represent diverse perspectives, including academic evaluators, community consumers, and industry practitioners. Purposive sampling was deemed appropriate because the respondents possessed the necessary familiarity with food products and were able to provide reliable assessments of sensory acceptability and consumer willingness to purchase.

Materials and Instruments

The preparation of squash flour and *piaya* required standard kitchen tools and equipment, including peelers, mixers, blenders, and a panini grill. Sensory evaluation was conducted using a structured questionnaire based on the 9-point hedonic scale developed by Peryam and Pilgrim (1957) to assess appearance, aroma, taste, and texture. A 5-point Likert scale, adapted from Burton et al. (1999) and Chandran and Morwitz (2005), measured consumer willingness to purchase in terms of product appeal, perceived value, purchase intention, and social influence.

Data Gathering Procedure

Each formulation of *piaya* was prepared and evaluated by the respondents, who rated the samples after being provided with tasting instructions. Water was provided between tastings to minimize sensory bias. Data on sensory attributes and consumer willingness were collected through administered questionnaires.

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Data Analysis

Descriptive statistics (mean and standard deviation) were computed to summarize sensory evaluations and purchase intentions. One-way ANOVA was used to test significant differences among treatments, while the Kruskal-Wallis H test and Dunn's post-hoc test were applied to identify specific group differences in sensory acceptability.

Ethical Considerations

The study observed ethical standards by ensuring voluntary participation, confidentiality of responses, and informed consent. Approval was secured from the West Visayas State University–Himamaylan City Campus administration and local authorities prior to conducting the study. Food safety protocols were followed during preparation and evaluation.

4. Results and Discussion

Table 1. Sensory Acceptability of Squash Flour-Based *Piaya* in Terms of Appearance, Aroma, Taste, and Texture

Treatment	Appearance (M)	Aroma (M)	Taste (M)	Texture (M)	Interpretation
A – 100% All-purpose flour	8.23	8.03	8.10	8.20	Very Acceptable
B – 25% Squash Flour	8.15	8.08	8.10	8.10	Very Acceptable
C – 50% Squash Flour	8.10	8.02	7.93	7.93	Very Acceptable
D – 75% Squash Flour	8.17	8.05	8.10	8.12	Very Acceptable
E – 100% Squash Flour	7.75	7.42	7.18	7.42	Moderately Acceptable

Note: 8.51–9.00 = Highly Acceptable; 7.51–8.50 = Very Acceptable; 6.51–7.50 = Moderately Acceptable.

The results in Table 1 indicate that all formulations of *piaya* with squash flour substitution up to 75% achieved “very acceptable” ratings across all sensory attributes. Treatment A (100% all-purpose flour) expectedly achieved the highest scores overall, but Treatments B, C, and D closely followed, suggesting that partial incorporation of squash flour does not diminish consumer preference. Treatment D (75% squash flour) was particularly notable for maintaining high acceptability scores across appearance (M = 8.17), taste (M = 8.10), and texture (M = 8.12), demonstrating that substantial substitution is feasible without compromising product quality. By contrast, Treatment E (100% squash flour) experienced a decline in aroma (M = 7.42), taste (M = 7.18), and texture (M = 7.42), with ratings dropping to the “moderately acceptable” range. This reduction may be attributed to the absence of gluten and the stronger vegetal notes of squash flour, which altered both structure and flavor. Similar trends have been observed in other vegetable-flour substitutions, where partial inclusion enhances sensory properties while complete replacement negatively affects acceptability (McArthur-Floyd & Brako, 2024; Wang et al., 2022). These results suggest that squash flour can successfully replace up to 75% of all-purpose flour in *piaya*.

production without diminishing sensory appeal, offering an opportunity for healthier product development while preserving consumer satisfaction.

Table 2. Physico-Chemical Properties of Squash Flour-Based *Piaya*

Treatment	Moisture Content (%)	Color and Appearance	Total Soluble Solids (°Brix)
A – 100% All-purpose flour	28.77	Creamy white with brown spots	20
B – 25% Squash Flour	34.24	Light yellow-orange with brown spots	20
C – 50% Squash Flour	37.92	Light yellow-orange with brown spots	20
D – 75% Squash Flour	37.39	Yellow-orange with dark spots	20
E – 100% Squash Flour	34.87	Deep yellow-orange with dark spots	20

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The inclusion of squash flour in table 2 altered the physico-chemical characteristics of *piaya*, particularly in terms of moisture content and color. Treatments containing squash flour showed higher moisture content compared to the 100% all-purpose flour control (28.77%). The highest value was observed in Treatment C (50% squash flour) at 37.92%, indicating that squash flour's natural water-binding capacity contributed to greater moisture retention. This outcome is consistent with findings that vegetable-based flours enhance water absorption and improve product moistness (Delgado et al., 2017). In terms of appearance, progressive substitution with squash flour shifted the color of the *piaya* from creamy white to varying shades of yellow-orange, with deeper hues observed at higher substitution levels. This transformation is attributable to β -carotene and other pigments present in squash, which naturally enhance the visual appeal of baked products (Adelerin et al., 2024). Such coloration may provide a marketing advantage, as consumers often associate natural pigments with freshness and nutritional value. Despite these differences, the total soluble solids (°Brix) remained consistent across all treatments at 20, suggesting that sweetness levels were unaffected by squash flour substitution. This stability indicates that product reformulation did not alter the core sweetness of *piaya*, supporting its sensory acceptability among consumers.

Table 3. Consumers' Willingness to Purchase Squash Flour-Based *Piaya*

Component	Mean	SD	Interpretation
Product Appeal	4.30	0.56	Willing
Perceived Value	4.30	0.42	Willing
Purchase Intention	4.27	0.60	Willing
Social Influence	4.32	0.50	Willing
Overall	4.30	0.52	Willing

Note: 4.51–5.00 = Very Willing; 3.51–4.50 = Willing; 2.51–3.50 = Neither Willing nor Unwilling; 1.51–2.50 = Unwilling; 1.00–1.50 = Very Unwilling.

As shown in Table 3, respondents expressed a positive willingness to purchase squash flour-based *piaya*, with all components rated within the "willing" range. The highest score was observed for social influence (M = 4.32), suggesting that peer and community perceptions play a strong role in shaping consumer choices. Product appeal and perceived value were equally rated (M = 4.30), indicating that consumers found the product visually attractive and worth purchasing at a fair price point. Purchase intention (M = 4.27) also reflected a favorable disposition toward buying the product in the future. These findings align with prior research indicating that health-oriented

consumers are generally open to innovative food products that combine nutritional benefits with cultural familiarity (Srisuwan et al., 2023). Moreover, the strong role of social influence supports the view that food purchasing decisions are often shaped by community trends and peer recommendations (Gligorić et al., 2023). Overall, the willingness to purchase squash flour-based *piaya* underscores its potential as a viable commercial product. Beyond its nutritional benefits, its positive social and cultural associations could enhance acceptance in local markets, making it a promising avenue for entrepreneurial ventures in bakery and food innovation.

Table 4. Differences in the Sensory Acceptability of Squash Flour-Based *Piaya* Among Five Treatment Groups

Treatment Group	N	Mean Rank	Kruskal–Wallis H	df	p-value
A – 100% All-purpose flour	60	174.23	20.847	4	.000*
B – 25% Squash Flour	60	165.23			
C – 50% Squash Flour	60	148.63			
D – 75% Squash Flour	60	158.08			
E – 100% Squash Flour	60	108.58			

Note: $p < .05$ indicates statistical significance.

The Kruskal–Wallis H test in table 4 revealed statistically significant differences in sensory acceptability among the five treatment groups ($H = 20.847$, $p = .000$). Treatment A (100% all-purpose flour) obtained the highest mean rank (174.23), followed closely by Treatment B (165.23) and Treatment D (158.08), indicating strong acceptability for formulations containing no squash flour or partial substitutions. Treatment C (50% squash flour) had a lower mean rank (148.63) but remained within the acceptable range. In contrast, Treatment E (100% squash flour) scored the lowest mean rank (108.58), suggesting that full substitution significantly reduced consumer acceptability. These findings indicate that while squash flour is well-accepted at partial substitution levels, complete replacement introduces unfavorable changes in sensory attributes. This outcome is consistent with previous studies highlighting that excessive substitution with vegetable flours may compromise sensory balance due to altered texture, flavor, and aroma profiles (Munawar et al., 2018; Wang et al., 2022). The significant overall test result underscores the importance of identifying optimal substitution ratios for product development. Specifically, substitution levels up to 75% maintain acceptability, while 100% substitution may hinder consumer preference. This reinforces the recommendation to limit squash flour inclusion to partial proportions when developing innovative, nutritionally enhanced *piaya*.

Table 5. Post Hoc Dunn’s Test for Pairwise Comparisons of Treatments in Terms of Sensory Acceptability

Treatment Comparison	Test Statistic	p-value	Interpretation
A vs. B	9.000	.410	Not Significant
A vs. C	25.600	.005*	Significant
A vs. D	16.150	.080	Not Significant
A vs. E	65.650	.000*	Significant
B vs. C	16.600	.070	Not Significant
B vs. D	7.150	.480	Not Significant
B vs. E	56.650	.000*	Significant
C vs. D	9.450	.400	Not Significant
C vs. E	40.050	.001*	Significant

Treatment Comparison	Test Statistic	p-value	Interpretation
D vs. E	30.600	.003*	Significant

Note: $p < .05$ indicates significant difference.

Table 5 presents the results of the Dunn's post hoc test, which was performed to determine where significant differences occurred among the treatment groups. Results indicated that Treatment A (100% all-purpose flour) significantly differed from Treatment C (50% squash flour) and Treatment E (100% squash flour), with the latter showing the greatest decline in acceptability. Similarly, Treatment B (25% squash flour) differed significantly from Treatment E, while Treatments C and D also demonstrated significant differences when compared to Treatment E. These findings confirm that the 100% squash flour formulation (Treatment E) was consistently less acceptable compared to other treatments, particularly in taste, aroma, and texture. However, no significant differences were found among Treatments A, B, and D, indicating that up to 75% squash flour substitution maintained comparable acceptability levels to the control. This aligns with earlier research suggesting that partial replacement with vegetable-based flours maintains desirable sensory characteristics, whereas complete substitution tends to compromise quality (Delgado et al., 2017; Waryat et al., 2023). Overall, the post hoc analysis reinforces that partial substitution—especially between 25% and 75%—is optimal for balancing nutritional improvements with consumer acceptability. Full substitution, while nutritionally beneficial, poses challenges for sensory appeal and marketability.

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5. Implications of the Results

Theoretical Implications.

The study contributes to the growing body of knowledge on functional food innovation by validating the application of the Theory of Planned Behavior and Sensory Evaluation Theory in the context of traditional delicacies. It demonstrates how consumer attitudes, social influence, and sensory perceptions interact to shape willingness to purchase, thereby supporting behavioral models of food choice. This integration enriches the literature on sensory evaluation and consumer studies by extending theoretical frameworks to localized food product development.

Practical Implications.

For bakers, entrepreneurs, and the food industry, the results show that squash flour can be used as a partial substitute for all-purpose flour in *piaya* without diminishing sensory quality, making it a viable option for product diversification. This innovation provides an opportunity for small and medium enterprises to offer healthier food alternatives that retain consumer appeal. The consistent sweetness and improved coloration of squash flour-based *piaya* further strengthen its potential marketability as both a nutritious and visually appealing product.

Societal Implications.

The findings also highlight the role of squash flour utilization in promoting sustainability and food security. By creating value-added products from locally abundant squash, communities can reduce agricultural waste, enhance nutritional intake, and support livelihoods through small-scale food enterprises. The cultural significance of *piaya* combined with the health benefits of squash flour aligns with national goals of preserving culinary heritage while

advancing sustainable food practices. This underscores the potential of such innovations to contribute not only to economic empowerment but also to community well-being and resilience.

6. Conclusion and Recommendations

Conclusion

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The study demonstrated that squash flour can be effectively utilized in *piaya* production at substitution levels of up to 75% without compromising sensory acceptability. Treatments with partial substitution-maintained ratings comparable to the control in terms of appearance, aroma, taste, and texture, while the 100% squash flour formulation showed moderate acceptability due to changes in flavor and texture. Physico-chemical analysis indicated higher moisture content and enhanced coloration in squash-based products, with sweetness levels remaining consistent across treatments. Consumers expressed a positive willingness to purchase, citing strong appeal, perceived value, purchase intention, and social influence, suggesting that squash flour-based *piaya* has potential as a nutritious and sustainable product.

Recommendations

The findings suggest that incorporating squash flour at 25% to 75% substitution levels offers both nutritional benefits and consumer acceptability, making it suitable for adoption by local bakers and entrepreneurs. Its enhanced visual appeal and health attributes can serve as strong marketing points for small enterprises seeking innovative food products, while agricultural stakeholders may leverage squash flour utilization as a strategy for food sustainability and waste reduction. Further research is recommended to assess shelf life, market expansion, and comparative studies with other vegetable-based flours to strengthen the commercial viability of squash flour-based *piaya*.

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