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Sensory Acceptability of Papaya Cupcakes with Varying Levels of Carica papaya (L.) Pulp: A Quasi-Experimental Study

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Abstract

The results of the study have far-reaching connotations for both culinary innovation, local agriculture, and the development of new food products. Since various ratios of shredded papaya pulp had no appreciable effects on appearance, flavor, smell, or general acceptability, papaya as an ingredient is found to be very versatile to use within cupcake products. Such versatility makes papaya an apt ingredient to use to blend into pastry products while not compromising on sensorial qualities. Blending is an option to produce more nutritious food products while not compromising sensorial qualities and acceptability. The stark texture contrast underlines the necessity to maximize the content of functional components like papaya pulp. The fact that the ½ cup treatment revealed a peak texture score indicates a specific level of papaya addition where moisture, softness, and mouthfeel are present simultaneously. This finding is particularly relevant to the development of baked goods for the market of healthy and functional foods where nutritional content and sensorial acceptability are most critical to the consumer. Agriculturally, the research confirms the value-adding potential of papaya as an ingredient in locally produced bakery products. Promotion of the utilization of papaya as an ingredient in bakery products can serve to generate further demand for the papaya fruit, to the benefit of smallholder farmers and farm sustainability. This conforms to goals of more enhanced farm-to-market linkages and greater agro-industry innovation in the Philippines and other tropical nations. Finally, the study reaffirms the role of sensory assessment as a critical instrument during food product development. Systematic use of a properly designed assessment method, the Hedonic scale with statistical analysis, provides evidence-based guidance towards developing products to meet consumers' needs. Future possibilities of these results are the development of standards for use of other tropical fruits in bakery and confectionary food, enabling increased utilization of locally produced materials during industrial food production.

Keywords: *Carica Papaya* (L.), Papaya Cupcake, Sensory Evaluation, Acceptability, Hedonic Scale, Quasi-Experimental Design, Texture, Appearance, Taste, Local Food Innovation

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1. Introduction

Papaya (Carica papaya L.) is a fruit with widespread cultivation and use as a nutrient-rich, health-giving fruit. Papaya, which is a plant originating from southern Mexico and Central America, is now a leading agriculture commodity in tropical and subtropical nations, particularly in the Philippines. Papaya is nutrient-rich and contains vitamins, minerals, and bioactive chemicals like papain with antioxidant, digestive, and anti-inflammatory effects (Noshad & Anjum, 2018; Verma et al., 2017). While consumed fresh or prepared as jam, candies, and beverages, papaya is now under development as an ingredient for functional foods with the capability to optimize both health and economic benefits.

The rationale behind this research is the need to formulate healthy but affordable bakery products with more utilization of local farm produce as well as fulfilling consumer demand for functional food. Papaya, readily available and inexpensive, presents an instant alternative to the use of traditional pastry recipe components. This research focused on the sensory acceptability of shredded papaya pulp enriched cupcakes with varying enrichment levels. This research, with focus on sensory traits of appearance, taste, texture, flavor, and overall acceptability, sought to provide empirical basis for the use of papaya on commercial bakery products, thus offering the consumer a healthier alternative but not compromising palatability.

The outcomes of this research are of value to various stakeholders. To the local farmers, the use of papaya as a bakery ingredient would generate market demand and improved livelihoods from value-addition. To food entrepreneurs and chefs, the study results provide information on product development strategies incorporating nutrition, innovation, and consumer acceptability. To academia, the research contributes to food product development and the studies on consumer testing. The research is also a model to other research trying to use indigenous or underutilized fruits as ingredients for commercial food products.

Aim

This study aimed to evaluate the sensory acceptability of cupcakes prepared with varying amounts of *Carica papaya* (L.) pulp. The research focused on assessing the quality of the papaya cupcakes in terms of appearance, taste, texture, aroma, and overall acceptability as perceived by a panel of evaluators.

Research Questions

1. What is the level of sensory acceptability of papaya cupcakes prepared with 1 cup, ½ cup, and 1/3 cup of shredded *Carica papaya* (L.) in terms of:
    a. appearance,
    b. taste,
    c. texture,
    d. aroma, and
    e. general acceptability?
2. Are there significant differences in the sensory acceptability of papaya cupcakes with 1 cup, ½ cup, and 1/3 cup of shredded *Carica papaya* (L.) in relation to:

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a. appearance,
b. taste,
c. texture,
d. aroma, and
e. general acceptability?

Conceptual Framework

This study was conducted within the context of Burke and Rogers' (2006) Theory of Innovation, where innovation is defined as the adoption and successful implementation of new approaches, products, or services in a social system. Use of Carica papaya (L.) as a key ingredient in the development of a cupcake is a pastry product development innovation in this study. The theory provides the reasons why consumers' sensory perception and acceptance are crucial to the diffusion and eventual adoption of such food innovations.

The research proposes the relationship between the amount of shredded papaya added to cupcake recipes (independent variable) and the scores of the sensory evaluations (dependent measures). Independent variable consisted of three treatments: cupcakes with 1 cup, ½ cup, and 1/3 cup shredded papaya pulp. Sensory attributes as evaluated by the consumers: appearance, taste, texture, aroma, and overall acceptability were the dependent measures. Sensory evaluation employed a six-point Hedonic scale to score the consumer panelists' perceptions.

The method involved preparation of the cupcake samples for each treatment according to the normal method, followed by sensory testing with a trained panel of assessors. Statistical analysis with mean scores, standard deviation, and one-way ANOVA were applied to examine variation of sensory characteristics among treatments. Assuming that the varying level of papaya will have an impact on one or more of the cupcake's sensory characteristics, which is texture as evidenced from this study.
This conceptual model provides a step-by-step method of examining how a nutrient-rich, locally available fruit like papaya can be integrated into typical pastry products to provide added value in the form of nutrition without compromising consumer acceptability.

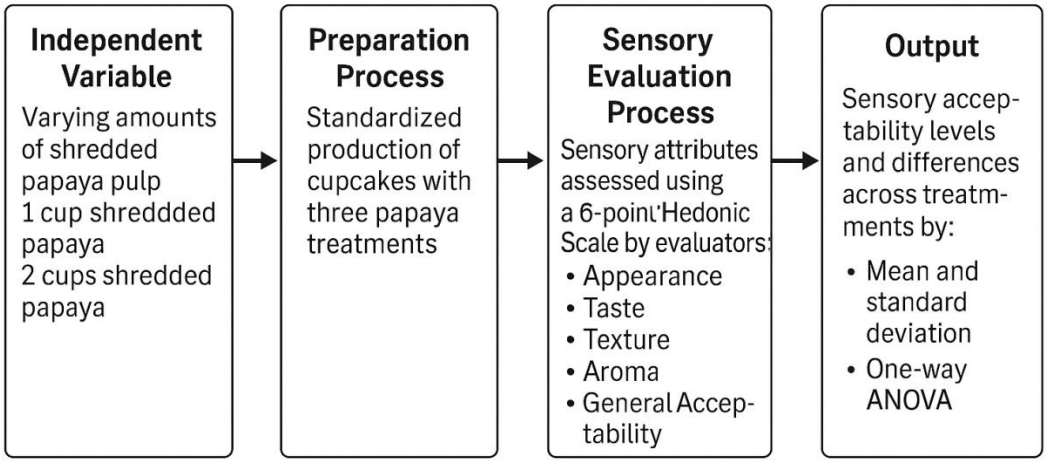

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Figure 1. Schematic Diagram of Conceptual Framework

Figure 1 is the conceptual flow of the research, highlighting the general stages from input to output. The independent variable is the variable levels of shredded papaya pulp (Carica papaya L.) in the recipes of the cupcakes. Preparation is the preparation of the cupcakes according to the variable papaya treatment. This is then followed by the sensory process, and the cupcakes are assessed on a 6-point Hedonic scale by an assessor for the appearance, taste, texture, smell, and general acceptability attributes. The output of the research is the levels of sensory acceptability and statistical comparison among the treatments, determined through mean, standard deviation, and one-way ANOVA. The diagram depicts the logical flow and study components' relationship.

2. Literature Review

Papaya (Carica papaya L.) is known for both nutritional and culinary value. Papaya fruit contains vitamin C, vitamin A, folate, and dietary fiber, and contains bioactive compounds like papain and carotenoids. These are the ones which are behind the health-giving properties of it (Saran et al., 2021). Papaya as an ingredient is utilized for the production of various food products because of the softness, sweetness, and functional nutritional aspects of papaya (Sharma & Ram, 2022). Scholars have referred to the use of papaya as an ingredient for baked products as there are not only nutritional value improvements but also an influence on senses like color, taste, and moisture (Singh et al., 2020).

Sensory analysis is the most critical method of food product development, reporting on consumer preference and acceptability. Sensory analysis is the systematic assessment of food qualities detected by the senses (Stone et al., 2020). Use of standardized sensory tools, i.e., the Hedonic scale, allows quantitative comparison of appearance, taste, smell, texture, and overall acceptability (Lawless & Heymann, 2018). Data from research on fruit-enriched cakes carried out by Kumari et al. (2021) revealed consumer acceptability to normally be impacted by fruit content vs. product texture, with higher levels of fruit sometimes causing unwanted softness or tackiness.

Incorporation of local or indigenous fruits for enrichment of bakery products is part of global trends toward sustainable and functional foods (Cardoso et al., 2021). Utilization of tropical fruits like papaya as value-added products in the Philippines has been supported as a driver for local innovation and empowerment of small-scale producers (Garcia & Lizada, 2019). David et al. (2020) tested banana and papaya bread and found that even though the two fruits enhanced nutritional quality, optimal blends for acceptability required precise formulation to achieve acceptable texture and flavor profiles.

Statistical analysis, including measures of central tendency and the inferential techniques like ANOVA, is an indispensable part of sensory research. These analyses determine whether treatment effects are or are not noteworthy, and inform product reformulation decisions (Meilgaard et al., 2016). ANOVA could detect divergence of odor and texture and lead to formula tweaking to achieve higher consumer acceptability, as indicated by a recent study on fruit-fortified muffins carried out by Tiwari et al. (2022).

In summary, the literature establishes the viability of papaya as a functional bakery ingredient. But success with incorporation requires the attainment of nutritional improvement and sensorial acceptability. This study

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contributes to the literature by empirically evaluating the sensorial acceptability of papaya cupcakes with varying levels of shredded papaya added, yielding data to support product development and local food innovations.

3. Methodology

A quasi-experimental research design was utilized in this study to establish the sensory acceptability of papaya cupcakes made with different quantities of shredded Carica papaya (L.) pulp. This had been selected to provide the independent variable—the quantity of shredded papaya pulp—with three levels of treatment so that its impact could be viewed on certain sensorial attributes of the cupcake recipes. The independent variable was composed of three treatment levels of shredded papaya pulp added to regular recipes for cupcakes in the quantity of 1 cup, ½ cup, and 1/3 cup. Sensory attributes of appearance, taste, texture, flavor, and overall acceptability formed the dependent variable. With this research strategy, the researchers were able to establish whether or not an increase or fluctuation in the quantity of papaya affected the sensorial attributes of the product.

The study was conducted in the second semester of the school year 2021-2022, University of Antique, Tario-Lim Memorial Campus. The panel members were 15 Bachelor of Science in Hospitality Management students and College of Business and Management faculty members who were randomly selected. Students who participated were selected considering experience and background in food sensory evaluation to provide knowledgeable and credible judgments as part of the assessment. The panel members were instructed to utilize the six-point Hedonic scale as the primary data collection tool prior to the assessment.

Preparation process employed a standard recipe to ensure uniform treatment. Base ingredients used involved all-purpose flour, sugar, butter, milk, eggs, salt, baking powder, and baking soda, which were blended with the specific quantity of shredded papaya pulp as per treatment. Ingredients in dry form were blended separately before being added with wet ones using the process of folding. Papaya pulp, for the final addition, was incorporated into the batter mixture to ensure retention of texture. Batter was poured into cupcake pans and baked between 25 to 30 minutes using an oven temperature of 350ºF by a preheated oven. Cupcakes were left to come to room temperature after baking before removal to perform sensory analysis.

Sensory testing was done using a pre-defined evaluation form on the six-point Hedonic scale. The panel members scored each product on appearance, taste, texture, odor, and overall acceptability, scored from 1 (strongly not liked or strongly not acceptable) to 6 (strongly liked or strongly acceptable). Data collected were analyzed using descriptive statistical analysis, i.e., mean and standard deviation, to detail the sensory ratings. To determine whether there were differences between the treatments, one-way analysis of variance (ANOVA) at a 0.05 level of significance was applied. Where variation between the groups was found to be significant, post hoc testing using Scheffé's test was applied in order to determine specific group variation. This statistical approach provided strong indication on the impact of papaya amount on the sensory characteristics of the cupcakes.

4. Results and Discussion

Table 1. Sensory Acceptability of Papaya Cupcake Preparations in Terms of Appearance

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Treatment	Mean	SD	Description	ANOVA F	p-value
1 cup shredded papaya	5.04	0.33	Liked moderately		
½ cup shredded papaya	5.13	0.24	Liked moderately	0.51	.61
1/3 cup shredded papaya	5.02	0.36	Liked moderately		

Scale: 5.17–6.00 = Liked very much; 4.34–5.15 = Liked moderately; 3.51–4.33 = Liked slightly; 2.68–3.50 = Disliked slightly; 1.84–2.67 = Disliked moderately; 1.00–1.83 = Disliked very much.

As shown in Table 1, the appearance of all papaya cupcake treatments was “liked moderately” by the panelists. The small variation in mean scores across treatments was nonsignificant, $F(2, 42) = 0.51$, $p = .61$. The inference is that the addition of various levels of shredded papaya did not significantly impact the appearance quality of cupcakes. The result is consistent with available research that the addition of fruit at moderate levels is likely to be sustained or improved in appearance in baked foods without inducing unwanted visual changes (Singh et al., 2020). The natural color of papaya might have positively contributed to evenness and attractiveness, a characteristic that is critical in informing consumer perception of product quality (Lawless & Heymann, 2018).

Table 2. Sensory Acceptability of Papaya Cupcake Preparations in Terms of Taste

Treatment	Mean	SD	Description	ANOVA F	p-value
1 cup shredded papaya	4.69	0.51	Liked moderately		
½ cup shredded papaya	4.82	0.33	Liked moderately	1.87	.17
1/3 cup shredded papaya	4.98	0.37	Liked moderately		

Scale: 5.17–6.00 = Liked very much; 4.34–5.15 = Liked moderately; 3.51–4.33 = Liked slightly; 2.68–3.50 = Disliked slightly; 1.84–2.67 = Disliked moderately; 1.00–1.83 = Disliked very much.

As indicated by Table 2, the papaya cupcake preparations' taste was "liked moderately" across all treatments. The 1/3 cup shredded papaya received the highest mean rating ($M = 4.98$) followed by the ½ cup ($M = 4.82$) and 1 cup ($M = 4.69$) preparations. The differences were not significant, $F(2, 42) = 1.87$, $p = .17$. The results indicate that even though there were minor differences in taste perception, the quantity of papaya pulp did not influence taste acceptability significantly within the tested range.

This agrees with other research highlighting fruits' balanced use within bakery products, where balanced use enhances inherent sweet taste and does not dominate the overall flavor (Kumari et al., 2021). Extensive use sometimes causes very minimal bitterness or interrupts the perception of sweet, but treatment here remained within threshold levels (Tiwari et al., 2022). All the results verify there is no reduction in customer satisfaction with added papaya at various levels of use within cupcake recipes.

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Table 3. Sensory Acceptability of Papaya Cupcake Preparations in Terms of Texture

Treatment	Mean	SD	Description	ANOVA F	p-value
1 cup shredded papaya	4.60	0.26	Liked moderately		
½ cup shredded papaya	4.93	0.36	Liked moderately	3.97	.03*
1/3 cup shredded papaya	4.80	0.35	Liked moderately		

Scale: 5.17–6.00 = Liked very much; 4.34–5.15 = Liked moderately; 3.51–4.33 = Liked slightly; 2.68–3.50 = Disliked slightly; 1.84–2.67 = Disliked moderately; 1.00–1.83 = Disliked very much. Significant at p < .05.

Findings in Table 3 reveal that all treatments were "liked moderately" in texture, yet mean ratings revealed differences between the preparations. The ½ cup shredded papaya preparation received the highest mean rating (M = 4.93), then 1/3 cup (M = 4.80), and 1 cup (M = 4.60). One-way ANOVA revealed significant differences, F(2, 42) = 3.97, p = .03. Post hoc analysis (not presented in table) revealed that the ½ cup papaya cupcake had significantly smoother texture compared to the 1 cup papaya preparation.

The same finding is consistent with earlier research on the level of fruit pulp content and the quality of texture of bakery products (Singh et al., 2020). Increased content of papaya pulp could have had higher levels of moisture beyond the optimum and therefore produced softer or even denser crumb, which the panelists evaluated as less smooth. A moderate content of incorporation, on the other hand, as with the incorporation of ½ cup, appears to have achieved the ideal balance and equilibrium of moisture and structure and hence yielded improved mouthfeel and texture (Tiwari et al., 2022). All the results indicate the critical significance of ingredient ratios to attain optimum texture, an influential factor of consumers' acceptance of products (Lawless & Heymann, 2018).

Table 4. Sensory Acceptability of Papaya Cupcake Preparations in Terms of Aroma

Treatment	Mean	SD	Description	ANOVA F	p-value
1 cup shredded papaya	4.74	0.41	Liked moderately		
½ cup shredded papaya	4.86	0.33	Liked moderately	0.89	.42
1/3 cup shredded papaya	4.91	0.35	Liked moderately		

Scale: 5.17–6.00 = Liked very much; 4.34–5.15 = Liked moderately; 3.51–4.33 = Liked slightly; 2.68–3.50 = Disliked slightly; 1.84–2.67 = Disliked moderately; 1.00–1.83 = Disliked very much.

In Table 4, one can see that the smell of papaya cupcake samples had an overall good and "liked moderately" perception among members of the panel. Aroma mean scores ranged from 4.74 for 1 cup shredded papaya to 4.91

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for that of 1/3 cup. Analysis of variance indicated these were not significantly different, F(2, 42) = 0.89, p = .42. The implication is that the amount of shredded papaya pulp added to the recipes of the cupcakes had no significant bearing on the smell perceived.

This finding is consistent with earlier research indicating the use of fruit pulp with subtlety in bakery products enhances natural aroma but not to a level of overpowering or objectionable smell (Kumari et al., 2021). Papaya's natural aromatic components would have been positive to use at each treatment but to levels not causing great perceptible discrimination (Sharma & Ram, 2022). This would mean papaya can be added usefully to cupcake recipes without affecting the aroma adversely, supporting their use for extensive use in functional and value-added bakery food.

Table 5. General Acceptability of Papaya Cupcake Preparations

Treatment	Mean	SD	Description	ANOVA F	p-value
1 cup shredded papaya	4.87	0.37	Moderately acceptable		
½ cup shredded papaya	5.11	0.20	Moderately acceptable	2.02	.15
1/3 cup shredded papaya	5.04	0.41	Moderately acceptable		

Scale: 5.17–6.00 = Very much acceptable; 4.34–5.15 = Moderately acceptable; 3.51–4.33 = Slightly acceptable; 2.68–3.50 = Slightly unacceptable; 1.84–2.67 = Moderately unacceptable; 1.00–1.83 = Very much unacceptable.

As seen in Table 5, the papaya cupcake preparations in general were “moderately acceptable” across treatments. They rated highest on the ½ cup shredded papaya preparation (M = 5.11), then the 1/3 cup (M = 5.04) and the 1 cup (M = 4.87) preparations. Although the ½ cup treatment ratings were slightly higher, the treatments were not significantly different, F(2, 42) = 2.02, p = .15.

These results demonstrate that the difference among shredded papaya pulp levels tested did not negatively affect the overall acceptability of the cupcakes. This finding concurs with the opinion that customers are largely receptive to fruit being added to bakery products when the amount does not overwhelm inherent sensory qualities (David et al., 2020). Highly acceptable ratings on all the treatments demonstrate that papaya can serve as the basis for functional use as an ingredient in cakes to ensure consumer satisfaction is not affected. These findings confirm the role of fruit-based innovations in the use of bakeries, whereby well-balanced formulae are able to meet nutritional goals while not diverging from marketable sensory qualities (Cardoso et al., 2021).

5. Conclusion and Recommendations

The findings of this study confirmed that cupcakes made with varying amounts of shredded Carica papaya (L.) pulp were, overall, acceptable to the panel of assessors. All treatments were “liked moderately” in terms of appearance, flavor, texture, and aroma, and “moderately acceptable” overall. Statistical analysis indicated no

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significant difference in appearance, flavor, aroma, nor overall acceptability among treatments, which indicates that the quantity of papaya used within the range tested had no significant impact on these sensory attributes. Significant difference was, however, observed in texture, with the ½ cup papaya treatment being rated higher, which can imply that a moderate level of papaya might have the most acceptable mouthfeel.

The study supports the viability of using papaya pulp as a value-added functional food ingredient to be added to baked foods to provide nutritional value while not compromising the acceptability of the consumer. This supports common food innovation efforts to include local agricultural products into industrial foods as a strategy to enhance nutritional and sensory values (Cardoso et al., 2021; David et al., 2020).

From the results, a recommendation for using moderate levels of shredded papaya pulp, i.e., ½ cup per batch, and incorporating them into cupcake formulations to enhance texture and overall sensory acceptability is made. For culinary and hospitality teaching demonstrations, course instructors can use this recipe to promote local food innovation through the use of tropical fruits. Suggestion for future work is to explore the use of the papaya with other functional ingredients or explore uses of papaya with other pastry products. Future research can also involve consumer acceptance with larger and more diverse consumer groups to validate results and determine market potential.

6. Implications of Results

The results of the study have far-reaching connotations for both culinary innovation, local agriculture, and the development of new food products. Since various ratios of shredded papaya pulp had no appreciable effects on appearance, flavor, smell, or general acceptability, papaya as an ingredient is found to be very versatile to use within cupcake products. Such versatility makes papaya an apt ingredient to use to blend into pastry products while not compromising on sensorial qualities. Blending is an option to produce more nutritious food products while not compromising sensorial qualities and acceptability.

The stark texture contrast underlines the necessity to maximize the content of functional components like papaya pulp. The fact that the ½ cup treatment revealed a peak texture score indicates a specific level of papaya addition where moisture, softness, and mouthfeel are present simultaneously. This finding is particularly relevant to the development of baked goods for the market of healthy and functional foods where nutritional content and sensorial acceptability are most critical to the consumer.

Agriculturally, the research confirms the value-adding potential of papaya as an ingredient in locally produced bakery products. Promotion of the utilization of papaya as an ingredient in bakery products can serve to generate further demand for the papaya fruit, to the benefit of smallholder farmers and farm sustainability. This conforms to goals of more enhanced farm-to-market linkages and greater agro-industry innovation in the Philippines and other tropical nations.

Finally, the study reaffirms the role of sensory assessment as a critical instrument during food product development. Systematic use of a properly designed assessment method, the Hedonic scale with statistical analysis, provides evidence-based guidance towards developing products to meet consumers' needs. Future

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