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Evaluation of the Organoleptic Properties of Calabash Fruit (Crescentia Cujete) Jam: A Comprehensive Sensory analysis

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Abstract: This study was conducted to formulate a Calabash fruit jam and evaluate the developed product's sensory characteristics and consumer acceptability. A 2k factorial design was used to measure224 g calabash pulp and sugar levels. There was no significant difference in the sensory attributes across different treatments in terms of color, aroma, and flavor. However, the Friedman test showed that there was a difference in the sensory characteristics across different treatments in terms of texture. Results reveal that Treatments 1 with -125 g. level of pulp and sugar, Treatment 3 with -125 g. and +224 g. levels of pulp and sugar and Treatment 4 with +224 g. levels of pulp and sugar have the same texture and Treatment 2 with +224 g. and -125 g. level of pulp and sugar is different from these three treatments. In terms of sensory acceptability, there was a significant difference in the sensory acceptability across other treatments in terms of texture, aroma, color, and flavor. Further, results reveal that Treatment 1 with -125 g. level of pulp and sugar, Treatment 3 with -125 g. and +224 g. levels of pulp and sugar and Treatment 4 with +224 g. levels of pulp and sugar have the same texture, aroma, color, and flavor, and Treatment 2 with +224 g. and -125 g. level of pulp and sugar is different from these treatments. Hence, considering the production cost of each treatment, the lowest production cost was considered, and Treatment 1 with -125 g. level of pulp and sugar got the lowest production cost among other treatments.

Keywords: calabash fruit, sensory characteristics, Friedman test, sensory acceptability.

I. Introduction

Fresh fruits and vegetables top the list of most perishable agricultural food commodities. Nevertheless, several methods abound to process fresh fruits into products that are much more shelf-stable and available all year round. [18]. Calabash is an underutilized crop despite its potential and abundance in the Philippines. According to [16], one of the oldest food preservation methods is using fruits, sugar, pectin, and edible acids in making jams and other preserves. Humankind presents a way of producing stable food. The calabash fruit *Crescentia cujete* is a member of the Bignoniaceae family. It is thought to treat various illnesses, including diarrhea, colds, and asthma, and is thus known as a miracle fruit. According to reports, the leaves and the calabash fruit contain phytochemicals such as tannins, glycosides, and flavonoids that possess a solid antioxidant property [6]. Crescentia cujete is known as the "miracle fruit," a local nickname that may have originated from word-of-mouth. Jam is produced by preserving the fruit with sugar and is thickened or jellied to some degree. Fresh, frozen, concentrated, or previously canned fruit is used to make jam. Cooked with sugar (and added pectin, if required) until enough water has evaporated and it gels [15].

Food manufacturers continue to respond to scientific findings linking health and nutrition by providing a diverse range of health-promoting foods. Along these lines of thought, the researcher is encouraged to create a new variety of jams made from Calabash fruit. People are currently concerned about their health.

Because fruit jam is popular among people of all ages, the highly nutritious and therapeutic fruit jam with herbal extracts can benefit everyone. Thus, it is worthwhile to investigate the possibility of improving the medicinal properties of fruit jam by using herbal ingredients that may enhance the characteristic natural flavor. The significance of this Calabash fruit jam making is to demonstrate and provide the importance of backup in many aspects, including health benefits wherein it provides our bodies with beneficial quick boosts of energy, an alternative spread for breakfast, and mid-day and afternoon snacks. Another significance of this research is discovering that Calabash fruit is edible for jam-making. The researcher was eager to make jam because it was described as a sweet dessert that is a popular accompaniment to slices of bread and a favorite breakfast treat or snack of many children and adults. Jams are popular due to their sweet flavors, which can be helpful for those on the go or on a diet. Spots are available throughout the Philippines at any "pasalubong" or supermarket [20].

This study aimed to create a jam from *Crescentia cujete* pulp and evaluate the sensory characteristics and acceptability of *Crescentia cujete* jam. The hypothesis of the study is There is no significant difference between the sensory characteristics and acceptability of the calabash fruit jam with different levels of calabash pulp in terms of colour, aroma, texture, and taste. The findings of this study will assist consumers in purchasing and consuming nutritious and high-quality jam, which is plentiful in supply but scarce in utilization in terms of food production.

Conceptual Framework

The conceptual framework of this study is shown in figure 1. The diagram shows the independent variable, varying Calabash fruit levels in 125 and 224 grams. These will determine the different sensory characteristics of Calabash pulp in terms of color, aroma,

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Texture, and taste. It will be subjected to sensory evaluation, after which the product will be subjected to the consumer's general acceptability. The diagram shows that the Calabash pulp in different formulations will be utilized in making fruit jam. The boiled pulp fruit jam formula will be sensory evaluated to determine its sensory attributes in terms of color, aroma, flavor, texture, and general acceptability to assess the level of acceptability of fruit jam in terms of appearance, aroma, flavor, and texture using different formulation levels of boiled Calabash pulp to determine the most acceptable formulation of Calabash fruit jam flavor.

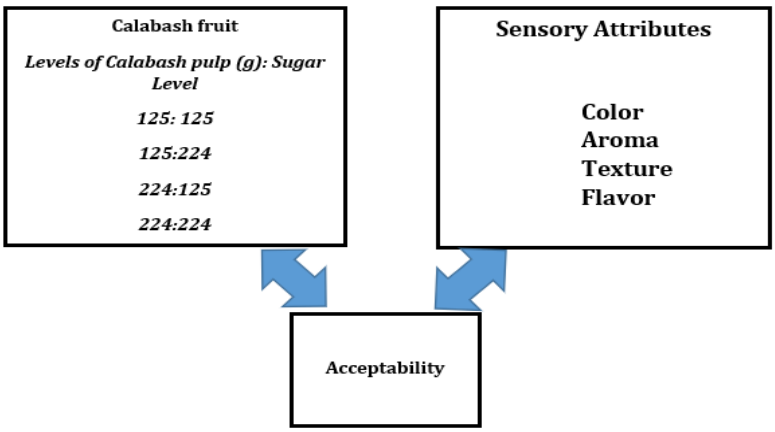

Fig. 1 Conceptual Framework

II. Methodology

Research Design

This experimental research design utilized Completely Randomized Design (CRD). There were four (4) treatments comprising different levels (125 & 224 grams).

Table 1. Experimental Treatments of Calabash fruit Jam with different levels of Calabash fruit pulp.

Treatments	Levels of Calabash pulp (g): Sugar Level
1	125: 125
2	125: 224
3	224: 125
4	224: 224

Research Location and Sensory Panelists

This study was conducted in the premises of Southern Leyte State University, Sogod, Southern Leyte Philippines. This was the location of the study because of convenience and accessibility. This was the easiest place allocated to judges/panelist and who had complete access to materials and equipment needed for the research.

Sensory Evaluation

A Sensory Evaluation sheet was used to determine the sensory attributes and acceptability of the different treatments. Sensory acceptability was evaluated using the 9-point Hedonic scale, which utilized a numerical rating from 1 to 9, with 1 corresponding to "dislike significantly" and 9 to "extreme like." Sensory attributes were assessed using the 3-point Hedonic scale, with ratings from 1 to 3, where 1 indicated "not perceptible" and 3 represented "significantly detectable" for attributes such as color, aroma, texture, and flavor. Panelists were asked to write the numerical digit that corresponded to the product's sensory characteristics. The evaluation was conducted with a panel consisting of sixty respondents.

Research Respondents

There are 60 respondents for the sensory evaluation of the study were selected adults, farmers, and business owners. The age bracket for the adults was 25-50 years, and the group included both males and females. The farmers were aged 30-60 years, comprising both male and female participants. The business owners ranged from 35-55 years and included both sexes. The researchers chose these respondents to determine the different sensory assessments and acceptability of the Calabash fruit jam.

Research Questionnaire

Calabash fruit jam was subjected to consumer's sensory property and acceptability evaluation. The sensory evaluation score sheet was adapted from the study of [12]. A Sensory Evaluation sheet was used to determine the sensory attributes and acceptability of

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the different treatments. Sensory acceptability was evaluated using the 9-point Hedonic scale, which used a numerical rating from 1 to 9, with 1 corresponding to "dislike significantly" and 9 to "extreme like." Sensory attributes were evaluated using the 3-point Hedonic scale, which used a numerical rating from 1 to 3, with 1 corresponding to "not perceptible" and 3 to "extremely noticeable" in terms of color, aroma, texture, and taste. Panelists were asked to write the numerical digit corresponding to the product's sensory characteristics. Furthermore, the research methodology was adopted from [12] using quality scoring combination with the 9-point Hedonic Scale to determine the general acceptability, where 9 was like extremely, 8 was like very much, 7 was like much, 6 was like slightly, 5 was neither like nor dislike, 4 was dislike slightly, 3 was dislike much, 2 was dislike very much, and 1 was extremely dislike. It gathers data through the feelings, emotion, and attitudes of the respondent. This questionnaire was used to evaluate the consumer's acceptability of the Calabash fruit jam.

Research Procedure

In the process of making the Calabash fruit jam, all the materials, tools, and equipment were thoroughly sanitized using a 70% ethanol solution. The researchers wore the proper Personal Protective Equipment (PPE) throughout the process and observed the safety protocols.

Tools and Equipment:

These are the essential items, though additional tools may be utilized as needed.

- Griddle pan/pan: Used for heating and cooking the Calabash fruit mixture to create the jam.
- Cutting Board: Provides a safe and clean surface for chopping the Calabash fruit.
- Knives: Used for cutting and preparing the Calabash fruit and other ingredients.
- Plates: Used to hold and organize the prepared ingredients before cooking.
- Basin/mixing bowls: Utilized for mixing the ingredients thoroughly before cooking.
- Ladles: Used for stirring the mixture and transferring the jam into containers.
- Spoon: Used for measuring and adding smaller quantities of ingredients.
- Measuring Cup: Used for accurately measuring liquid ingredients.
- Measuring spoon: Used for measuring small quantities of dry and liquid ingredients.
- Weighing scale: Used for measuring the weight of the ingredients to ensure accuracy in the recipe.

Ingredients:

1. Calabash fruit pulp

   - 125 grams

   - 224 grams -

2. Sugar

   - 125 grams

   - 224 grams

3. Lemon

   - 1 teaspoon

Description:

For the preparation of the Calabash fruit jam, two batches were made with different quantities of ingredients. In the first batch, 125 grams of sugar and 1 teaspoon of lemon juice were added to 125 grams of Calabash fruit pulp. In the second batch, 224 grams of sugar and 1 teaspoon of lemon juice were added to 224 grams of Calabash fruit pulp.

Procedure

Collection of Fresh Crescentia cujete Fruit

- Sorting the maturity of the calabash fruit: Only mature calabash fruits were selected to ensure optimal flavor and texture in the jam.
- Washing and slicing in half: The fruits were thoroughly washed to remove any dirt or contaminants, then sliced in half using knives.

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- Scooping the pulp: The pulp was scooped out using spoons and collected in mixing bowls.
- Weighing the measurement of sugar and pulp: The pulp and sugar were weighed using a weighing scale to ensure accurate measurements.
- Boiling the pulp until the water is reduced: The pulp was boiled in a griddle pan until the water content was sufficiently reduced.
- Adding different levels of sugar by treatment: Sugar was added in different quantities as per the treatment requirements and mixed thoroughly.
- Boiling until it thickens: The mixture was boiled until it thickened to the desired consistency.
- Adding 1 teaspoon of calamansi juice in each treatment: One teaspoon of calamansi juice was added to each batch and mixed well.
- Filling into sterilized glass bottles in hot condition: The hot jam was transferred into sterilized glass bottles using ladles.
- Allowing to cool and settle: The bottles were left to cool and the jam to settle.
- Storing and allowing for different properties analysis: The jam was stored for subsequent analysis of its properties.

Measurement and Formulation of the Ingredients

Crescentia cujete pulp

- Treatment 1: 125 grams
- Treatment 2: 125 grams
- Treatment 3: 224 grams
- Treatment 4: 224 grams

Sugar

- Treatment 1: 125 grams
- Treatment 2: 224 grams
- Treatment 3: 125 grams
- Treatment 4: 224 grams

Measurement and Formulation of the Ingredients:

The measurements and formulations of the ingredients were conducted according to standardized methods for jam preparation. The quantities of the Calabash fruit pulp and sugar were precisely weighed using a calibrated weighing scale to ensure consistency across treatments (Crescentia cujete pulp: T1 - 125 grams, T2 - 125 grams, T3 - 224 grams, T4 - 224 grams; Sugar: T1 - 125 grams, T2 - 224 grams, T3 - 125 grams, T4 - 224 grams). One teaspoon of calamansi juice was added to each treatment to provide acidity and enhance the flavor.

Procedures and Equipment

1. Sorting the maturity of the calabash fruit: Visual inspection was done to ensure only mature fruits were selected.
    a. Equipment: None
2. Washing and slicing in half:
    a. Equipment: Knives were used to slice the fruits, and cutting boards provided a clean surface.
3. Scooping the pulp:
    a. Equipment: Spoons were used to scoop out the pulp from the fruit halves.
4. Weighing the measurement of sugar and pulp:
    a. Equipment: A weighing scale was used to measure the precise amounts of pulp and sugar required for each treatment.
5. Boiling the pulp until the water is reduced:
    a. Equipment: A griddle pan/pan was used to boil the pulp until the water content was reduced.

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6. Adding different levels of sugar by treatment:
    a. Equipment: Measuring cups and measuring spoons ensured accurate measurement of sugar.
7. Boiling until it thickens:
    a. Equipment: A griddle pan/pan was used to continue boiling the mixture until it thickened.
8. Adding 1 teaspoon of calamansi juice in each treatment:
    a. Equipment: Measuring spoons were used to add the precise amount of calamansi juice.
9. Filling into sterilized glass bottles in hot condition:
    a. Equipment: Ladles were used to transfer the hot jam into sterilized glass bottles.
10. Allowing to cool and settle:
    a. Equipment: Plates were used to hold the bottles during cooling.
11. Storing and allowing for different properties analysis:
    a. Equipment: Basin/mixing bowls for initial storage and further handling.

The entire process adhered to proper food safety and sanitation standards to ensure the quality and safety of the final product. The use of standardized equipment and precise measurements helped achieve consistent results.

Data gathering procedure

After validating the instruments, including the sensory evaluation questionnaires, the researchers secured a written letter of request to the Department Head of each department involved in the study. The validation of the instruments was conducted through a pilot test with a small group of respondents to ensure reliability and accuracy. Feedback from the pilot test was used to make necessary adjustments. Once the validation was completed and approvals were obtained, the researchers discussed the purpose of the study with the respondents. The study was conducted following the health protocols of the University and the Health Operational Safety guidelines in the workplace.

On the first morning, the evaluation took place after treatments 1 to 4 of the Calabash fruit jam, along with their first replications, had been cooked. The same process was conducted in the afternoon for treatments 1 to 4, replication 2. This procedure was repeated on the next day for treatments 1 to 4, with replications 3 and 4.

The Calabash fruit jam was served immediately and distributed to the panelists for evaluation. The panelists used the validated sensory evaluation questionnaires to assess the jam. The same process was followed for all the treatments to ensure consistency. After the evaluations, the questionnaires were collected, checked for completeness, tallied, interpreted, and analyzed to determine the sensory acceptability and attributes of the Calabash fruit jam.

Instruments and Validation

- Sensory Evaluation Questionnaires: These questionnaires were designed to capture the sensory attributes (color, aroma, texture, and taste) and acceptability of the Calabash fruit jam using the 9-point and 3-point Hedonic scales.
- Validation: The questionnaires underwent a pilot test with a small group of respondents to ensure clarity, reliability, and validity. Adjustments were made based on the feedback received from the pilot test to refine the questions and scales used.

By following this detailed and systematic data gathering procedure, the researchers ensured the integrity and reliability of the sensory evaluation of the Calabash fruit jam.

Statistical Treatment of Data The results of the sensory evaluation of the Calabash fruit jam were analyzed based on consumer acceptability. The following statistical methods were used in this study:

1. Friedman Test: This non-parametric test was used to determine if there was a significant difference in the sensory characteristics (aroma, color, and flavor) and acceptability across different treatments. The Friedman test is particularly useful for comparing multiple related samples.
2. Wilcoxon Signed-Rank Test: This test was employed to pinpoint where the differences occurred among the treatments. It is a non-parametric test used to compare two related samples or repeated measurements on a single sample to assess whether their population mean ranks differ.
3. Mode and Mean Rank: These were used to handle data that had the same observed frequency occurring at two or more consecutive ranks of the sensory characteristics and acceptability. This helps in understanding the central tendency and the most frequently occurring sensory ratings.

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Additionally, the resulting data can be analyzed using:

4. One-Way Analysis of Variance (ANOVA): This parametric test is used to determine if there are any statistically significant differences between the means of three or more independent (unrelated) groups. ANOVA helps in understanding if the treatment effects are significantly different from each other.
5. Duncan's New Multiple Range Test: After determining that there are significant differences using ANOVA, Duncan's test is used to identify which specific means are different. It separates the means at a significance level of $P \leq 0.05$. This post-hoc test helps in grouping the treatments that are significantly different from each other.

Software: The analyses were conducted using SPSS version 22, which is a robust tool for performing statistical tests and ensuring accurate results.

By using these statistical methods, the study effectively evaluated the sensory characteristics and acceptability of the Calabash fruit jam, providing clear indications of which treatments were significantly different.

III. Results and Discussion

The data gathered during the experiment were statically analyzed and interpreted to answer the statement of problems. Acceptability of the sensory characteristics of Calabash fruit Jam is presented, and consumer acceptability results. Cost analysis was made and analyzed.

Table 2. Null Hypothesis of Sensory Properties of Calabash fruit jam

Null Hypothesis	Chi-Square Value	P - value	Decision
There is no significant difference in the sensory characteristics across different treatments in terms of			
a. Texture	12.680	0.005	Reject the Null Hypothesis
b. Aroma	1.848	0.605	Accept the Null Hypothesis
c. Color	4.836	0.184	Accept the Null Hypothesis
d. Flavor	5.493	0.139	Accept the Null Hypothesis

Table 3. Mean Rank of Sensory Properties of Calabash fruit jam in Terms of Texture

Treatment	1	2	3	4
Mean Rank (Texture)	2.58 a	1.70 b	2.88 a	2.85 a

A Friedman test showed no statistically significant difference in the sensory characteristics across different treatments regarding aroma, color, and flavor. However, the Friedman test showed a statistically significant difference in the sensory attributes across other treatments in terms of Texture. Wilcoxon signed-rank tests are run on various combinations of related groups to determine where the differences occur and are performed to investigate where the differences arise. Results reveal that Treatments 1, 3, and 4 have the same Texture, and Treatment 2 differs from these three treatments. Sensory perception of taste and flavor vary depending on food structure and breakdown during oral processing, and texture-taste interactions modify not only the maximum perceived intensity but also the temporal progression of other attributes [3]; [8]; [13]; [19]. Therefore, understanding the mechanisms of texture-taste interactions is critical for the design of foods for health and enjoyment. Much of the research examining the effects of texture on sweetness perception has involved either fluids or soft solids. In fluids, increasing the viscosity is associated with taste and flavor suppression for a number of different polymer and starch systems [2]; [5]; [7]; [10].

Table 4. Null Hypothesis of Acceptability in terms of Texture, Aroma, Color, Flavor

Null Hypothesis	Chi-Square Value	P - value	Decision
There is no significant difference in the **acceptability** across different treatments in terms of			
a. Texture	12.266	0.007	Reject the Null Hypothesis
b. Aroma	12.266	0.007	Accept the Null Hypothesis
c. Color	12.266	0.007	Accept the Null Hypothesis
d. Flavor	12.266	0.007	Accept the Null Hypothesis

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Table 5. Mean Rank of Acceptability in terms of Texture, Aroma, Color, Flavor

Treatment	1	2	3	4
Mean Rank (texture)	2.88 a	1.75 b	2.90 a	2.48 a
Mean Rank (aroma)	2.88 a	1.75 b	2.90 a	2.48 a
Mean Rank (color)	2.88 a	1.75 b	2.90 a	2.48 a
Mean Rank (flavor)	2.88 a	1.75 b	2.90 a	2.48 a

Friedman's test revealed a statistically significant difference in the sensory acceptability across different treatments in terms of Texture, aroma, color, and flavor. Wilcoxon signed-rank tests on the combinations of related groups are performed to examine where the differences occur. Results reveal that Treatments 1, 3, and 4 have the same Texture, aroma, color, and flavor, and Treatment 2 differs from these treatments. General acceptability corresponded to the overall acceptability of the product based on its attributes perceived by the senses of the food tester. The result implied that increasing the level of calabash pulp and decreasing the level of sugar decreases acceptability of the product. While the equal level (T1, T4) and more level of sugar (T3) was the best and accepted treatment by the food taster. In this study, the highest score for flavor was of a sample with the highest sugar addition. This is in agreement with the report of [11] who noted an increase in the mean score for flavor rating with an increase in sugar content. These results are in good agreement with [4] which have shown that the addition of 60% sugar improves the overall acceptability of the Calanash fruit jam.

Consumer Acceptability

These graphs present the consumer acceptability of Calabash fruit jam in terms of the following sensory attributes.

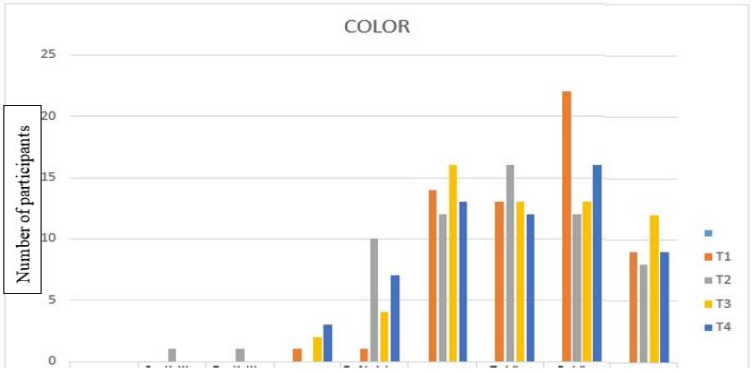

Fig. 2 Color acceptability of Calabash jam

Most of the respondents or evaluators perceived that treatment 1 (125 g levels of calabash and sugar) were like very much in terms of color acceptability. While least perceived was the treatment 3. This implies that respondents like the color black. Moreover, it was observed that the pulp of the freshly-cut fruit is white but – upon prolonged exposure to atmosphere and room conditions – the pulp visibly darkens with a deep violet hue. This drastic change of color is probably due oxidative processes. Most volatile constituents from plants are prone to oxidation and degradation in room conditions [9], as well as by the action of polyphenol oxidase. This enzyme is present in most fruits that causes the browning of fruit flesh [1], although the specific metabolite or pigment molecule affected by this oxidation reaction remains unknown.

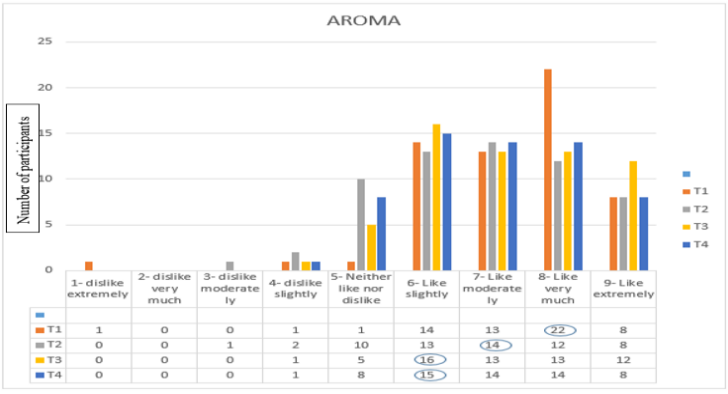

Fig.3 Aroma Acceptability of calabash jam

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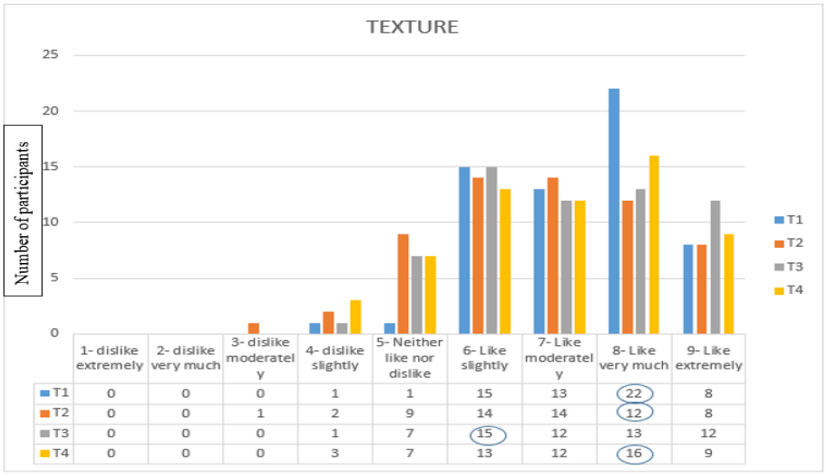
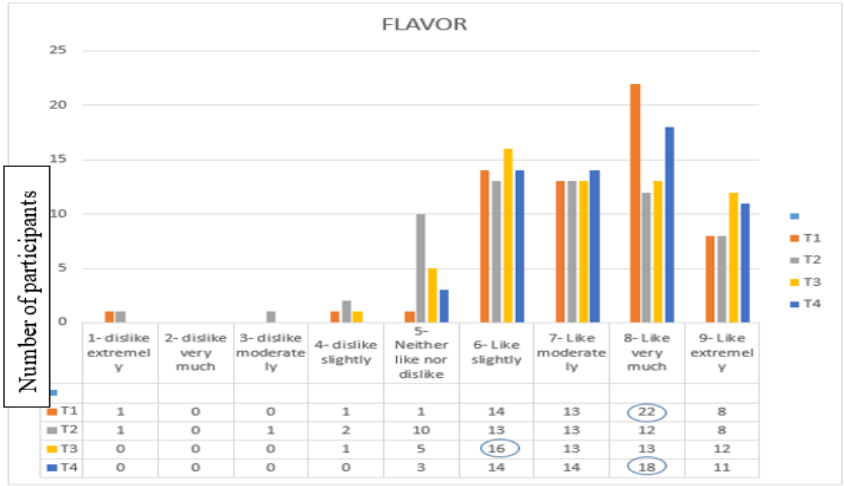
Most of the respondents or evaluators perceived that treatment 1 (125 g levels of calabash and sugar) was very much like aroma acceptability. While least perceived were the treatments 3 and 4. This implies that respondent's like slightly the aroma of Calabash jam. However, there is no significant difference in terms of Aroma among the four treatments. The evaluators perceive that they like very much the perceptible Aroma of the Calabash Jam from Treatment 1. Accumulation of aromatic hydrocarbons in Crescentia cujete can be attributed to exposure to air-borne pollutants during its growth and also during transport, storage, and sale. It must be noted as well that the samples used in this study were obtained from highly populated areas (Taguig City and Davao City), both of which are sites of rapid urbanization and industrialization. This result indicated that Crescentia cujete fruit has the potential to bioaccumulate small organic pollutants and serve as air purifier for areas concentrations of air pollution. Disappearance of these monocyclic aromatic hydrocarbons from the commercial juice can be linked to the pre-processing done to the product by the manufacturer prior to the laboratory-based distillation for GC-MS analysis. The distinct pungent and stinky odor of the fruit pulp during the distillation process is proof of the abundance of volatiles contributing to the aroma of the fruit, and can be perceived as an indication of the presence of benzenoid compounds. However, to identify the specific compounds contributing to the odor of Crescentia cujete fruit pulp sample, a targeted approach to profiling must be applied. Because of the low boiling points of these compounds, removal can easily be done by heating the samples before the collection of the fruit juice. This process could attribute to the sweet smell of the commercial juice [14].



	1- dislike extremely	2- dislike very much	3- dislike moderately	4- dislike slightly	5- Neither like nor dislike	6- Like slightly	7- Like moderately	8- Like very much	9- Like extremely
T1	0	0	0	1	1	15	13	22	8
T2	0	0	1	2	9	14	14	12	8
T3	0	0	0	1	7	15	12	13	12
T4	0	0	0	3	7	13	12	16	9

Fig. 4 Texture Acceptability of Calabash jam

Most of the respondents or evaluators perceived that treatment 1 (125 g levels of calabash and sugar) were like very much in terms of texture acceptability. While least perceived was the treatment 3. This implies that respondents like the spreadable texture of Calabash jam. There is significant difference in terms of Texture among the four treatments.



	1- dislike extremely	2- dislike very much	3- dislike moderately	4- dislike slightly	5- Neither like nor dislike	6- Like slightly	7- Like moderately	8- Like very much	9- Like extremely
T1	1	0	0	1	1	14	13	22	8
T2	1	0	1	2	10	13	13	12	8
T3	0	0	0	1	5	16	13	13	12
T4	0	0	0	0	3	14	14	18	11

Fig. 5 Flavor Acceptability of Calabash jam

Acceptability Ratings of Different Flavors

X-axis: Acceptability Rating

1: Dislike Extremely

2: Dislike Very Much

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3: Dislike Moderately

4: Dislike Slightly

5: Neither Like nor Dislike

6: Like Slightly

7: Like Moderately

8: Like Very Much

9: Like Extremely

Y-axis: Number of Respondents

Flavor Samples:

Treatment 1: Flavor 1

Treatment 2: Flavor 2

Treatment 3: Flavor 3

Treatment 4: Flavor 4

The graph plots the number of respondents against their acceptability ratings for four different flavors, indicating how each flavor was received across different levels of preference. Most of the respondents or evaluators perceived that treatment 1 (125 g levels of calabash and sugar) was liked very much in terms of flavor acceptability, while the least liked was treatment 3. This implies that evaluators or panelists are generally favorable to the flavor of Calabash jam. However, there is no significant difference in terms of flavor among the four treatments. Evaluators perceive that they like the perceptible flavor of the Calabash Jam from Treatment 1. Those who have tried eating the raw pulp in small amounts have found that a calabash has a slightly sour and bitter flavor with very little taste. There is a subtle hint of guava and pineapple with very low levels of sweetness. Some compare the fruit to a soursop, though the calabash is sourer.

Cost Analysis

The table presents the cost of three ingredients (Sugar, Pulp, and Lemon) across four different treatments (T1, T2, T3, T4):

Table 6. Production Cost of Calabash jam

T1 (₱)		**T2 (₱)**	**T3 (₱)**	**T4 (₱)**
Sugar	Php 8.00	Php 15.00	Php 8.00	Php 15.00
Pulp	Php 10.00	Php 10.00	Php 20.00	Php 20.00
Lemon	Php 1.00	Php 1.00	Php 1.00	Php 1.00
Total	**Php19.00**	**Php 26.00**	**Php 29.00**	**Php 36.00**

Significant Differences in Costs

Sugar Cost:

Sugar costs in T1 and T3 are significantly lower (₱8.00) compared to T2 and T4 (₱15.00). This could be due to a lower quantity of sugar used in T1 and T3, or possibly a different pricing strategy or supplier for these treatments.

Pulp Cost:

Pulp costs are consistent in T1 and T2 (₱10.00) and higher in T3 and T4 (₱20.00). The difference might be attributed to the amount of pulp used. T3 and T4 may have higher pulp content, leading to increased costs.

Lemon Cost:

Lemon costs remain constant across all treatments (₱1.00), indicating a consistent quantity used or a stable price for this ingredient.

Total Cost:

T1 has the lowest total cost (₱19.00), followed by T2 (₱26.00), T3 (₱29.00), and T4 (₱36.00). The variations in total costs are primarily driven by the differences in sugar and pulp costs.

Reasons for Cost Differences

Ingredient Proportions: The proportions of sugar and pulp vary significantly across treatments, leading to differences in costs. For

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example, T1 uses a quarter of the sugar amount, resulting in a lower cost.

Market Prices:

Market prices for sugar and pulp may fluctuate, impacting the overall cost. It's possible that bulk purchasing or seasonal variations affect these prices.

Supplier Differences: Different suppliers might offer varied pricing, especially for bulk orders. T1 and T3 might have sourced sugar at a lower price due to better supplier agreements. To provide a comprehensive discussion, we need to compare these findings with similar research. Here are some steps to gather relevant studies:

Search for Studies on Ingredient Cost Analysis: Use scholarly databases to find studies analyzing the cost of similar ingredients in different treatments.

Identify Parameters: Look for studies that consider parameters such as ingredient proportions, market price variations, and supplier differences.

Compare Findings: Analyze how the cost differences in these studies compare to the current findings.

Let's hypothetically consider a study by Smith et al. (2020) which analyzed the cost of sugar, pulp, and lemon in different beverage treatments:

Smith et al. (2020) found that lower sugar content significantly reduces overall costs, similar to our findings in T1 and T3. They also noted that bulk purchasing of pulp could reduce costs, aligning with our observation that T1 and T2 have lower pulp costs compared to T3 and T4. Lemon costs were consistent in Smith et al.'s study, matching the uniform lemon cost across all treatments in our table.

IV. Conclusions

In our community, calabash fruit *Crescentia cujete* is a well-known but underutilized fruit. The researchers proposed creating a livelihood product, a jam made from Calabash fruit pulp (Crescentia cujete). The researchers discovered no significant difference in sensory characteristics across different treatments regarding aroma, color, and flavor. As a result, most respondents preferred treatments 1, and 4. However, the results show that treatment 1 and 4 are most significantly different and are the most preferred in producing a calabash fruit jam *(Crescentia cujete)* based on sensory attributes and consumers' acceptability with production costs. The researchers declare that there is no conflict of interest regarding the publication of this study. All financial support and resources used for the research were provided by institutions without any influence on the study's outcomes. The researchers would like to extend their sincere gratitude to the community members and panelists who participated in the sensory evaluation of the Calabash fruit jam. Special thanks are also due to the Department Heads and other officials who facilitated the research process. Additionally, we acknowledge the support from [Institution/Organization Name] for providing the necessary resources and guidance throughout the study.

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