IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.311 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 5, May 2026

DOI: 10.17148/IARJSET.2026.13578

Elevating the Classic Pie Crust with Coconut Flour, Jute, and Citrus Infusions

Miami Rose R. Tabernilla

Capiz State University-Main Campus, Roxas City, Philippines

This study developed and evaluated a functional pie crust enriched with coconut flour, crop jute (saluyot), and citrus fruits such as lemon, calamansi, and orangeto enhance nutritional value, sensory quality, and product functionality. The product was conceptualized as a healthier bakery alternative utilizing locally available ingredients with potential dietary and antioxidant benefits. Specifically, the study assessed sensory qualities in terms of appearance, aroma, taste, and texture; determined general acceptability; evaluated acceptability when applied to pie; examined significant differences among treatments; established shelf life under varying storage conditions; and subjected the best formulation to microbial and proximate analysis. An experimental-developmental design was employed using a Completely Randomized Design (CRD). Three treatment levels of dehydrated citrus (5 g, 10 g, and 15 g) were tested for each citrus type while keeping base ingredients constant. Sensory evaluation was conducted using a 9-point Hedonic Scale with 10 semi-trained panelists for sensory attributes and 100 consumers for general acceptability. Data were analyzed using mean, Analysis of Variance (ANOVA) at a 0.01 level of significance, and Tukey HSD for post hoc comparison. Results showed that all formulations were Very Acceptable; however, the Orange-Based Pie Crust – Treatment C (15 g dehydrated orange) consistently achieved the highest ratings across sensory attributes and general acceptability. Its superior performance was associated with balanced sweetness, enhanced aroma, and desirable color and texture. Lemon-based formulations showed moderate acceptability, while calamansi-based products ranked lowest due to higher acidity. Significant differences were observed among treatments. Shelf-life testing indicated longer stability under refrigeration than at room temperature. The selected best formulation met microbial safety standards and demonstrated acceptable proximate composition, supporting its potential as a functional bakery product.

Keywords: Pie Crust, Coconut Flour, , Lemon, Food Product Development.

I. INTRODUCTION

Food product development had long required a careful balance between quality, acceptability, and nutritional value. In bakery production, pie crust is commonly prepared with wheat flour because it forms gluten, which contributes to the desired structure and texture. However, growing awareness of health and sustainability concerns has encouraged the exploration of alternative ingredients that could enhance nutritional quality without significantly affecting product acceptability (Hossain et al., 2016; Novitasari et al., 2023).

The continued dependence on wheat flour presented certain limitations, particularly in terms of dietary fiber content and gluten-related concerns. In response, recent studies have examined the use of plant-based and non-traditional flours as substitutes or partial replacements in baked products. These alternatives were found to improve the nutritional profile, especially by increasing fiber and bioactive compounds, although they also introduced challenges related to texture and consistency (Khomych et al., 2025). Despite these challenges, such innovations opened opportunities for developing more functional and health-oriented food products.

This direction of innovation reflected key priorities within the College of Education, particularly in the areas of Innovation and Digital Transformation and Sustainability and Disaster Risk Reduction in Education. The integration of food technology into research activities demonstrated how scientific knowledge could be applied to address real-world concerns such as nutrition, sustainability, and resource utilization. At the same time, it supported Entrepreneurship and Community Development by promoting the use of locally available materials in value-added product development.

Coconut flour has emerged as a viable alternative to wheat flour due to its high fiber content and naturally gluten-free composition. As a by-product of coconut processing, it also contributed to waste reduction and sustainable food production practices (Karandeep et al., 2019). Previous findings indicated that incorporating coconut flour into baked goods improved their nutritional content, particularly in terms of fiber, while maintaining acceptable sensory characteristics (Hossain et al., 2016; Ramya et al., 2020). These properties made it suitable for use in developing healthier bakery products.

Jute leaves (Corchorus olitorius), locally known as saluyot, have also been recognized for their nutritional value. They were rich in essential vitamins, minerals, and dietary fiber, making them a potential ingredient for functional food applications. Studies had pointed out their high levels of beta-carotene, iron, and calcium, as well as their antioxidant

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.311 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 5, May 2026

DOI: 10.17148/IARJSET.2026.13578

properties (Ngomuo et al., 2017; Lian et al., 2021). Despite being widely available, their use in processed food products remained limited, suggesting the need for further exploration.

Citrus fruits, particularly the orange, have been widely valued for their nutritional and functional properties. They contained significant amounts of vitamin C, flavonoids, and other phytochemicals known for their antioxidant activity (Uthman & Garba, 2023). In addition to their health benefits, citrus components contributed to flavor, aroma, and potential preservation effects in food products (Rehman et al., 2020). The use of citrus by-products, such as peels, has also been associated with waste reduction and the development of value-added ingredients (Iftikhar, 2019).

Bringing these ingredients together offered a practical approach to improving both the nutritional and functional qualities of a traditional pie crust. The use of coconut flour, jute leaves, and citrus components not only enhanced the product's composition but also supported sustainable practices through the utilization of locally sourced and underused materials. This approach reflected broader efforts to connect food innovation with community needs and environmental responsibility.

In this context, the study titled "Elevating the classic pie crust: Coconut flour, jute and citrus fruits infusions" was conducted to develop an alternative pie crust formulation. It specifically examined the effects of these ingredients on the product's physicochemical and sensory properties. The study aimed to contribute to ongoing efforts in developing sustainable and nutritious food products while supporting educational research that encouraged innovation and community-based applications.

Objectives of the Study

This study aimed to develop and evaluate an innovative pie crust infused with coconut flour, crop jute (saluyot), and citrus fruits to enhance its nutritional value, sensory qualities, and functional properties. Specifically, this study sought to:

1. Determine the sensory qualities of the pie crust infused with coconut flour, crop jute, and citrus fruits in terms of appearance, aroma, taste, and texture;
2. Determine the general acceptability of the pie crust infused with coconut flour, crop jute, and citrus fruits in terms of appearance, aroma, taste, and texture;
3. Determine the acceptability of the crust when applied to pie in terms of appearance, aroma, taste, and texture;
4. Determine whether a significant difference exists in the sensory qualities of the pie crust infused with coconut flour, crop jute, and citrus fruits;
5. Determine whether a significant difference exists in the general acceptability of the pie crust infused with coconut flour, crop jute, and citrus fruits;
6. Determine whether a significant difference exists in the acceptability of the crust when applied to pie in terms of appearance, aroma, taste, and texture;
7. Determine the shelf life of the pie crust infused with coconut flour, crop jute, and citrus fruits; and
8. Submit the best product for microbial and proximate analysis.

II. METHODOLOGY

Research Design

The study employed a Completely Randomized Design (CRD) as the experimental framework. This design was used to systematically compare the different treatment formulations under uniform conditions, ensuring that each sample had an equal chance of being evaluated without bias. The use of CRD allowed for a clear assessment of differences among the treatments based on the levels of dehydrated citrus incorporated into the pie crust.

The experimentation involved multiple treatment combinations of lemon, calamansi, and orange, each prepared in varying concentrations. This design made it possible to determine which formulation produced the most acceptable sensory qualities in terms of appearance, aroma, taste, texture, and overall acceptability.

Parameters for Analysis

The analysis of data in this study was guided by specific sensory and statistical parameters to ensure objective interpretation of results. These parameters were used to evaluate the quality and acceptability of the developed pie crust formulations across different treatments.

The primary sensory parameters included appearance, aroma, taste, texture, and general acceptability. Appearance referred to the visual quality of the pie crust, including color, shape, and overall presentation. Aroma described the perceived smell of the product, particularly the influence of the incorporated citrus ingredients. Taste

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.311 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 5, May 2026

DOI: 10.17148/IARJSET.2026.13578

measured the flavor profile and palatability of the pie crust, while texture assessed the mouthfeel and structural quality of the crust, including crispness and firmness. General acceptability represented the overall evaluation of the product based on combined sensory impressions.

In addition to sensory parameters, statistical parameters were also applied in the analysis of data. The mean was used to determine the average rating of each treatment for every sensory attribute. This provided a clear measure of central tendency for comparison among formulations. Furthermore, Analysis of Variance (ANOVA) was employed to determine whether significant differences existed among the three treatments for each citrus type. A level of significance was set at 0.01 to ensure a more rigorous interpretation of results. This allowed the study to identify which formulation produced statistically significant differences in sensory acceptability.

III.PRESENTATION, ANALYSES, AND INTERPRETATION OF DAT

This chapter presents, analyzes, and interprets the data gathered from the evaluation of the developed pie crust formulated with coconut flour, crop jute, and citrus fruits. The results are organized in accordance with the objectives of the study and are analyzed using appropriate statistical tools to determine significant differences among treatments and to identify the most acceptable formulation in terms of sensory qualities and general acceptability.

Sensory Qualities of Pie Crust Infused with Coconut Flour, Crop Jute and Citrus Fruits in terms of Appearance, Aroma, Taste and Texture

Table 2 presents the sensory evaluation results of the developed pie crust across three product variants, lemon, calamansi, and orange, assessed in terms of appearance, aroma, taste, and texture. Showed that both the type and level of citrus significantly affected appearance, aroma, taste, and texture. For the lemon-based crust, increasing the lemon content to 15 g (Treatment C) resulted in the highest scores across all attributes, with an overall mean of 7.80, considered "Very Much Appealing." In the calamansi-based crust, lower citrus content (5 g, Treatment A) produced better overall acceptability with a mean score of 7.18, "Moderately Appealing," as higher levels negatively affected taste despite high texture ratings. The orange-based crust consistently performed the best across all sensory attributes, with 15 g orange (Treatment C) scoring highest in appearance (8.90), aroma (9.00), taste (8.90), and texture (9.00), resulting in an overall mean of 8.95, interpreted as "Extremely Appealing." Overall, orange was the most preferred variant for its balanced flavor and strong aroma, lemon showed moderate improvement with higher levels, and calamansi required careful formulation due to its acidity impacting taste.

Table 2. Sensory qualities of pie crust infused with coconut flour, crop jute and citrus fruits in terms of appearance, aroma, taste and texture.

TREATMENTS		Treatment A		Treatment B		Treatment C	
Product	**Quality Attributes**	**Mean**	**Adjectival Description**	**Mean**	**Adjectival Description**	**Mean**	**Adjectival Description**
A. Lemon	Appearance	7.30	Appealing	7.40	Appealing	7.50	Appealing
	Aroma	8.00	Pleasant	7.70	Pleasant	8.10	Pleasant
	Taste	7.20	Moderately Delicious	7.50	Delicious	7.50	Delicious
	Texture	7.90	Fine	7.80	Fine	8.10	Fine
	Average	**7.60**	**-**	**7.60**	**-**	**7.80**	**-**
B. Calamansi	Appearance	8.00	Appealing	7.70	Appealing	7.70	Appealing
	Aroma	7.20	Pleasant	7.10	Moderately Pleasant	7.50	Pleasant

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.311 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 5, May 2026

DOI: 10.17148/IARJSET.2026.13578

	Taste	5.30	Neither Savory Nor Not Savory	5.50	Neither Savory Nor Not Savory	5.10	Neither Savory Nor Not Savory
	Texture	8.20	Extremely Fine	8.10	Fine	8.20	Extremely Fine
	Average	**7.18**		**7.10**		**7.13**	
C. Orange	Appearance	8.30	Extremely Appealing	8.40	Extremely Appealing	8.90	Extremely Appealing
	Aroma	8.20	Extremely Pleasant	8.20	Extremely Pleasant	9.00	Extremely Pleasant
	Taste	8.30	Extremely Savory	8.30	Extremely Savory	8.90	Extremely Savory
	Texture	8.40	Extremely Fine	8.40	Extremely Fine	9.00	Extremely Fine
	Average	**8.30**		**8.33**		**8.95**	

Legend: Adjectival Description (AD)

Score	Appearance	Aroma	Taste	Texture
8.12 – 9.00	Extremely Appealing	Extremely Pleasant	Extremely Savory	Extremely Soft
7.23 – 8.11	Very Much Appealing	Very Much Pleasant	Very Much Savory	Very Much Soft
6.34 – 7.22	Moderately Appealing	Moderately Pleasant	Moderately Savory	Moderately Soft
5.45 – 6.33	Slightly Appealing	Slightly Pleasant	Slightly Savory	Slightly Soft
4.56 – 5.44	Neither Appealing Nor Unappealing	Neither Pleasant Nor Unpleasant	Neither Savory Nor Not Savory	Neither Fine Nor Not Fine

General Acceptability of Pie Crust Infused with Coconut Flour, Crop Jute, and Citrus Fruits in terms of Appearance, Aroma, Taste and Texture

Table 3 presents the overall acceptability of the developed pie crust variants, lemon, calamansi, and orange, based on consumer evaluation in terms of appearance, aroma, taste, and texture. The results reflect how each product was perceived holistically, considering the combined influence of all sensory attributes.

The lemon-based crust scored well in all attributes, with high ratings for aroma (8.30) and texture (8.30), resulting in a general acceptability mean of 7.98, “Liked Very Much.” The calamansi-based crust had mixed results: it was visually appealing and aromatic, but its taste scored low (4.90, “Neither Liked nor Disliked”), leading to the lowest overall acceptability mean of 7.20 among the three variants. The orange-based crust consistently achieved the highest ratings in all sensory attributes, including taste (8.90), aroma (8.50), appearance (8.60), and texture (8.30), with a general acceptability mean of 8.58, “Liked Extremely,” making it the most preferred variant. Overall, the results indicate that while incorporating citrus enhances sensory qualities, the type of citrus is crucial: orange provided the most balanced and favorable profile, lemon performed well but slightly lower, and calamansi required careful formulation due to its high acidity affecting taste.

Table 3. General acceptability of pie crust infused with coconut flour, crop jute, and citrus fruits in terms of appearance, aroma, taste and texture.

Quality Attributes	Product A (Lemon)		Product B (Calamansi)		Product C (Orange)	
	Mean	AD	Mean	AD	Mean	AD

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.311 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 5, May 2026

DOI: 10.17148/IARJSET.2026.13578

Appearance	7.30	Liked Very Much	7.90	Liked Very Much	8.60	Liked Extremely
Aroma	8.30	Liked Extremely	8.30	Liked Extremely	8.50	Liked Extremely
Taste	8.00	Liked Very Much	4.90	Neither Like Nor Disliked	8.90	Liked Extremely
Texture	8.30	Liked Extremely	7.70	Liked Very Much	8.30	Liked Extremely
General Acceptability	**7.98**	**Liked Very Much**	**7.20**	**Liked Very Much**	**8.58**	**Liked Extremely**

Legend: Adjectival Description (AD)

Score	*General Acceptability*
8.12 – 9.00	*Liked Extremely (LE)*
7.23 – 8.11	*Liked Very Much (LVM)*
6.34 – 7.22	*Liked Moderately (LM)*
5.45 – 6.33	*Liked Slightly (LS)*
4.56 – 5.44	*Neither Liked nor Disliked (NLND)*
3.67 – 4.55	*Disliked Slightly (DS)*

Acceptability of Crust when Applied to Pie in terms of Appearance, Aroma, Taste and Texture

Table 4 presents the acceptability of the developed pie crust when used as a base for pie products, evaluated in terms of appearance, aroma, taste, and texture. The results reflect consumer perception of the crust in a more practical context, where it functioned as part of a complete food product rather than as a standalone sample.

When applied to pie, the lemon-based crust received consistently positive ratings, with notable improvements in aroma (8.40, “Liked Extremely”) and texture (8.37, “Liked Extremely”), achieving an overall acceptability mean of 8.11, “Liked Very Much.” The calamansi-based crust showed significant improvement compared to its standalone evaluation, particularly in taste (8.00, “Liked Very Much”) and appearance (8.18, “Liked Very Much”), resulting in a general acceptability of 8.12, “Liked Extremely,” as the pie filling moderated its acidity. The orange-based crust consistently achieved the highest scores across all attributes, including taste (8.30), aroma (8.55), and appearance (8.50), with a general acceptability of 8.43, “Liked Extremely,” confirming it as the most preferred formulation. Overall, the inclusion of filling enhanced flavor balance and sensory perception, highlighting that product context significantly influences consumer acceptability, with orange remaining the most suitable citrus for pie crust formulation.

Table 4. Acceptability of crust when applied to pie in terms of appearance, aroma, taste and texture.

Quality Attributes	Product A (Lemon)		Product B (Calamansi)		Product C (Orange)	
	Mean	AD	Mean	AD	Mean	AD
Appearance	7.55	Liked Very Much	8.18	Liked Very Much	8.50	Liked Extremely

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.311 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 5, May 2026

DOI: 10.17148/IARJSET.2026.13578

Aroma	8.40	Liked Extremely	8.20	Liked Extremely	8.55	Liked Extremely
Taste	8.10	Liked Very Much	8.00	Neither Like Nor Disliked	8.30	Liked Extremely
Texture	8.37	Liked Extremely	8.10	Liked Very Much	8.35	Liked Extremely
General Acceptability	**8.11**	**Liked Very Much**	**8.12**	**Liked Very Much**	**8.43**	**Liked Extremely**

Legend: Adjectival Description (AD)

Score	General Acceptability
8.12 – 9.00	Liked Extremely (LE)
7.23 – 8.11	Liked Very Much (LVM)
6.34 – 7.22	Liked Moderately (LM)
5.45 – 6.33	Liked Slightly (LS)
4.56 – 5.44	Neither Liked nor Disliked (NLND)
3.67 – 4.55	Disliked Slightly (DS)

Difference in the Sensory Qualities of Pie Crust Infused with Coconut Flour, Crop Jute and Citrus Fruits in terms of Appearance, Aroma, Taste and Texture

Table 5 presents the analysis of differences in the sensory qualities of the pie crust infused with coconut flour, crop jute, and citrus fruits. The evaluation covered appearance, aroma, taste, and texture across treatments for each product. The interpretation was anchored at the 0.01 level of significance, where values greater than the threshold indicated "Not Significant," while values below it indicated "Significant" differences among treatments.

The statistical analysis of the citrus-based pie crusts showed that variations in lemon and calamansi concentrations did not produce significant differences in appearance, aroma, taste, or texture, indicating that these citrus types maintained stable sensory attributes across all treatment levels. Although Treatment C (15 g lemon) showed slightly higher mean scores, the differences were not statistically significant. In contrast, the orange-based crust demonstrated a significant effect on aroma ($p = 0.002$), with higher concentrations producing a stronger citrus scent that evaluators could clearly distinguish, while appearance, taste, and texture remained statistically unchanged. Overall, the null hypothesis was accepted for lemon and calamansi, suggesting stable sensory profiles across levels, whereas for orange, the null hypothesis was partially rejected due to significant differences in aroma, highlighting its sensitivity to concentration changes and the impact of volatile aromatic compounds on overall perception.

Table 5. Difference in the of pie crust infused with coconut flour, crop jute and citrus fruits in terms of appearance, aroma, taste and texture.

Quality Attributes		z	p value	Remarks
Product 1	Appearance	0.48	0.788	ns
	Aroma	6.572	0.037	ns
	Taste	1.359	0.507	ns
	Texture	2.579	0.275	ns
Product 2	Appearance	2.068	0.356	ns
	Aroma	0.966	0.617	ns
	Taste	0.037	0.982	ns

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.311 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 5, May 2026

DOI: 10.17148/IARJSET.2026.13578

	Texture	0.229	0.892	ns
Product 3	Appearance	8.027	0.018	ns
	Aroma	12.083	0.002	s
	Taste	7.813	0.020	ns
	Texture	8.324	0.016	ns

Legend: level of significance = 0.01; ns = not significant; s=significant

Difference in the Acceptability of Pie Crust Infused with Coconut Flour, Crop Jute, and Citrus Fruits in terms of Appearance, Aroma, Taste and Texture

Table 6 presents the results of the Analysis of Variance (ANOVA) used to determine whether significant differences existed in the acceptability of the pie crust when applied to pie in terms of appearance, aroma, taste, texture, and general acceptability.

The statistical analysis revealed significant differences among the three citrus-based pie crusts for all evaluated attributes. Appearance showed a significant variation ($F = 196.453$, $p = 0.000$), suggesting that visual quality differed depending on the citrus type, with orange-based crusts producing the most desirable color and browning. Aroma also varied significantly ($F = 5.910$, $p = 0.003$), reflecting the influence of volatile compounds like limonene intensified during baking. Taste exhibited a highly significant difference ($F = 2421.833$, $p = 0.000$), indicating that sweetness and acidity balance differed across citrus types, with orange offering the most favorable flavor profile. Texture differed significantly as well ($F = 56.571$, $p = 0.000$), likely due to variations in moisture retention and gluten interaction. General acceptability showed a highly significant difference ($F = 676.105$, $p = 0.000$), confirming that overall consumer preference varied among the products. These results led to the rejection of the null hypothesis, highlighting that citrus type strongly affected pie crust acceptability, with orange-based Treatment C (15 g dehydrated orange) emerging as the most preferred formulation due to its balanced flavor, enhanced aroma, appealing color, and desirable texture.

Table 6. Difference in the acceptability of crust when applied to pie in terms of appearance, aroma, taste and texture.

Quality Attributes	Source of Variance	Sum of Squares	df	Mean Square	F	P value	Remarks
Appearance	Between Groups	84.667	2	42.333	196.453	.000	s
	Within Groups	64.000	297	0.215			
	Total	148.667	299				
Aroma	Between Groups	2.667	2	1.333	5.910	0.003	s
	Within Groups	67.000	297	0.226			
	Total	69.667	299				
Taste	Between Groups	880.667	2	440.333	2421.833	0.000	s
	Within Groups	54.000	297	0.182			
	Total	934.667	299				
Texture	Between Groups	24.000	2	12.000	56.571	0.000	s

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.311 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 5, May 2026

DOI: 10.17148/IARJSET.2026.13578

	Within Groups	63.000	297	0.212			
	Total	87.000	299				
General Acceptability	Between Groups	95.042	2	47.521	676.105	0.000	s
	Within Groups	20.875	297	0.070			
	Total	115.917	299				

Legend: level of significance = 0.01; ns = not significant; s=significant

Difference in the Acceptability of Crust when Applied to Pie in terms of Appearance, Aroma, Taste and Texture

Table 7 presents the Analysis of Variance (ANOVA) results determining whether significant differences existed in the acceptability of the pie crust when applied to pie in terms of appearance, aroma, taste, texture, and general acceptability. The interpretation was based on a 0.01 level of significance, where p-values lower than 0.01 indicated significant differences among treatments.

The analysis revealed significant differences among the three pie crust formulations for all sensory attributes. Appearance varied significantly ($F = 107.563$, $p = 0.000$), indicating that citrus type and concentration affected color, browning, and visual appeal, with orange-based treatments producing the most attractive crusts. Aroma also showed a significant difference ($F = 14.143$, $p = 0.000$), reflecting the impact of volatile compounds such as limonene and citral, which intensified during baking. Taste differed significantly as well ($F = 23.100$, $p = 0.000$), suggesting variations in sweetness and acidity balance, while texture varied ($F = 12.209$, $p = 0.000$), likely due to moisture interaction and fiber content from coconut flour, crop jute, and citrus inclusion. General acceptability was significantly different ($F = 37.949$, $p = 0.000$), confirming that overall consumer preference was influenced by all sensory attributes. These results led to the rejection of the null hypothesis, highlighting that citrus type significantly affected pie crust acceptability, with higher-level orange-based formulations being consistently the most preferred due to balanced sweetness, enhanced aroma, and appealing appearance.

Table 7. Difference in the acceptability of crust when applied to pie in terms of appearance, aroma, taste and texture.

Quality Attributes	Source of Variance	Sum of Squares	df	Mean Square	F	P value	Remarks
Appearance	Between Groups	46.727	2	23.363	107.563	0.000	s
	Within Groups	64.510	297	0.217			
	Total	111.237	299				
Aroma	Between Groups	6.167	2	3.083	14.143	0.000	s
	Within Groups	64.750	297	0.218			
	Total	70.917	299				

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.311 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 5, May 2026

DOI: 10.17148/IARJSET.2026.13578

Taste	Between Groups	4.667	2	2.333	23.100	0.000	s
	Within Groups	30.000	297	0.101			
	Total	34.667	299				
Texture	Between Groups	4.527	2	2.263	12.209	0.000	s
	Within Groups	55.060	297	0.185			
	Total	59.587	299				
General Acceptability	Between Groups	6.522	2	3.261	37.949	0.000	s
	Within Groups	25.520	297	0.086			
	Total	32.042	299				

Legend: level of significance = 0.01; ns = not significant; s=significant

Shelf -Life of Pie Crust Infused with Coconut Flour, Crop Jute and Citrus Fruit at Room and Chilling Temperatures

Table 8 presents the shelf-life performance of the developed pie crust under two storage conditions, namely room temperature and chilling (refrigerated storage), observed over 15 days. The findings document a progressive decline in product quality, evidenced by distinct organoleptic indicators of spoilage, including mold proliferation, odor development, and textural degradation.

Under room temperature, the pie crust samples maintained good quality for the first five days, showing no mold and stable appearance and texture. By days 6–7, slight deterioration occurred, such as harder texture and reduced freshness, and from days 8–15, the crust became unsafe for consumption due to spoilage indicators like unpleasant odor and probable microbial growth, giving it a short shelf life of about five days. Under chilling conditions, the crust remained acceptable from days 1–10, with minor changes in firmness and aroma appearing on days 11–13. By days 14–15, quality declined to an unacceptable level. Overall, refrigeration significantly extended shelf life, slowing microbial activity and physicochemical changes, while room temperature storage allowed only short-term use. These results suggest that the pie crust is best for fresh consumption or refrigerated distribution, despite the functional benefits of coconut flour, crop jute, and citrus fruits.

Table 8. Shelf life of pie crust infused with coconut flour, crop jute, and citrus fruits.

Storage Condition	Days															Remarks
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.311 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 5, May 2026

DOI: 10.17148/IARJSET.2026.13578

Room Temperature	0	0	0	0	0	+	+	++	++	++	++	++	++	++	++	Safe up to 5 days, changes texture for 6-7 days, and unsafe for consumption for 11-15 days
Storage Condition	Days															Remarks
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Chilling (Refrigerator)	0	0	0	0	0	0	0	0	0	0	+	+	+	++	++	Safe up to 10 days, changes texture for11-12 days, and unsafe for consumption for 14-15 days

Legend:
0 – Absence of mold; safe, good quality
+ – Still edible but with slight quality changes (texture harden, needs reheating)
++ – Unsafe: risk of bacterial growth or mold, unpleasant odor/taste

The observed shelf-life behavior aligns with established food science literature, which indicates that bakery products are highly perishable at ambient temperatures due to microbial growth and moisture-related deterioration, while refrigeration significantly delays spoilage and extends product usability (Robertson, 2016; Kilcast & Subramaniam, 2011; Smith et al., 2016). Similar studies also report that mold development and texture degradation are primary limiting factors in stored baked goods, particularly when exposed to room temperature conditions for extended periods (Dagnas & Membré, 2013; Vermelho et al., 2024).

Microbial Analysis of the Best Treatment of Pie Crust Infused with Coconut Flour, Crop Jute, and Citrus Fruits

Table 9 presents the microbial quality assessment of the pie crust infused with coconut flour, crop jute (saluyot), and citrus fruits. The analysis was conducted to determine whether the developed product met microbiological safety standards based on acceptable limits set by food safety regulatory references. The results provide an indication of product stability, hygienic quality, and suitability for consumption.

The microbiological evaluation of the pie crust revealed that all tested parameters were within safe limits. Aerobic Plate Count (APC) was 10 CFU/g, well below the maximum allowable limit, indicating effective microbial control through baking and low moisture content. Escherichia coli was <3 CFU/g, confirming the absence of fecal contamination, while yeast was not detected, and mold counts were <10 CFU/g, reflecting minimal fungal growth. Salmonella spp. was absent in 25 g of sample, meeting critical food safety standards. These results demonstrate that the pie crust infused with coconut flour, crop jute, and citrus fruits is microbiologically safe, with the combination of dehydration, controlled baking, and proper storage effectively minimizing contamination. The findings also support the feasibility of developing functional, plant-based bakery products without compromising safety.

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.311 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 5, May 2026

DOI: 10.17148/IARJSET.2026.13578

Table 9 Microbial analysis of pie crust infused with coconut flour, crop jute, and citrus fruits.

Sample Description	Parameter	DOST Result	FDA M	M
Pie Crust Sample	Aerobic Plate Count (CFU/g)	10	10^4 CFU/g	10^5 CFU/g
	Escherichia coli (CFU/g)	< 3.0	<10 CFU/g	≥10^2 CFU/g
	Yeast Count (CFU/g)	Not Detected / Not Indicated	10^2 CFU/g	10^3 CFU/g
	Mold Count (CFU/g)	<10	10^2 CFU/g	10^3 CFU/g
	Salmonella spp. (per 25 g)	Absent / Not Detected	Absent in 25 g	Present in 25 g

Legend:

- FDA M: Maximum acceptable limit before a product may pose a hazard.
- M: Unsafe or unsatisfactory threshold as per microbiological standards.
- Reference Standards:
  - Philippine FDA Circular No. 2021-013: Microbiological Criteria for Processed Food
  - PNS/BAFPS 2006: Standards for Dried Fruit-Based Products
  - DOST-ITDI: Food Safety Guidelines and Laboratory Protocols

The findings are consistent with established food microbiology principles, which state that low-moisture baked products typically exhibit reduced microbial activity and extended shelf stability (Sperber & Doyle, 2019). The absence of Salmonella and low aerobic counts align with safety expectations for properly baked food systems (FDA, 2022). Additionally, studies confirm that dehydration and baking significantly reduce fungal and bacterial growth potential in food matrices (Legan & Voysey, 2015).

Proximate Analysis of the Best Treatment of Pie Crust Infused with Coconut Flour, Crop Jute, and Citrus Fruits

Table 10 presents the proximate composition of the pie crust infused with coconut flour, crop jute (saluyot), and citrus fruits. The analysis was conducted to determine the nutritional profile of the developed product in terms of protein, fat, carbohydrates, dietary fiber, and energy content, and to evaluate its alignment with recommended dietary allowances and energy distribution standards.

The pie crust contained 4 g of protein per serving, slightly below the recommended contribution, likely due to substituting wheat flour with coconut flour and the limited protein from plant-based additives like citrus and jute. Total fat was 7 g, within the acceptable range, contributing to flavor, tenderness, and mouthfeel, while carbohydrates were 22 g, within recommended energy ranges and serving as the main energy source. Dietary fiber was low (<2 g), insufficient to meet daily intake recommendations, despite contributions from jute and citrus peels. Energy content was moderate at 165 kcal per serving. Overall, the pie crust provides a balanced source of energy from carbohydrates and fats, with moderate protein and low fiber, making it suitable as an energy-based bakery item rather than a high-protein or high-fiber functional food. Adjustments such as increasing jute content or adding fiber-rich ingredients could improve its nutritional profile if targeting health-focused consumers.

Table 10. Proximate analysis of pie crust infused with coconut flour, crop jute, and citrus fruits.

Nutrient	Result	Reference Value (FNRI/FDA)	Interpretation
Protein	4 g	10–15% of total energy	Slightly below recommended contribution; moderate protein source
Total Fat	7 g	20–30% of total energy	Within an acceptable range; contributes to energy and texture

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.311 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 5, May 2026

DOI: 10.17148/IARJSET.2026.13578

Carbohydrates	22 g	55–70% of total energy	Within the recommended range; main energy source
Fiber	< 2 g	~20–25 g/day (adults)	Low fiber per serving; minimal contribution to daily requirement
Energy	165 kcal	~2000–2530 kcal/day	Moderate energy content; suitable for snack portions

Legend: Percent RENI Values (Macronutrient Energy Contribution)

- Protein: 10–15% of total energy intake
- Fat: 20–30% of total energy intake
- Carbohydrates: 55–70% of total energy intake
- Fiber: Guideline typically expressed in grams per day (e.g., ~20–25 g for adults) not usually given as % RENI

VI. CONCLUSIONS

Based on the results of the study, conclusions were drawn in relation to each specific objective to clearly reflect the outcomes of the investigation.

The sensory evaluation of the pie crust revealed that the Orange-Based Pie Crust – Treatment C (15 g dehydrated orange) was the best formulation. It consistently obtained the highest mean ratings in appearance, aroma, taste, and texture due to its balanced sweetness, pleasant citrus aroma, and enhanced color development during baking. This formulation demonstrated a more favorable sensory profile compared to the lemon and calamansi variants, which showed moderate acceptability and higher acidity levels, respectively.

The general acceptability results showed significant differences among treatments, with the Orange-Based Pie Crust – Treatment C emerging as the most preferred formulation. It obtained the highest acceptability rating, attributed to its well-balanced flavor, appealing aroma, and attractive appearance. The lemon-based formulation was followed with moderate acceptability, while the calamansi-based formulation received the lowest ratings due to its stronger sourness, which negatively affected consumer preference.

The acceptability of the crust improved when applied to pie products, as the filling helped balance acidity and enhance overall flavor harmony. The Orange-Based Pie Crust – Treatment C remained the most preferred formulation in the pie application, maintaining the highest acceptability ratings. The lemon-based formulation followed, while the calamansi-based formulation showed improvement but remained the least preferred among the three.

Significant differences were observed in the sensory qualities of the pie crust formulations; thus, the null hypothesis was rejected. These differences were attributed to variations in citrus type and concentration, which influenced flavor compounds, aroma intensity, and physical characteristics of the product.

Significant differences were also found in the general acceptability of the formulations, leading to the rejection of the null hypothesis. Consumer preference was significantly influenced by formulation composition, with the orange-based product consistently receiving the highest acceptability due to its balanced sensory attributes.

Similarly, significant differences were observed in the acceptability of the crust when applied to pie. This also resulted in the rejection of the null hypothesis, indicating that product application significantly influenced sensory perception. The interaction between crust and filling improved overall acceptability, particularly for formulations with higher acidity.

The pie crust exhibited varying shelf life depending on storage conditions. Samples stored at room temperature deteriorated faster and became unsafe after approximately five days, while refrigerated samples maintained acceptable quality for up to ten days before showing signs of deterioration. Chilling significantly extended product shelf life by slowing microbial growth and delaying spoilage processes.

The best formulation complied with microbial safety standards and demonstrated acceptable proximate composition. It showed low microbial load and was within safe limits for key microbiological indicators, confirming its suitability for consumption. However, proximate analysis indicated moderate energy content with relatively low protein and fiber levels, suggesting potential for further nutritional enhancement in future product development.

Recommendations

Based on the results of the study, conclusions were drawn in relation to each specific objective to clearly reflect the outcomes of the investigation.

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.311 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 5, May 2026

DOI: 10.17148/IARJSET.2026.13578

The sensory evaluation of the pie crust revealed that the Orange-Based Pie Crust – Treatment C (15 g dehydrated orange) was the best formulation. It consistently obtained the highest mean ratings in appearance, aroma, taste, and texture due to its balanced sweetness, pleasant citrus aroma, and enhanced color development during baking. This formulation demonstrated a more favorable sensory profile compared to the lemon and calamansi variants, which showed moderate acceptability and higher acidity levels, respectively.

The general acceptability results showed significant differences among treatments, with the Orange-Based Pie Crust – Treatment C emerging as the most preferred formulation. It obtained the highest acceptability rating, attributed to its well-balanced flavor, appealing aroma, and attractive appearance. The lemon-based formulation was followed with moderate acceptability, while the calamansi-based formulation received the lowest ratings due to its stronger sourness, which negatively affected consumer preference.

The acceptability of the crust improved when applied to pie products, as the filling helped balance acidity and enhance overall flavor harmony. The Orange-Based Pie Crust – Treatment C remained the most preferred formulation in the pie application, maintaining the highest acceptability ratings. The lemon-based formulation followed, while the calamansi-based formulation showed improvement but remained the least preferred among the three.

Significant differences were observed in the sensory qualities of the pie crust formulations; thus, the null hypothesis was rejected. These differences were attributed to variations in citrus type and concentration, which influenced flavor compounds, aroma intensity, and physical characteristics of the product.

Significant differences were also found in the general acceptability of the formulations, leading to the rejection of the null hypothesis. Consumer preference was significantly influenced by formulation composition, with the orange-based product consistently receiving the highest acceptability due to its balanced sensory attributes.

Similarly, significant differences were observed in the acceptability of the crust when applied to the pie. This also resulted in the rejection of the null hypothesis, indicating that product application significantly influenced sensory perception. The interaction between crust and filling improved overall acceptability, particularly for formulations with higher acidity.

The pie crust exhibited varying shelf life depending on storage conditions. Samples stored at room temperature deteriorated faster and became unsafe after approximately five days, while refrigerated samples maintained acceptable quality for up to ten days before showing signs of deterioration. Chilling significantly extends product shelf life by slowing microbial growth and delaying spoilage processes.

The best formulation complied with microbial safety standards and demonstrated acceptable proximate composition. It showed low microbial load and was within safe limits for key microbiological indicators, confirming its suitability for consumption. However, proximate analysis indicated moderate energy content with relatively low protein and fiber levels, suggesting potential for further nutritional enhancement in future product development.

REFERENCES

[1]. Abduljelili, U., & Garba, Y. (2023). Nutritional and health benefits of citrus fruits. Journal of Food and Nutrition Research.

[2]. Adenaike, O., & Abakpa, G. O. (2021). Health benefits and bioactive compounds of citrus fruits. International Journal of Food Science.

[3]. Aliteg, M. (2015). Use and acceptability of kamote, saluyot, malunggay and cacao in the preparation of chiffon cake (Unpublished undergraduate thesis).

[4]. AOAC. (2016). Official methods of analysis (20th ed.). AOAC International.

[5]. Ares, G., & Jaeger, S. R. (2015). Check-all-that-apply questions: Influence of attribute order on sensory product characterization. Food Quality and Preference, 42, 60–67.

[6]. Atmaja, A., et al. (2022). Functional properties of flour in pie crust development. Journal of Food Processing and Technology.

[7]. Balakireva, A. V., & Zamyatnin, A. A. (2016). Properties of gluten-free food products and their health implications. Food Chemistry.

[8]. Biswas, S., et al. (2020). Nutritional composition and micronutrient content of jute leaves. Journal of Agricultural Science.

[9]. Carreiro, A. L., et al. (2016). Dietary fiber intake and its association with body weight regulation. Nutrition Reviews.

[10]. Cauvain, S. P., & Young, L. S. (2017). Technology of breadmaking (3rd ed.). Springer.

[11]. Centers for Disease Control and Prevention. (2022). Dietary fiber and blood sugar regulation. Retrieved March 13, 2026, from https://www.cdc.gov

[12]. Chan, Y. (2022). The role of dietary fiber in digestive health. Journal of Gastrointestinal Nutrition.

DOI: 10.17148/IARJSET.2026.13578

[13]. Chen, J., & Rosenthal, A. (2017). Modifying food texture: Sensory and instrumental approaches. Food Hydrocolloids, 68, 1–9.
[14]. Clarkson, J. D., et al. (2009). The history and development of pies in culinary tradition. Journal of Culinary History.
[15]. Creswell, J. W. (2014). Research design: Qualitative, quantitative, and mixed methods approaches (4th ed.). Sage Publications.
[16]. Dagnas, S., & Membré, J. M. (2013). Predicting and preventing mold spoilage of food products. Food Microbiology.
[17]. Delima, J., Juric, L., & Jao, M. (2023). Sensory evaluation of pandesal with dried saluyot (Corchorus olitorius) leaves. Philippine Journal of Food Science.
[18]. Dhingra, D., et al. (2017). Dietary fibre in foods: A review. Journal of Food Science and Technology, 54(3), 1–10.
[19]. Dijksterhuis, J., & Samson, R. A. (2017). Food mycology: A multifaceted approach to fungi and food spoilage. CRC Press.
[20]. Dong, L., et al. (2021). Vegetable jute as a nutritious leafy vegetable crop. Journal of Plant Nutrition.

