



PRODUCT DEVELOPMENT OF PAPAYA (*Carica Papaya*) FLOUR-BASED DELICACIES

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ABSTRACT

This study developed three papaya (*Carica papaya*) flour-based delicacies—(P1) Torta, (P2) Bibingka, and (P3) Puto Cheese—using green papaya flour as an alternative ingredient, employing a quasi-experimental research design in the Second Congressional District II of Bohol during the School Year 2025–2026. A total of 70 respondents, including Food Technology teachers, local bakers, and delicacy makers, evaluated the products using a 4-point hedonic scale. Data were analyzed using Jamovi, applying weighted mean to determine levels of preference, one-way ANOVA to assess significant differences among products, and pairwise comparisons to identify specific differences in sensory evaluation. Results indicated that all formulations were generally accepted in terms of appearance, aroma, taste, texture, and overall acceptability, with (P3) Puto Cheese receiving the highest preference ratings, followed by (P1) Torta, and then (P2) Bibingka. Shelf-life testing showed that the products remained acceptable for 2–3 days at room temperature and 5–6 days under refrigeration. Nutritional analysis revealed that the products are energy-rich and contain essential nutrients, with (P2) Bibingka providing the highest protein content (4.71%) and caloric value (300 kcal/100 g), while (P3) Puto Cheese and (P1) Torta contributed significant amounts of carbohydrates, fats, calcium, and potassium. Statistical analysis confirmed significant differences in preference among certain formulations. The study concludes that papaya flour is a viable ingredient for developing nutritious and marketable delicacies and recommends improvements in processing, packaging, and storage to enhance quality and consumer acceptance.

Keywords: *papaya flour, flour-based delicacies, sensory evaluation, product development, nutritional analysis, and consumer acceptability*

INTRODUCTION

The growing demand for nutritious, affordable, and culturally relevant food products has intensified interest in the development of functional delicacies using locally available crops. In the Philippines, traditional food products such as torta, bibingka, and puto remain widely consumed because of their familiarity, accessibility, and cultural significance. These delicacies are deeply embedded in Filipino food heritage and continue to represent local identity and culinary continuity. However, many of these products are commonly prepared using refined flour and other conventional ingredients that are often low in dietary fiber and essential micronutrients. As health consciousness continues to increase, consumers are now seeking food products that not only satisfy sensory expectations but also provide added nutritional value.

In response to this shift, food product development has increasingly focused on the use of indigenous and underutilized crops as functional ingredients in traditional products. Papaya (*Carica papaya*), a tropical fruit widely grown in the Philippines, has gained attention because of its nutritional, agricultural, and industrial potential. It is recognized as a rich source of dietary fiber, antioxidants, and important vitamins, particularly vitamins A and C. In addition, papaya contains bioactive compounds that contribute to its value as a functional food ingredient. Vieira et al. (2019) emphasized that papaya has promising applications in locally manufactured products such as flour and other processed food materials, suggesting its potential not only for nutritional improvement but also for strengthening local agricultural production and reducing dependence on imported ingredients. Similarly, Santos et al. (2014) identified the presence of fiber, protein, and vitamins in papaya flour, supporting its use as a healthier alternative to refined flour in food formulations.

Among its forms of utilization, green papaya is especially suitable for flour production. Compared with ripe papaya, green papaya contains lower sugar and moisture content and is therefore more appropriate for drying and milling into flour. This characteristic makes it a practical ingredient for bakery and delicacy production. Adeyanju and Bamidele (2022) reported that papaya flour improves the softness and texture of bread because of its water-holding capacity, while also enhancing antioxidant levels and resistant starch content. In another study, Feng et al. (2022) found that papaya powder improved the appearance, flavor, and texture of baked products, contributing to higher acceptability among consumers. These findings suggest that papaya flour can support both sensory quality and nutritional enhancement, making it a viable ingredient for the reformulation of traditional delicacies.

The use of papaya in delicacy development also aligns with current trends in food innovation, where local products are reformulated to respond to changing consumer preferences without losing their traditional identity. Traditional food products must undergo continuous innovation to remain relevant, appealing, and competitive while preserving their cultural identity in a dynamic food market (Guerrero et al., 2009). This is particularly important in the case of products such as torta, bibingka, and puto, which are valued not only for their taste but also for their symbolic and socio-cultural role in local

communities. Integrating papaya flour into these products offers an opportunity to preserve traditional food forms while improving their health value and market relevance.

Despite the recognized benefits of papaya and the growing interest in functional food development, the literature remains limited in its treatment of papaya flour as a main ingredient in traditional Filipino delicacies. Existing studies have often focused on papaya's nutritional and medicinal properties, or on its use in selected bakery items such as breads and cookies, rather than in culturally established delicacies. Mantos et al. (2019) reported that papaya-incorporated cookies and lactation bread were well accepted in terms of taste and texture while providing vitamins A and C. Pathak et al. (2018) likewise noted that papaya pulp powder enhanced flavonoid and papain content while maintaining acceptable aroma and texture. However, these studies did not fully address product characteristics such as shelf life, commercialization, and comparative acceptability across multiple delicacy types. Varastegani et al. (2015) also found that papaya addition improved fiber and antioxidant content, although sensory preference did not always significantly increase, suggesting that formulation outcomes may vary depending on product type and processing conditions.

Processing conditions likewise play a critical role in determining the success of papaya-based products. Wijayanti et al. (2019) observed that papaya flour may produce a slight bitterness when processing is not carefully controlled, indicating that ingredient preparation influences both flavor and acceptability. Shankhu et al. (2022) further explained that papaya ripeness affects sweetness, firmness, and mouthfeel, demonstrating that raw material quality is closely linked to final product performance. These findings suggest that product development using papaya flour requires not only nutritional consideration but also careful attention to formulation, preparation methods, and sensory balance.

Consumer acceptance is equally important in evaluating the feasibility of functional delicacies. Food products may offer nutritional benefits, but their marketability depends heavily on sensory attributes such as appearance, aroma, taste, and texture. Consumers often prioritize familiar flavor, reasonable cost, and perceived health value when selecting food products, as these factors strongly influence acceptance and purchasing decisions (Tuorila & Hartmann, 2020). Consumers are increasingly willing to pay premium prices for functional foods that provide added health benefits and align with their dietary preferences (Granato et al., 2020). These observations suggest that papaya-enriched delicacies may appeal to both traditional and health-conscious markets, provided that product quality and sensory acceptability are maintained. Tuorila and Hartmann (2020) also emphasized that sensory pleasure remains a strong predictor of food acceptance, reinforcing the need for sensory evaluation in product development studies.

Beyond consumer preference, papaya flour-based delicacies also present economic and sustainability advantages. The use of locally grown papaya supports agricultural value-adding activities, strengthens local supply chains, and creates opportunities for small-scale entrepreneurship. The utilization of locally available crops

supports sustainable food systems by reducing dependence on imported inputs and strengthening local agricultural development (Canton, 2021). Since papaya is widely available and bears fruit regularly, it offers a relatively accessible raw material for functional food production. The transformation of green papaya into flour also helps minimize waste and extends its usability beyond fresh consumption. Thus, the development of papaya flour-based delicacies has implications not only for nutrition and product innovation but also for local livelihood generation and community-based enterprise.

Taken together, the reviewed literature suggests that papaya has strong potential as a functional ingredient in food development, yet important gaps remain. Few studies have comprehensively examined its use in flour form across multiple traditional delicacies while also considering sensory attributes, nutritional content, shelf life, and commercialization potential within a single product development framework. This limitation points to the need for a more integrated investigation of papaya flour as an alternative ingredient in native delicacies.

In response to this gap, the present study focuses on the development of papaya (*Carica papaya*) flour-based delicacies, specifically torta, bibingka, and puto, using green papaya flour. It evaluates the developed products in terms of ingredients and cost, tools and equipment, procedure, nutritional content, shelf life, and commercialization plan. It further determines their sensory attributes in terms of appearance, aroma, taste, and texture, as well as the respondents' level of preference and the significant differences among product evaluations. Through this approach, the study seeks to contribute to food product innovation, support the utilization of local agricultural resources, and provide empirical evidence on the development of healthier and potentially marketable traditional delicacies.

Research Questions

The study aimed to determine the product development of papaya (*Carica papaya*) flour-based delicacies. It was conducted in the Second Congressional District of the Province of Bohol, Philippines, during the second semester of the School Year 2025–2026.

Specifically, the study sought to answer the following questions:

1. What were the descriptions of the papaya flour-based delicacies using green papaya flour—(F1) papaya flour torta, (F2) papaya flour bibingka, and (F3) papaya flour puto—in terms of:
 - 1.1 ingredients and cost;
 - 1.2 tools and equipment used;
 - 1.3 procedure;
 - 1.4 nutritional content;
 - 1.5 shelf life; and
 - 1.6 commercialization plan?

2. What were the sensory attributes of the papaya flour-based delicacies in different formulations in terms of:
 - 2.1 appearance;
 - 2.2 aroma;
 - 2.3 taste; and
 - 2.4 texture?
3. What was the respondents' level of preference?
4. Was there a significant difference in the respondents' level of preference?
5. What commercialization plan could be proposed based on the results of the study?

METHODOLOGY

Research Design

The study employed a quasi-experimental research design to develop and evaluate papaya (*Carica papaya*) flour-based delicacies. This design was appropriate as it involved the manipulation of ingredients to produce new formulations without random assignment of samples. The study focused on developing papaya flour-based products using papaya as a supplementary ingredient and comparing the resulting formulations.

The developed products were evaluated through sensory analysis using established hedonic scales appropriate for food evaluation. This approach allowed for the systematic assessment of product acceptability across key sensory attributes.

Research Environment

The study was conducted in selected municipalities within the Second Congressional District of the Province of Bohol, Philippines, specifically in Talibon, Trinidad, and Ubay. These areas are recognized for their active local pastry production and traditional delicacy-making practices, providing an appropriate setting for the development and evaluation of papaya flour-based products. The study was carried out in environments consistent with local food preparation and processing practices, ensuring that the product development and evaluation reflected real-world conditions within the community.

Research Participants

The study involved 70 respondents composed of food technology teachers, local bakers, and native delicacy makers selected from Talibon, Trinidad, and Ubay. Participants were chosen based on their expertise in food preparation and evaluation, making them suitable assessors of product quality and acceptability.

The sample size was determined using G*Power software, which indicated a required total of 210 responses to achieve a statistical power of 95%. Since each

participant evaluated all three product formulations, the final number of respondents was 70.

Quota sampling was employed due to the absence of a complete population list, and data collection was concluded once the required number of participants was reached. The distribution of respondents is presented in Table 1.

Table 1. The distribution of respondents

Municipality	Food Tech Teachers	Local Bakers	Native Delicacy Makers	Total
Talibon	5	5	5	15
Trinidad	5	5	5	15
Ubay I, II, III	20	10	10	40
Total	30	20	20	70

Research Instrument

A modified questionnaire was used as the primary data-gathering instrument to determine the acceptability of the papaya (*Carica papaya*) flour-based delicacies. The instrument measured four key sensory attributes: appearance, aroma, taste, and texture.

The questionnaire utilized a modified 4-point hedonic scale adapted from Gatchalian (1976), with response options ranging from 4 (“Highly Preferred”) to 1 (“Not Preferred”). The use of a 4-point scale eliminated a neutral option, thereby encouraging respondents to provide a clear evaluation of each product.

During the assessment, respondents indicated their level of preference by selecting the appropriate rating for each sensory attribute. This structured approach ensured consistency in responses and facilitated a more reliable evaluation of product acceptability based on the results of the food testing.

Research Procedure

The study followed a systematic procedure consisting of preparation, product development, testing, and data collection. Prior to the conduct of the study, permission was secured from the appropriate authorities, including the Dean, Campus Director, Municipal Mayors, and the Schools Division Superintendent of Bohol. Approval from the research adviser was also obtained before proceeding with the implementation. Papaya flour was prepared by washing, peeling, slicing, and sun-drying green papaya for two to three days. The dried papaya was then ground into fine powder and sifted to ensure uniformity. The resulting flour was used as a primary ingredient in the formulation of torta, bibingka, and puto. Each product was prepared using appropriate cooking methods and allowed to cool prior to evaluation. The developed products were subjected to proximate analysis in an accredited laboratory, First Analytical Services and Technical Cooperative (F.A.S.T.), to determine moisture, ash, protein, fat, carbohydrates, calories, total sugar, calcium, iron, potassium, and vitamin content. Shelf-life observation was also conducted

at room temperature by monitoring the products daily for signs of spoilage, such as mold growth and off-odor, to determine their safe consumption period.

Sensory evaluation was conducted by presenting the samples to the respondents for tasting. A one-minute interval, along with water, was provided between samples to prevent flavor carryover. After tasting, respondents completed the questionnaire to evaluate the products based on appearance, aroma, taste, and texture. The researcher guided the respondents during the process to ensure clarity and completeness of responses. All completed questionnaires were collected, and the data were organized, tabulated, and prepared for statistical analysis.

Data Analysis

The data were analyzed using Jamovi statistical software. Descriptive and inferential statistical techniques were employed to interpret the results of the sensory evaluation.

The level of preference was determined using weighted mean and interpreted based on a descriptive rating scale, where 4.00 indicated “Highly Preferred,” 3.00 indicated “Moderately Preferred,” 2.00 indicated “Slightly Preferred,” and 1.00 indicated “Not Preferred.” The corresponding numerical ranges and interpretations are presented in Table 2.

To determine significant differences in respondents’ level of preference across the developed papaya (*Carica papaya*) flour-based products, both parametric and non-parametric tests were applied. One-way analysis of variance (ANOVA) was used to examine differences among product formulations. In addition, the Friedman test was employed as a non-parametric alternative for related samples based on respondents’ ratings.

When significant differences were identified, pairwise comparisons using the Durbin–Conover test were conducted to determine which specific product formulations differed significantly. All statistical tests were interpreted at the 0.05 level of significance.

A sensory evaluation matrix was also utilized to provide qualitative descriptors for each rating level across the three products—torta, bibingka, and puto—ensuring consistent interpretation of appearance, aroma, taste, and texture during evaluation.

Table 2. Descriptive Rating for the Level of Preference of the Papaya flour-based Products

Scale	Numerical Range	Descriptive Rating	Interpretation
4	3.26 – 4.00	Highly Preferred	Extreme satisfaction with the product
3	2.51 – 3.25	Moderately Preferred	Average satisfaction with the product

2	1.76 – 2.50	Slightly Preferred	Slight satisfaction with the product
1	1.00 – 1.75	Not Preferred	Dissatisfaction with the product

RESULTS

This section presents the findings on the sensory attributes and respondents' level of preference for the developed papaya (*Carica papaya*) flour-based delicacies. It includes the analysis and interpretation of data related to the product formulations, specifically torta, bingka, and puto. The results further describe the characteristics of the developed products in terms of ingredients and cost, tools and equipment, procedure, nutritional content, and shelf life.

Product Descriptions

Table 1.1
Ingredients and Cost of Torta, Bingka and Puto cheese papaya-based flour

Ingredients	Unit	Unit Cost	F1		F2		F3	
			Qty	Cost	Qty	Cost	Qty	Cost
Green Papaya Flour	grams	₱10.00/120g	240	₱20.00	228g	₱15.00	228g	₱15.00
Baking Powder	grams	25.00/50g	20	10.00	8g	5.00	12	7.00
Salt	grams	12.25/250g	5	1.00	2.5g	1.00	2.5g	1.00
Sugar	grams	80.00/1000g	150	10.00	150g	10.00	200g	16.00
Eggs	pcs.	9.00/pc.	10	90.00	2pcs	18.00		
Unsalted Butter	grams	45.00/225g	113	10.00	91g	18.20		
Vanilla	MI	23.00/110ml	14.79	4.00	10ml	2.00		
Evaporated Milk	MI	24.00/365ml	59	10.00			473ml	34.00
Water	MI	1.00/250ml	250	1.00				
Parchment Paper	pc.	30.00/roll	1	10.00			1pc	10.00
Vegetable oil	MI	69.00/500 ml	125	17.25				
cake plastic Container	pcs.	3.00/pc.	15	45.00	15pcs	45.00	15pcs	45.00
Instant Yeast	grams	129.00/500g			8g	2.00		
Rice Flour	grams	35.00/500g			30g	5.00	30g	5.00
Coco milk	MI	53.00/400ml			400ml	53.00		
Banana leaves	pc.	1.00/pc.			1pc	1.00		
Cheddar cheese	grams	55.00/160g					80g	27.50
Production Cost								
Total Cost			₱233.25		₱175.20		₱160.50	
Operating Expenses			₱46.65		₱ 35.04		₱32.10	
Mark-up Cost			₱69.98		₱52.56		₱48.15	
Total Cost of Production			₱280.00		₱210.24		₱192.60	
Total serving packs			15 pcs.		15 pcs.		15 pcs.	
Price per pack			₱24.26 or ₱25.00		₱18.22 or ₱20.00		₱16.69 or ₱20.00	

Table 1.1 presents the ingredients and cost for the three baked products. The researcher computed the total expenses for each recipe. Torta incurred the highest production cost. It reached a total of ₱ 280.00 for 15 pieces. This sets the selling price at ₱ 25.00 per piece. The bibingka cost lower at ₱ 210.24. This gives a selling price of ₱ 20.00. Puto cheese is evidently the cheapest to make. It only required ₱ 192.60 total capital. The selling price is also ₱ 20.00. The green papaya flour is highly affordable. It only costs ₱ 10.00 for 120 grams. This helps minimize the overall expenses that the baker deals with. The pricing includes a 20% operating expense and a 30% markup. This specific structure ensures the profitability of the products.

Table 1.2
Tools and Equipment

Quantity	Unit	Tools and Equipment	Description
1	Pc	Mixing Bowl	Used for combining and mixing ingredients
1	Pc	Flour sifter	Used to remove lumps and aerate flour for a finer texture
1	Pc	Spatula	Used for mixing, folding, and scraping batter
1	set	Measuring cup	Used for measuring liquid and dry ingredients accurately
1	Set	Measuring spoon	Used for measuring small quantities of ingredients
1	Pc	Wooden ladle	Used for stirring mixtures during preparation
1	Pc	kitchen knife	Used for cutting and preparing ingredients
1	Pc	Rubber scrapper	Used for scraping batter from bowls to minimize waste
1	Pc	Can opener	Used to open canned ingredients like evaporated milk
45	Pcs	Plastic container	Used for packaging and storing finished products
15	Pcs	Torta molder	Used to shape torta into uniform sizes
15	Pcs	Puto cheese molder	Used to shape puto cheese during steaming
1	Pcs	Bibingka molder	Used to shape bibingka evenly
1	Pc	Chopping board	Used as a surface for cutting ingredients
1	Pc	Grinder	Used to process dried papaya into flour
1	Pc	Oven	Used for baking products like torta and bibingka
15	Pcs	Food tray	Used for holding or displaying prepared products
3	Pcs	Food gloves	Used for hygienic handling of food
1	Pc	steamer	Used for cooking puto cheese through steaming
1	Pc	Saucepan	Used for heating or preparing ingredients
1	Pc	Electric mixer	Used for faster and more efficient mixing of ingredients
1	Pc	gas stove	Used as a heat source for cooking and steaming

Table 1.2 shows the tools and equipment used. The researcher utilized standard baking instruments to prepare the products. The equipment includes an oven, a steamer, and an electric mixer. These are essential for the thermal and mixing processes. Measuring cups and spoons ensure accurate ingredient portions. The grinder is particularly needed to pulverize the dried papaya. Proper molders give the torta, bibingka, and puto their distinct shapes. The researcher also used food gloves. This maintains sanitation during the preparation phase. Most of these tools are readily available in a typical kitchen. This makes the production highly accessible to start with.

1.3 Procedure

The following steps or procedure in preparing the dried green papaya flour:

Table 1.3.1
Procedures in preparing the Papaya flour

1	Wash the green or unripe papaya thoroughly with clean water.
2	Peel the papaya using a knife or peeler.
3	Slice the papaya in half lengthwise and use a spoon to scrape out the seeds.
4	Slice the papaya into thin, small pieces to facilitate faster drying.
5	Dry the sliced papaya under direct sunlight until completely dehydrated.
6	Grind the dried papaya using a pulverizer until it reaches a fine flour-like consistency.

Table 1.3.2
Procedures in preparing the Torta papaya-based flour

1	Sift papaya flour and measure it.
2	Put water and sugar in a saucepan to form a syrup in a low medium heat. Boil in 5 mins.
3	In a separate bowl, put the liquid ingredients: egg yolks, sugar syrup, evaporated milk, vegetable oil, butter and vanilla. Mix it well.
4	Put the dry ingredients except baking powder into the liquid mixture. Mix well using electric mixer at a low speed in 1 minute then to medium speed.
5	Put the baking powder. Then mix for 30 seconds.
6	Place the parchment paper on the torta molder.
7	Pour into the torta molder $\frac{3}{4}$ full.
8	Bake at 340F for 30-45 minutes, or until done.

Table 1.3.3
Procedure in preparing Bibingka papaya-based flour

1	Wash and cut the banana leaves, then pass them over an open flame or stove top to make them pliable.
2	Place to the bibingka molders and brush with butter.
3	In a mixing bowl, combine rice flour, papaya flour, sugar, baking powder, yeast and mix it well.
4	In a separate bowl, add egg and salt, melted butter and vanilla extract, coconut milk. Mix well to incorporate
5	Put the wet ingredients to dry ingredients. Do not over mix. The batter should be normally runny.
6	Slowly pour to the bibingka molders. Be sure not to fill more than half it will rise while baking.
7	Bake at 180C for 15-20 minutes, or until done.

Table 1.3.4
Procedure in preparing Puto cheese papaya-based flour

1	Sift papaya and rice flour and measure it.
2	Put baking powder, salt and white sugar together. Mix well and set aside.
3	Add the evaporated milk, and blend until the mixture is smooth.
4	Slice the cheddar cheese into thin rectangles.
5	Place the parchment paper on the puto molder.
6	Pour the mixture into the Puto molder $\frac{3}{4}$ full as it will rise as you steam.
7	Then, top with cheese.

8	Arrange the puto molders in the steamer.
9	Steam for 20-30 minutes, or until done.

1.4 Nutritional Content

The researcher submitted the finished products for laboratory testing. F.A.S.T. Laboratories conducted the chemical analysis. They analyzed the nutritional composition of the baked goods. This section presents the laboratory results.

Table 1.4.1
Nutritional Profile of Puto Cheese

Parameters	Unit	Test Method	Results
Moisture	g/100g	Vacuum Oven Drying	57.7
Ash	g/100g	Ignition - Gravimetry	1.7
Fat	g/100g	Acid Hydrolysis - Mojonnier Extraction	8.06
Protein (N x 6.25)	g/100g	Kjeldahl	2.16
Carbohydrates	g/100g	By Computation	30.4
Calories/100g	-	By Computation	203
Total Sugar	g/100g	Munson - Walker	22
Calcium ^a	mg/100g	Flame AAS	100
Iron ^a	mg/100g	Flame AAS	0.566
Potassium ^a	mg/100g	Flame AES	326
Vit C	mg/100g	Titrimetry	< 1.25

Table 1.4.1 shows the nutritional profile of the puto cheese. The product basically contains 57.7 g/100g of moisture. This high-water retention explains the soft crumb structure. Carbohydrates yielded 30.4 g/100g. Calories amounted to 203 per 100 grams. The product is actually a light snack. Fat registered at a low 8.06 g/100g. Protein recorded 2.16 g/100g. These macronutrients provide basic human energy. Total sugar is evidently 22.0 g/100g. The baker used evaporated milk and white sugar. This heavily explains the high sugar output. Ash content is 1.70 g/100g. This indicates the mineral residue. Potassium reached 326 mg/100g. Calcium showed 100 mg/100g. Iron is present at 0.566 mg/100g. Vitamin C recorded less than 1.25 mg/100g. The steaming process easily destroys ascorbic acid. Heat exposure strictly causes this vitamin loss.

Table 1.4.2
Nutritional Profile of Torta

Parameters	Unit	Test Method	Results
Moisture	g/100g	Vacuum Oven Drying	51.4
Ash	g/100g	Ignition – Gravimetry	1.44
Fat	g/100g	Acid Hydrolysis - Mojonnier Extraction	14.8

Protein (N x 6.25)	g/100g	Kjeldahl	2.75
Carbohydrates	g/100g	By Computation	29.6
Calories/100g	-	By Computation	263
Total Sugar	g/100g	Munson - Walker	19.8
Calcium ^a	mg/100g	Flame AAS	89.8
Iron ^a	mg/100g	Flame AAS	0.566
Potassium ^a	mg/100g	Flame AES	258
Vit C	mg/100g	Titrimetry	< 1.25

Table 1.4.2 presents the nutritional breakdown of the torta. The product generated 263 calories per 100 grams. Carbohydrates registered at 29.6 g/100g. Fat content reached 14.8 g/100g. The added vegetable oil and butter cause this higher fat yield. Moisture content dropped to 51.4 g/100g. This specific lower moisture makes the torta structure firmer. Protein reached 2.75 g/100g. Total sugar is 19.8 g/100g. Consumers can safely get sufficient energy from this item. Ash content yielded 1.44 g/100g. Potassium is present at 258 mg/100g. Calcium showed 89.8 mg/100g. The iron content is exactly 0.566 mg/100g. Vitamin C also recorded less than 1.25 mg/100g. The prolonged baking time effectively removes the natural vitamins to deal with.

Table 1.4.3
Nutritional Profile of Bibingka

Parameters	Unit	Test Method	Results
Moisture	g/100g	Vacuum Oven Drying	43.7
Ash	g/100g	Ignition – Gravimetry	2.05
Fat	g/100g	Acid Hydrolysis - Mojonnier Extraction	16.6
Protein (N x 6.25)	g/100g	Kjeldahl	4.71
Carbohydrates	g/100g	By Computation	32.9
Calories/100g	-	By Computation	300
Total Sugar	g/100g	Munson - Walker	15.2
Calcium ^a	mg/100g	Flame AAS	120
Iron ^a	mg/100g	Flame AAS	1.27
Potassium ^a	mg/100g	Flame AES	43.7
Vit C	mg/100g	Titrimetry	< 1.25

Table 1.4.3 displays the laboratory test results of the bibingka. This product generated the highest caloric value. It recorded 300 calories per 100 grams. Fat content is also the highest at 16.6 g/100g. The coconut milk ingredient strongly drives this fat increase. Carbohydrates are evidently 32.9 g/100g. Protein content peaked at 4.71 g/100g. The yeast and eggs contribute to this protein boost. Moisture content is the lowest at 43.7 g/100g. This lack of water results in a denser bite. Total sugar went down to 15.2 g/100g. Ash content is 2.05 g/100g. The mineral profile is actually robust. Potassium registered a high 460 mg/100g. Calcium yielded 120 mg/100g. Iron showed 1.27

mg/100g. Vitamin C remained at less than 1.25 mg/100g. Thermal degradation perfectly explains this low vitamin output. This bibingka provides substantial macronutrients to sustain bodies with.

Explanation of Parameters and Interpretation of Results Moisture

Moisture content refers to the amount of water present in a product, which affects its texture, freshness, and shelf life. Among the three formulations, puto cheese recorded the highest moisture at 57.7 g/100g, making it the softest but also the most prone to microbial growth, thus having the shortest shelf life. Torta had a moderate moisture content of 51.4 g/100g, while bibingka had the lowest at 43.7 g/100g, indicating that it is the most shelf-stable among the three products.

Ash

Ash content represents the total mineral composition of a food product, reflecting its nutritional value in terms of essential minerals. Bibingka had the highest ash content at 2.05 g/100g, making it the richest in minerals, followed by puto cheese at 1.7 g/100g and torta at 1.44 g/100g.

Fat

Fat content measures the lipid composition, which enhances flavor, texture, and energy content, although very high fat levels may reduce shelf life due to oxidation. Bibingka had the highest fat content at 16.6 g/100g, contributing to a richer taste and higher energy value, followed by torta at 14.8 g/100g, while puto cheese had the lowest at 8.06 g/100g.

Protein

Protein is essential for tissue growth and repair, and a higher protein content indicates better nutritional quality. Bibingka again recorded the highest protein content at 4.71 g/100g, followed by torta at 2.75 g/100g and puto cheese at 2.16 g/100g. Carbohydrates are the primary energy source, and among the three products, bibingka had the highest carbohydrate content at 32.9 g/100g, providing more energy, followed by puto cheese at 30.4 g/100g, and torta at 29.6 g/100g. Correspondingly, the caloric content was highest in bibingka at 300 kcal/100g, followed by torta at 263 kcal/100g, and puto cheese at 203 kcal/100g, reflecting their energy-dense properties.

Total Sugar

Total sugar contributes to sweetness and overall taste. Puto cheese had the highest sugar content at 22 g/100g, making it the sweetest, followed by torta at 19.8 g/100g, while bibingka had the lowest sugar at 15.2 g/100g. Calcium, an essential mineral for strong bones and teeth, was highest in bibingka at 120 mg/100g, followed by puto cheese at 100 mg/100g, and lowest in torta at 89.8 mg/100g. Iron, necessary for

hemoglobin production, was also highest in bibingka at 1.27 mg/100g, while both torta and puto cheese had the same lower content of 0.566 mg/100g.

Potassium

Potassium, which helps regulate fluid balance, muscle, and nerve function, was highest in puto cheese at 326 mg/100g, followed by torta at 258 mg/100g, and lowest in bibingka at 43.7 mg/100g. Vitamin C, a water-soluble vitamin important for immunity and antioxidant protection, was very low in all three products at less than 1.25 mg/100g, providing minimal contribution to the diet.

Vitamin C

Vitamin C is a water-soluble vitamin that functions as an antioxidant and supports the immune system, collagen synthesis, and overall health. The results for all three formulations—puto cheese, torta, and bibingka—showed Vitamin C levels of less than 1.25 mg/100g, which is considered very low. This minimal content is likely due to heat degradation during cooking or baking, as Vitamin C is sensitive to high temperatures and prolonged processing.

The low Vitamin C value indicates that these papaya-based flour delicacies cannot be relied upon as a significant source of Vitamin C, and consumption of other fruits and vegetables rich in Vitamin C would be necessary to meet dietary requirements. While the products provide energy, minerals, and other nutrients, their contribution to antioxidant intake is negligible.

Overall, the comparison of moisture content suggests that bibingka will have the longest shelf life, followed by torta with moderate shelf stability, and puto cheese having the shortest shelf life. In terms of nutritional highlights, bibingka is the most nutritious, being rich in protein, fat, calories, ash, calcium, and iron. Torta offers moderate nutrition with good energy and sweetness, while puto cheese stands out for its sweetness and high potassium content, along with a softer texture but lower shelf stability.

Therefore, bibingka is ideal for consumers seeking energy and minerals, torta for balanced energy and sweetness, and puto cheese for taste and softness, though proper storage is necessary due to its higher moisture content.

1.5 Shelf Life

The researcher evaluated the shelf life of the baked products. To determine the maximum storage duration. The test utilized two specific temperature setups. The products were stored at room temperature and daily observations based on physical appearance and aroma were recorded. The presence of mold growth was examined through visual examination of the Torta papaya, Bibingka Papaya and Puto Cheese papaya. Understanding shelf life is essential in assuring the safety and quality of the product.

Table 1.5.1
Shelf Life in a Room Temperature

Formulations	Sensory Attributes	Number of Days			
		1	2	3	4
Formulation 1	Appearance	Golden brown, uniform shape, visually appealing	Slightly dull but still acceptable	Noticeable dryness on the surface	Visible signs of spoilage, discoloration with mold spots.
	Aroma	Pleasant, slightly sweet with a mild papaya scent	Mild decrease in aroma, still pleasant	Faint aroma, less appealing	Unpleasant with sour odor
	Taste	Soft, mildly sweet, with a balanced flavor	Slightly less flavorful but still acceptable	Bland with slight off-taste developing	Off-taste, no longer acceptable
	Texture	Moist, soft, and fluffy	Slightly firmer, less moist	Dry and firm, less palatable	Very dry, sticky, indicating spoilage
Formulation 2	Appearance	Light golden brown with slightly crisp edges; visually appealing	Slightly dry surface but still acceptable	Duller color with noticeable dryness	Discoloration, mold growth; no longer appealing
	Aroma	Pleasant, mildly sweet with a distinct coconut and papaya aroma	Aroma slightly reduced but still pleasant	Faint aroma, less appealing	Sour, unpleasant odor
	Taste	Sweet and flavorful with a balanced taste	Slight decrease in sweetness and flavor intensity	Bland with slight off-taste beginning	Off-taste, unacceptable for consumption
	Texture	Soft, moist, and slightly sticky	Less moist, slightly firmer	Dry and firm, less sticky	Hard, overly dry, indicating spoilage
Formulation 3	Appearance	Bright, uniform color with visible melted cheese on top; visually appealing	Slight drying on the surface; cheese slightly hardened but still acceptable	Noticeable dryness; cheese appears dry, slightly discolored	mold growth on surface on cheese
	Aroma	Mildly sweet with a pleasant cheesy aroma	Aroma slightly reduced; cheese scent still noticeable	Faint aroma; less appealing	Sour or unpleasant odor
	Taste	Soft, slightly sweet, with a balanced cheesy flavor	Slight decrease in sweetness and cheese flavor	Bland with slight off-taste developing	Off-taste; no longer acceptable
	Texture	Moist, soft, and fluffy	Less moist, slightly firm	Dry and firm; less fluffy	Hard, dry, slightly sticky—indicating spoilage

Table 1.5.1 presents the shelf life of Torta, Bibingka, and Puto with cheese formulated with papaya flour when stored at room temperature. The findings indicate that room temperature storage is more favorable in maintaining the freshness of the products.

Table 1.5.2
Shelf Life in a Chiller Temperature

Formulations	Sensory Attributes	Number of Days					
		1	2	3	4	5	6
Formulation 1	Appearance	Golden brown, intact structure, visually appealing	No significant change; still visually acceptable	Slight dullness in color but acceptable	Minimal changes; no visible spoilage	Slight drying on the surface	Signs of spoilage discoloration, mold spots
	Aroma	Pleasant, mildly sweet with a subtle papaya scent	Slightly reduced aroma but still pleasant	Faint aroma, still acceptable	Slightly bland aroma	Faint aroma	Unpleasant, slightly sour odor
	Taste	Soft, slightly sweet, and flavorful	Slight decrease in flavor intensity	Mild reduction in sweetness and flavor	Less flavorful but still acceptable	Bland but still consumable	Off-taste; no longer acceptable
	Texture	Moist, soft, and fluffy	Slightly firmer due to chilling but still moist	Firmer and less moist, but still palatable	Noticeably firm; slight dryness	Dry and firm	Very dry and hard, indicating spoilage
Formulation 2	Appearance	Light golden brown with slightly crisp edges; visually appealing	No significant change; still visually acceptable	Slight dullness in color; still acceptable	Minimal changes; no visible spoilage	Surface begins to dry; edges slightly hardened	Discoloration, mold growth
	Aroma	Pleasant, mildly sweet with a distinct coconut and papaya aroma	Slightly reduced aroma but still pleasant	Faint aroma but not unpleasant	Slightly bland aroma	Faint aroma	Unpleasant, sour odor
	Taste	Sweet and flavorful with balanced taste	Slight decrease in sweetness and flavor intensity	Mild reduction in flavor	Less flavorful but still acceptable	Borderline acceptable; off-taste beginning	Off-taste; no longer acceptable for consumption

	Texture	Soft, moist, and slightly sticky	Slightly firmer; moisture slightly reduced	Less moist, moderately firm	Noticeably firmer with slight dryness	Dry, firm, and less palatable	Very dry, hard, or tough—indicating spoilage
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Table 1.5.2 presents the shelf life of the baked products stored under chiller conditions. Chilled products can last up to six days when refrigerated, however, may alter the flavor and texture. The chilling procedure may result in undesirable changes and a reduction in nutritional value.

Sensory Attributes of the Papaya-Flour Delicacies

Table 2.1

Sensory Attributes of the Torta Papaya Flour-based Delicacies

Name of Product	Sensory Attributes	Level of Preference	Frequency	Percentage %	Rank
Torta	Appearance				
	Highly Preferred	4	43	61.43	1
	Moderately Preferred	3	26	37.14	3
	Slightly Preferred	2	1	1.43	
	Not Preferred	1	0	0	
	Aroma				
	Highly Preferred	4	33	47.14	2
	Moderately Preferred	3	35	50	
	Slightly Preferred	2	2	2.86	
	Not Preferred	1	0	0	
	Taste				
	Highly Preferred	4	33	47.14	1
	Moderately Preferred	3	32	45.71	2
	Slightly Preferred	2	5	7.14	
	Not Preferred	1	0	0	
	Texture				
	Highly Preferred	4	32	45.71	2
	Moderately Preferred	3	36	51.43	
	Slightly Preferred	2	2	2.86	
	Not Preferred	1	0	0	

Table 2.1 presents the sensory evaluation of torta made from papaya-based flour in terms of appearance, aroma, taste, and texture.

In terms of appearance, the product obtained the highest preference rating of 4 with a frequency of 43 or 61.43%, indicating that the majority of the respondents highly preferred the visual quality of the product. Only 1.43% rated it as 2, and no respondents gave the lowest rating. This suggests that the appearance of the torta is highly preferred.

For aroma, most respondents rated the product as 3 (50%) and 4 (47.14%), indicating that the aroma was moderately preferred by the respondents. Only 2.86% rated it as 2, showing slightly preferred.

In terms of taste, 47.14% of the respondents rated it as 4, while 45.71% rated it as 3. This indicates that the taste of the torta is highly preferred, with very few respondents (7.14%) rating it as 2.

As to texture, the majority rated it as 3 (51.43%) and 4 (45.71%), indicating that the texture is moderately preferred. Only 2.86% expressed slightly preferred or slight satisfaction with the product.

Overall, the results reveal that the torta papaya flour-based delicacy is highly preferred, particularly in terms of appearance and taste.

Table 2.2
Sensory Attributes of the Bibingka Papaya Flour-based Delicacies

Name of Product	Sensory Attributes	Level of Preference	Frequency	Percentage %	Rank
Bibingka	Appearance				
	Highly Preferred	4	27	38.57	
	Moderately Preferred	3	37	52.59	2
	Slightly Preferred	2	3	4.29	
	Not Preferred	1	3	4.29	
	Aroma				
	Highly Preferred	4	27	38.57	
	Moderately Preferred	3	38	58.29	1
	Slightly Preferred	2	5	7.14	
	Not Preferred	1	0	0	
	Taste		29		
	Highly Preferred	4	32	45.71	1
	Moderately Preferred	3	29	41.43	
	Slightly Preferred	2	9	12.86	2
	Not Preferred	1	0	0	
	Texture				
	Highly Preferred	4	27	38.57	3
	Moderately Preferred	3	35	50	
	Slightly Preferred	2	4	5.71	
	Not Preferred	1	4	5.71	

Table 2.2 presents the sensory evaluation of bibingka made from papaya-based flour.

For appearance, the majority of respondents rated the product as 3 (52.59%), followed by 4 (38.57%). A small percentage rated it as 2 and 1 (4.29% each), indicating that while the product is moderately preferred, there is slight variation in preference.

In terms of aroma, most respondents rated it as 3 (58.29%) and 4 (38.57%), indicating that the aroma is moderately preferred. A small portion (7.14%) rated it as 2.

Regarding taste, 45.71% rated it as 4 and 41.43% rated it as 3, showing that the taste is highly preferred to moderately preferred. However, 12.86% rated it as 2, suggesting that taste may require slight improvement.

For texture, the majority rated it as 3 (50%) and 4 (38.57%), while some respondents rated it as 2 (5.71%) and 1 (5.71%). This indicates that texture is slightly and not preferred but may need refinement to improve consistency.

Overall, the bibingka papaya-based flour delicacy is moderately preferred to slightly not preferred, though improvements in texture and taste may enhance consumer preference.

Table 2.3
Sensory Attributes of the Puto cheese Papaya Flour-based Delicacies

Name of Product	Sensory Attributes	Level of Preference	Frequency	Percentage %	Rank
Puto Cheese	Appearance				
	Highly Preferred	4	43	61.43	1
	Moderately Preferred	3	23	32.86	
	Slightly Preferred	2	3	4.29	
	Not Preferred	1	1	1.43	
	Aroma				
	Highly Preferred	4	38	58.29	1
	Moderately Preferred	3	25	35.71	
	Slightly Preferred	2	7	10	
	Not Preferred	1	0	0	
	Taste				
	Highly Preferred	4	33	47.14	1
	Moderately Preferred	3	32	45.71	2
	Slightly Preferred	2	5	7.14	
	Not Preferred	1	0	0	
	Texture				
	Highly Preferred	4	40	57.14	1
	Moderately Preferred	3	27	38.57	
	Slightly Preferred	2	3	4.29	
	Not Preferred	1	0	0	

Table 2.3 shows the sensory evaluation of puto cheese made from papaya-based flour. In terms of appearance, most respondents rated it as 4 (61.43%), indicating highly preferred. Only a small percentage rated it as 2 (4.29%) and 1 (1.43%).

For aroma, 58.29% rated it as 4 and 35.71% as 3, indicating that the aroma is highly preferred among respondents.

In terms of taste, 47.14% rated it as 4 and 45.71% as 3, demonstrating that the taste is highly preferred with average satisfaction with the product.

Regarding texture, 57.14% rated it as 4 and 38.57% as 3, showing strong preference of the product's texture.

Overall, the results indicate that the puto cheese papaya flour-based delicacy is highly preferred across all sensory attributes, consistently receiving the highest ratings among the three products.

Respondents' Level of Preference

Table 3.1
Difference on Level of Preference of the Products

Name of Products	Mean	Standard Deviation	Descriptive Value
Torta			
Appearance	3.60	0.522	Highly Preferred
Aroma	3.44	0.555	Highly Preferred
Taste	3.40	0.623	Highly Preferred
Texture	3.43	0.554	Highly Preferred
Overall	3.47	0.440	Highly Preferred
Bibingka			
Appearance	3.26	0.736	Highly Preferred
Aroma	3.31	0.603	Highly Preferred
Taste	3.33	0.696	Highly Preferred
Texture	3.22	0.802	Moderately Preferred
Overall	3.28	0.583	Highly Preferred
Puto Cheese			
Appearance	3.54	0.655	Highly Preferred
Aroma	3.44	0.673	Highly Preferred
Taste	3.40	0.623	Highly Preferred
Texture	3.53	0.583	Highly Preferred
Overall	3.49	0.535	Highly Preferred

Table 3.1 shows that all three products were generally highly preferred by the respondents. Among them, puto cheese obtained the highest overall mean (3.49), making it the most preferred product. This was followed by torta (3.47) and bibingka (3.28), which were also rated as highly preferred.

All sensory attributes of puto cheese and torta were rated highly preferred, indicating strong acceptability. However, bibingka's texture was rated moderately preferred, suggesting a need for improvement in this aspect. Overall, the results indicate that the products are acceptable to consumers, with torta as the most favored.

Table 3.2
Weighted Means of Level of Preference

Name of Product	Appearance	Aroma	Taste	Texture	Overall Weighted Means
(P1)Torta	3.60	3.44	3.40	3.43	3.47
(P2)Bibingka	3.26	3.31	3.33	3.22	3.28
(P3)Puto Cheese	3.54	3.44	3.40	3.53	3.49

Table 3.2 presents the weighted mean scores of the respondents' level of preference for the three papaya flour-based products— (P1) Torta, (P2) Bibingka, and (P3) Puto Cheese in terms of appearance, aroma, taste, texture, and overall acceptability.

Among the three products, (P3) Puto Cheese obtained the highest overall weighted mean of 3.49, indicating that it is the most preferred product by the respondents. This is followed by (P1) Torta with an overall mean of 3.47, while (P2) Bibingka received the lowest overall mean of 3.28.

In terms of specific attributes, both (P1) Torta and (P3) Puto cheese showed consistently high ratings across appearance, aroma, taste, and texture, suggesting that respondents found these products more appealing and acceptable. On the other hand, P2 (Bibingka), although still rated positively, obtained comparatively lower scores in all attributes.

Overall, the results indicate that all three products were generally highly preferred, but Puto Cheese (P3) emerged as the most acceptable among the formulations, followed closely by Torta (P1).

These values validate the commercial viability of the papaya flour substitute. The market basically accepts this agricultural formulation based on current data. The highly preferred ratings firmly validate the commercial potential of green papaya flour. Joymak et al. (2021) emphasized that unripe papaya by-products practically serve as excellent functional ingredients for human consumption.

Consumers basically accept the sensory adjustments when the primary formulation mimics traditional recipes. Puspitarini (2019) recorded similar high acceptability scores in cookies supplemented with papaya powder. The slight preference for the bibingka heavily highlights the consumer inclination towards softer textures. Sanusi and Sunmonu (2025) explicitly noted that crumb softness positively influences the general consumer liking. The strategic reformulation of these heritage pastries does not alienate the target market. Estruch et al. (2020) previously argued that health-oriented pastry reformulations must essentially maintain standard taste profiles to succeed. The papaya flour substitution successfully achieves this delicate balance to work with.

Table 4.1
Difference on Level of Preference in terms of Appearance among 3 Formulations

Friedman test (χ^2)	Df	P-value	Decision
19.6	2	0.001	Significant; Ho:Rejected
Pairwise Comparison			
Compared Treatment (Pairs)	Computed p- Value (Appearance)	Decision	Interpretation
P1 vs P2	0.001	Significant Ho: Rejected	P1 > P2
P1 vs P3	0.511	Insignificant Ho: Accepted	P1 = P3
P2 vs P3	0.001	Significant	P2 < P3

		Ho: Rejected	
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Table 4.1 shows the Friedman test to determine whether there is a significant difference in the respondents' level of preference across the three formulations in terms of sensory attributes. For appearance ($\chi^2 = 19.6$, $p = 0.001$), the p-values are less than 0.05, indicating a significant difference among the formulations.

The pairwise comparison results for appearance reveal that respondents were able to distinguish certain product formulations while perceiving others similarly. Specifically, there is a significant difference between (P1) torta and (P2) bibingka ($p = 0.001$) and between (P2) bibingka and (P3) puto cheese ($p = 0.001$), leading to the rejection of the null hypothesis in both cases. This indicates that the appearance of (P2) bibingka is noticeably different from both (P1) torta and (P3) puto cheese, making it more distinguishable to the respondents.

On the other hand, the comparison between (P1) torta and (P3) puto cheese ($p = 0.511$) shows no significant difference, resulting in the acceptance of the null hypothesis. This means that respondents perceived the appearance of these two products as similar.

Overall, the findings suggest that (P2) bibingka stands out in terms of appearance, while (P1) torta and (P3) puto cheese share comparable visual characteristics, indicating that formulation differences influenced how respondents visually evaluated the products.

Table 4.2
Difference on Level of Preference in terms of Aroma and Taste among 3 Formulations

Aroma			
Friedman test (χ^2)	df	P-value	Decision
4.74	2	0.094	Insignificant; Ho: Accepted
Taste			
1.09	2	0.580	Insignificant; Ho: Accepted

Table 4.2, on the other hand, aroma ($\chi^2 = 4.74$, $p = 0.094$) and taste ($\chi^2 = 1.09$, $p = 0.580$) have p-values greater than 0.05, which indicates no significant difference among the formulations. This suggests that the respondents perceived the aroma and taste of the products to be generally similar.

Table 4.3
Difference on Level of Preference in terms of Texture among 3 Formulations

Friedman test (χ^2)	Df	P-value	Decision
13.2	2	0.001	Significant; Ho: Rejected

Paiwise Comparison			
Compared Treatment (Pairs)	Computed p- Value (Appearance)	Decision	Interpretation
P1 vs P2	0.030	Significant Ho: Rejected	P1>P2
P1 vs P3	0.152	Insignificant Ho: Accepted	P1 = P3
P2 vs P3	0.001	Significant Ho: Rejected	P2 < P3

Table 4.3 shows that there is a significant difference in texture among the three products, with a Friedman test result of 13.2, 2 degrees of freedom, and a p-value of 0.001. Since the p-value is less than 0.05, the null hypothesis (Ho) is rejected.

The pairwise comparison results for texture reveal that some product formulations differ significantly, while others are perceived as similar. Specifically, there is a significant difference between (P1) torta and (P2) bibingka ($p = 0.030$) and between (P2) bibingka and (P3) puto cheese ($p = 0.001$), leading to the rejection of the null hypothesis in both comparisons. This indicates that respondents were able to distinguish differences in mouthfeel, such as consistency, softness, or chewiness, particularly involving (P2) bibingka.

In contrast, the comparison between (P1) torta and (P3) puto cheese ($p = 0.152$) shows no significant difference, resulting in the acceptance of the null hypothesis. This means that these two products have comparable textures and were perceived similarly by the respondents.

Overall, the findings suggest that (P2) bibingka stands out in terms of texture, while (P1) torta and (P3) puto cheese share similar textural characteristics. This implies that formulation variations influenced the physical properties of the products, affecting how they were experienced in terms of mouthfeel.

Table 4.4
Difference on Overall Level of Preference among 3 formulations

Friedman test (χ^2)	Df	P-value	Decision
39.5	2	<0.001	Significant; Ho:Rejected
Over all Pairwise Comparison Result			
Compared Treatment (Pairs)	Computed p- Value (Appearance)	Decision	Interpretation
P1 vs P2	0.001	Significant Ho: Rejected	P1 > P2
P1 vs P3	0.907	Insignificant Ho: Accepted	P1 = P3
P2 vs P3	0.001	Significant Ho: Rejected	P2 < P3

The results of the Friedman test show that there is a statistically significant difference in the level of preference among the three product formulations, as indicated by the computed value (39.5), degrees of freedom ($df = 2$), and p-value of less than 0.001. Since the p-value is lower than the standard level of significance (0.05), the null hypothesis (H_0) is rejected.

This means that the respondents did not rate the three products equally; instead, at least one product formulation was significantly preferred over the others in terms of overall sensory attributes. Furthermore, the significant results for appearance and texture imply that these attributes played an important role in influencing consumer preference.

Overall, the findings suggest that variations in formulation affect how consumers perceive the products, highlighting the importance of optimizing sensory qualities to improve acceptability.

Post hoc Durbin-Conover analysis showed the overall pairwise comparison results indicate that respondents were able to distinguish differences in the overall sensory quality of some product formulations, while others were perceived similarly. Specifically, there is a significant difference between (P1)torta and (P2)bibingka ($p = 0.001$) and between (P2)bibingka and (P3) puto cheese ($p = 0.001$), leading to the rejection of the null hypothesis in both cases. This suggests that respondents were able to clearly differentiate these product pairs in terms of combined sensory attributes such as appearance, aroma, taste, and texture.

On the other hand, the comparison between (P1)torta and (P3) puto cheese ($p = 0.907$) shows no significant difference, resulting in the acceptance of the null hypothesis. This indicates that respondents perceived these two products as similar overall, with no noticeable difference in their sensory characteristics.

Overall, the findings highlight that (P2) bibingka is significantly different from both (P1) torta and (P3) puto cheese in overall acceptability, while (P1) torta and (P3) puto cheese are comparable, suggesting that the formulation of (P2) bibingka influenced the overall sensory perception of the respondents.

The steaming method of puto cheese enhanced moisture retention, creating a superior sensory experience, whereas the dry heat of baking reduced bibingka's moisture, affecting texture and overall acceptability. Torta balanced key sensory attributes, demonstrating that formulation and cooking method critically influence product acceptability.

These findings align with previous studies showing that functional flours react differently to thermal processes (Hussien et al., 2023; Lira, 2023; Dwiloka et al., 2019; Sanusi & Sunmonu, 2025) and that product format dictates expected mouthfeel, as seen in steamed cakes versus baked biscuits (Pathak et al., 2018; Ávila et al., 2020; Nuradiana & Sobari, 2021). Proper alignment of flour type and cooking technique is therefore essential to ensure optimal sensory quality and consumer satisfaction.

DISCUSSION

The main purpose of this study was to determine the product development of Papaya (*Carica Papaya*) Flour-Based Delicacies. It also aims to formulate a commercialization plan.

The researcher used quasi-experimental research design to develop and evaluate papaya-based flour delicacies. The researcher manipulated ingredients without random assignment to evaluate the three products—torta, bibingka, and puto cheese and compared their sensory qualities using a structured evaluation process.

The research was conducted in selected municipalities of the Second Congressional District II of Bohol, specifically Talibon, Trinidad, and Ubay, known for local delicacy production. The respondents consisted of 70 respondents, including food technology teachers, local bakers, and delicacy makers, selected through quota sampling. The sample size was determined using Jamovi, a statistical software for data analysis.

Data were collected using a validated modified questionnaire based on a 4-point Hedonic Scale, measuring four sensory attributes: appearance, aroma, taste, and texture. The instrument underwent expert validation, pilot testing, and reliability testing using Cronbach's alpha to ensure consistency.

The data gathering procedure included securing approvals, preparing papaya flour and products, conducting laboratory nutritional analysis, and performing shelf-life testing. Sensory evaluation was administered through controlled product tasting, with proper intervals to avoid bias. Respondents rated each product, and the data were collected and tabulated.

Statistical analysis was conducted using friedman test with the use of jamovi statistical software, employing weighted mean to determine the level of preference and one-way ANOVA to test significant differences among the products. A defined descriptive rating scale was used to interpret the preference levels. Finally, conclusions and recommendations were drawn based on the findings of the study.

Findings

After the data were gathered, analyzed and interpreted accordingly, the researcher came up with the following findings:

1. The study successfully developed three papaya based- flour delicacies: torta, bibingka, and puto cheese, and evaluated them in terms of ingredients and cost, tools and equipment used, procedure, nutritional content, shelf life, and sensory acceptability.

1.1 In terms of ingredients and cost, the findings revealed that torta had the highest production cost (₱280.00 for 15 pieces), followed by bibingka (₱210.24), and puto cheese as the least expensive (₱192.60). Despite cost differences, all products remained economically viable due to the low cost of green papaya flour and the application of a 20% operating expense and 30% markup, ensuring profitability.

1.2 For tools and equipment, the study found that standard and readily available kitchen tools such as ovens, steamers, mixers, and grinders were sufficient for production, making the process accessible for small-scale bakers and entrepreneurs.

1.3 In terms of procedure, the preparation of papaya flour involved washing, peeling, slicing, drying, and grinding. Each product followed simple and standardized steps, with torta requiring oven baking for 55 minutes, while bibingka and puto cheese required 40 minutes using baking and steaming methods, respectively.

1.4 Regarding nutritional content, bibingka had the highest calorie (300 kcal/100g), fat, and protein content, while torta had moderate values. Puto cheese had the lowest calorie content but the highest moisture, contributing to its softer texture. All products contained essential minerals such as calcium, iron, and potassium, but showed low vitamin C due to heat processing.

1.5 For shelf life, the products remained acceptable for up to 3 days at room temperature and showed spoilage by the 4th day. Under refrigerated conditions, shelf life extended up to 6 days, although slight changes in texture and flavor were observed.

2. In terms of sensory attributes, torta and puto cheese obtained the highest rating in appearance, while puto cheese ranked highest in texture. Bibingka consistently received the lowest scores among the three products. Statistical analysis showed a significant difference only in appearance and texture ($p = 0.005$), while aroma and taste, showed no significant differences.

Overall, the findings indicate that papaya flour can be effectively utilized in developing acceptable, nutritious, and economically viable baked products, with torta and puto cheese showing better sensory performance compared to bibingka.

3. In terms of respondents' level of preference, all products were rated highly preferred, with an over all preference in mean of 3.41. Puto cheese obtained the highest rating ($M = 3.49$), followed closely by torta ($M = 3.47$), while bibingka had the lowest ($M = 3.28$). The preference for puto and torta suggests that consumers favor softer and moister textures.

The Friedman test confirmed a significant difference in overall preference among the three products. Post hoc analysis showed that torta and puto cheese were similarly preferred, while bibingka differed significantly. These results indicate that texture and

cooking method significantly influence consumer acceptability. Overall, the results confirm that papaya flour-based products are highly preferred to consumers, with puto and torta showing stronger market potential. The findings also emphasize that processing methods significantly influence product quality and consumer preference, particularly in terms of appearance and overall preference.

Conclusions

The study concludes that green papaya flour is a viable and effective alternative ingredient in the production of traditional baked products such as torta, bibingka, and puto cheese. The findings demonstrate that all three products are economically feasible, nutritionally beneficial, and highly acceptable to consumers, confirming the potential of papaya flour for food innovation and small-scale commercialization.

Among the products, puto cheese and torta emerged as the most preferred formulations due to their favorable sensory qualities, particularly in terms of appearance, texture, and overall acceptability. Bibingka, although still rated highly acceptable, received comparatively lower scores, likely due to its denser texture and lower moisture content. Statistical analysis further confirmed that significant differences existed in appearance and overall preference, emphasizing the influence of cooking methods on product quality and consumer preference.

The study also established that steaming and baking techniques affect the sensory and physical characteristics of the products, with steaming producing softer and more moist textures that are generally preferred by consumers. Additionally, the nutritional analysis revealed that the products contain essential macronutrients and minerals, although vitamin C content is reduced due to heat processing.

Furthermore, the shelf-life evaluation indicated that the products remain safe and acceptable for up to three days at room temperature and up to six days under refrigeration, making them suitable for short-term storage and retail.

Recommendations

Based on the findings and conclusions of the study, the following recommendations are proposed:

1. Use mature but unripe green papaya of uniform size and quality to ensure consistency in flour production.
2. Apply pre-processing techniques such as blanching and anti-browning agents to color and extend shelf life.
3. Control the drying process at moderate temperatures (around 60°C) to retain nutrients and functional properties.
4. Develop composite flour blends (e.g., wheat, rice, cassava) to improve texture, structure, and acceptability.

5. Maintain moisture content below 10% and use airtight, moisture-resistant packaging for proper storage.
6. Explore wider product applications such as bread, cookies, noodles, and other baked goods.
7. Promote technology transfer through training, seminars, and workshops for educators and communities.
8. Incorporate nutrient-rich ingredients or optimize processing to preserve heat-sensitive vitamins.
9. Develop improved packaging and storage methods to extend shelf life and ensure product safety.
10. Encourage entrepreneurs to adopt papaya flour and apply effective branding and marketing strategies.
11. Support training programs by local institutions to promote livelihood opportunities and reduce food waste.

Proposed Commercialization Plan

I. Executive Summary

The researcher presents the proposed commercialization plan for the developed papaya (*Carica papaya*) flour-based delicacies, namely torta, bibingka, and puto cheese. The technology involves the production of flour derived from unripe papaya and its utilization as a substitute ingredient in traditional Filipino baked products. This innovation aims to promote the use of locally available agricultural resources while improving the nutritional value and affordability of delicacies. The developed products offer a unique value proposition by providing a healthier and cost-efficient alternative to conventional wheat-based delicacies. The commercialization initiative targets households, local bakeries, and small-scale entrepreneurs, with opportunities for expansion in both national and international markets. The overall commercialization strategy includes direct production and marketing, partnerships with local bakeries, and technology transfer through training and licensing to micro, small, and medium enterprises (MSMEs).

II. Market Analysis

Industry Overview

The bakery and delicacy industry in the Philippines is continuously expanding due to increasing consumer demand for affordable, ready-to-eat food products. Additionally, there is a growing preference for healthier and functional food alternatives, which creates an opportunity for innovative products such as papaya flour-based delicacies. However, the industry also faces challenges such as competition from established wheat-based products, varying consumer preferences, and limitations in product shelf life. Despite these challenges, the availability of raw materials like papaya and the increasing support from government agencies for food innovation contribute positively to the market potential.

Target Market

The target market for the developed products includes households, local bakeries, delicacy producers, school canteens, and health-conscious consumers. These groups are likely to benefit from affordable and nutritious food alternatives. Geographically, the commercialization will initially focus on local communities, particularly in Bohol and nearby provinces. Expansion is envisioned at the regional level and eventually in national markets, where there is increasing interest in functional and indigenous food products.

III. Problem Statement

The heavy reliance on imported wheat flour in the production of baked products leads to increased production costs and limited accessibility for small-scale producers. Moreover, there is underutilization of locally abundant crops such as papaya, which can serve as a viable alternative raw material. The developed papaya flour-based delicacies address these concerns by providing a sustainable, cost-effective, and nutritious substitute for traditional flour while promoting local agricultural resources.

Competitive Landscape

Existing products in the market include wheat-based and rice-based delicacies, which dominate consumer preference due to familiarity and established production systems. However, the developed products offer several competitive advantages, including the use of locally sourced ingredients, enhanced nutritional content, and product innovation. These advantages position the papaya flour-based delicacies as a unique alternative in the market, particularly among health-conscious consumers and local entrepreneurs seeking cost-efficient production methods.

IV. Value Proposition

The developed products are characterized by their innovative use of papaya flour as a primary ingredient in traditional delicacies. This innovation serves as a healthier alternative due to its potential nutritional benefits, including increased fiber content. Furthermore, the products provide economic benefits by reducing reliance on imported wheat flour and lowering production costs. The utilization of locally available raw materials also contributes to sustainability and supports local farmers. Overall, the products offer a combination of affordability, nutritional value, and product uniqueness, making them competitive in the market.

V. Commercialization Strategy

Pathways to Market

The commercialization of the developed products will be achieved through multiple pathways. Direct commercialization will involve the production and sale of papaya flour-

based delicacies in local markets. Partnerships with bakeries and cooperatives will enable wider product distribution. Additionally, technology transfer through training programs and licensing agreements will allow entrepreneurs and MSMEs to adopt the innovation, thereby increasing its reach and impact.

Business Model

The business model will generate revenue through direct product sales, distribution of papaya flour, and training services for technology adoption. Pricing strategies will be competitive with existing delicacies while considering the added value of improved nutrition and innovation.

Go-to-Market Plan

Marketing efforts will focus on promoting the health benefits and uniqueness of the products through local markets, trade fairs, and digital platforms. Distribution channels will include local bakeries, retail stores, and direct selling. Strategic partnerships with government agencies such as the Department of Trade and Industry (DTI), local government units (LGUs), and agricultural organizations will support product promotion and business development.

Timeline to Commercialization

The commercialization process will be implemented in phases. Initial activities will include product refinement and pilot testing within the first six months. This will be followed by market expansion and partnership development within the next 6 to 18 months. Full-scale commercialization and regional expansion are targeted within two to three years.

VI. Operations Plan

Production will begin on a small scale and gradually expand to semi-commercial levels. The process will involve sourcing raw papaya locally, followed by drying, grinding, and incorporation into delicacy production. Supply chain management will prioritize local sourcing to ensure cost efficiency and sustainability. Required facilities include drying areas, grinding equipment, and baking tools necessary for product preparation.

VII. Management and Team

The commercialization effort will be managed by a team consisting of a project leader, production manager, marketing officer, and financial officer. Each member will contribute expertise in food processing, business management, marketing, and financial planning. External support from academic institutions, government agencies, and industry partners will further strengthen the implementation of the commercialization plan.

IV. Financial Plan

The financial requirements include costs for raw materials, equipment, packaging, labor, and marketing. Initial investment will focus on establishing production capability and product promotion. Revenue is expected to grow gradually, with a break-even point anticipated within the first year of operation. Increased profitability is projected in subsequent years as production scales and market reach expands. Funding sources may include government grants, microfinance institutions, and private investors interested in food innovation and local enterprise development.

IX. Risk Analysis and Mitigation

Potential risks include technical challenges in maintaining product quality, market resistance to new products, financial limitations, and lack of intellectual property protection. These risks will be mitigated through standardization of production processes, active marketing and product promotion, careful financial planning, and proper registration of the developed technology and products.

IX. Implementation Timeline

The implementation will follow a phased approach, beginning with product standardization and pilot production, followed by market testing and business registration. Full-scale commercialization will be achieved after successful market acceptance and operational stability. Key milestones include completion of product development, pilot testing, establishment of partnerships, and expansion into broader markets. The sensory evaluation proved the high consumer acceptability of the puto cheese and torta. The market basically demands these specific softer textures to deal with. The laboratory results strictly confirm the nutritional value of the baked goods. These health parameters easily attract conscious buyers to profit from. The business strategy deliberately includes proper packaging and refrigeration protocols. The financial computation guarantees a stable 30% markup on top of the operating expenses. This economic feasibility strongly motivates the local food industry to adopt the technology. The plan specifically focuses on the highest-performing formulations to ensure entrepreneurial success.

Proposed Technology Guide for The Production of Torta, Bibibngka and Puto Cheese Using Papaya (Carica Papaya) Based-Flour Delicacies

Areas of Concern	Objectives	Strategies	Persons Involved	Budget	Time Frame	Output
Technology Transfer and Orientation	To introduce the green papaya flour formulation to local bakers.	Conduct hands-on baking demonstrations. Distribute standardized recipe manuals.	Researcher, local bakeshop owners, food technology teachers	P 2,500.00	Month 1	The local bakers successfully replicate the exact puto and torta recipes.

Product Standardization and Safety	To strictly enforce proper food handling and storage.	Implement strict refrigeration guidelines. Train the bakers on proper airtight packaging techniques.	Researcher, food safety officers, partner bakers	P 1,500.00	Month 2	Partner bakeshops effectively establish safe chilling stations to deal with.
Market Testing and Consumer Sampling	To validate actual market sales and consumer repeat purchases.	Offer free tasting booths in local public markets. Utilize direct selling techniques.	Researcher, student volunteers, target consumers	P 2,000.00	Month 3	Consumers actually buy the products and provide real-world feedback to look at.
Entrepreneurial Launch and Scaling	To fully integrate the papaya pastries into commercial menus.	Formulate strategic pricing based on the 30% markup. Execute local social media marketing.	Bakeshop owners, marketing personnel, local government units	P 3,000.00	Month 4 to Month 6	Local bakeshops experience an actual increase in daily income and product variety.

Compliance with Ethical Consideration

The study adhered to established ethical standards in research involving human participants. Permission to conduct the study was obtained from relevant authorities prior to data collection. Participation was voluntary, and respondents were informed of the purpose of the study before taking part in the sensory evaluation. Confidentiality and anonymity were ensured by not collecting personally identifiable information, and all responses were treated with strict confidentiality. All data were used solely for academic purposes and were securely handled throughout the research process.

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