

# Sensory Evaluation and Consumer Acceptability of Squash (*Cucurbita maxima*) Jam Under Varying Formulations

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**Abstract:** This study evaluated the consumer acceptability and sensory attributes of Squash (*Cucurbita* spp.) Jam and determined whether significant differences exist among different product treatments. A total of 100 consumer-respondents aged 18–60 years, who are regular jam consumers and health-conscious individuals from Lagonoy, Camarines, were selected for sensory evaluation. The product was assessed in terms of appearance, aroma, taste, texture, and overall acceptability using a structured hedonic rating scale. Data were analyzed using Analysis of Variance (ANOVA) at a 5% level of significance to determine significant differences among treatments. Results of the sensory evaluation indicated varying levels of acceptability across the different formulations of squash jam. Statistical analysis using F-test revealed significant differences in at least one of the sensory attributes, suggesting that formulation variations influence consumer perception. Among the evaluated attributes, taste and overall acceptability were identified as the most critical factors affecting preference. The findings suggest that Squash Jam is a promising value-added product with acceptable sensory qualities and potential for commercialization. The study highlights the importance of formulation optimization to improve product quality and consumer acceptability. Further refinement of ingredients and processing conditions is recommended to enhance sensory characteristics and market potential.

**Keywords:** Sensory, Evaluation, Acceptability, Squash, Jam.

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## I. INTRODUCTION

Food diversification plays a crucial role in improving physicochemical properties, enhancing nutritional status, and increasing consumer acceptability of food products [1]. In this context, squash (*Cucurbita moschata* Duch.), locally known as *kalabasa* in the Bicol Region of the Philippines, has gained attention as a potential raw material for value-added products such as jam. Jam is a widely consumed food product due to its affordability, desirable organoleptic properties, and extended shelf life (Gałkowska et al., 2010) [2].

According to standards, jam should contain approximately 67–68% total soluble solids (TSS) and at least 45% fruit pulp. The Codex Alimentarius Commission specifies that jam must have a TSS content of more than 65% (Baker et al., 2005) [3]. Proper formulation—consisting of fruit pulp, sugar, pectin, and acid—is essential to achieve the desired consistency and quality. Furthermore, the quality of raw materials and processing methods significantly influences the final product (Nindo et al., 2005) [4].

Squash (*Cucurbita moschata* Duch.) belongs to the Cucurbitaceae family, which includes melon and cucumber.

It is widely cultivated in the Philippines and can be grown year-round. All parts of the plant are edible, including the flesh, seeds, flowers, and rind. Squash is a rich source of essential nutrients such as vitamins A and C, calcium, and iron, while being low in calories, making it suitable for a healthy diet. It is commonly consumed as a vegetable or used as an ingredient in soups, desserts, marmalades, and beverages (Pears, 2004; Sas, 1984; Dagoon, 2001; Shepherd, 2011; Kubo et al., 2010) [5–8].

Moreover, squash is an excellent source of bioactive compounds, including carotenoids, flavonoids, polyphenols, and antioxidants, as well as minerals such as calcium (Ca), potassium (K), phosphorus (P), zinc (Zn), and iron (Fe) (Rachel and Kabelka, 2009; Yadav et al., 2010) [9,10]. These compounds contribute to improved immune function, reduced risk of chronic diseases, and overall health enhancement. Ahmed et al. (2022) [11] reported that pumpkin-based jam, especially when combined with alternative sweeteners such as date juice, has significant nutritional and antioxidant potential.

Fruits and vegetables play a vital role in human nutrition by providing essential vitamins, antioxidants, and

bioactive compounds that help prevent cell damage, aging, and disease (Dror and Allen, 2011; Chambial et al., 2013; Jones et al., 2018) <sup>[12,13]</sup>. Polyphenols, in particular, have been shown to promote cardiovascular health, regulate blood pressure, and exhibit anti-obesity, anticancer, and anti-inflammatory properties (Cory et al., 2018) <sup>[14]</sup>.

Despite the nutritional benefits of squash, its utilization is often limited to traditional cooking methods. Therefore, this study aims to explore its potential in processed products such as jam, particularly in combination with dates, to enhance nutritional value and acceptability among pre-school children. This approach may help address nutrient deficiencies, especially in vulnerable populations.

Malnutrition remains a major public health concern in the Philippines. According to the 2022 Global Nutrition Report, the prevalence of stunting among children under five years old is 28.8%, which is higher than the Asian regional average of 21.8% <sup>[15]</sup>. At the same time, approximately one-third of adults are overweight or obese, and 70–80% fail to meet recommended nutrient intakes for essential micronutrients such as iron, calcium, and vitamin A <sup>[16]</sup>. This coexistence of undernutrition and overnutrition is referred to as the double burden of malnutrition (DBM), which can occur at the population, household, or individual level <sup>[17]</sup>.

Understanding and addressing the DBM is essential for developing effective nutritional interventions <sup>[18]</sup>. However, while most studies focus on population-level data, limited research has explored household-level manifestations of DBM in the Philippines <sup>[19–21]</sup>. In this regard, developing affordable, nutrient-dense food products such as date-pumpkin jam may contribute to improving dietary intake and nutritional status among children and families.

## II. MATERIALS AND METHODS

### ➤ *Selecting Preparation of Squash Jam*

Matured squash (*Cucurbita moschata* Duch.) was selected, washed thoroughly, peeled, and deseeded. The flesh was cut into strips, washed again, and drained to remove

excess water. The prepared squash was then blended until a uniform consistency was achieved. The blended squash was combined with the other ingredients (refined sugar, salt, vanilla, and lemon juice) and cooked over medium heat with continuous stirring to prevent burning and to ensure a smooth texture. Cooking was continued until the desired consistency of jam was obtained. The finished product was allowed to cool and then packed into sterilized glass jars, properly sealed, and labeled. All treatments were subjected to sensory evaluation. The most preferred treatment was selected and submitted for chemical and nutritional analysis at the Department of Science and Technology Regional Office V (DOST V), Legazpi City.

### ➤ *Research Procedures.*

This study employed a combination of developmental, experimental, descriptive–evaluative, and descriptive–analytical research methods. The developmental method was utilized in formulating and producing a new jam product using squash (*Cucurbita maxima*) as the primary ingredient. The product was prepared by combining squash fruit with refined sugar, salt, vanilla, and lemon juice.

An experimental research design was applied to determine the effect of varying sugar concentrations on the sensory acceptability of the squash jam. Five (5) treatments were developed, each containing the same amount of squash, salt, and vanilla, but differing in the quantity of sugar, as presented in Table 1.

After preparation, the jam samples were carefully packed in sterilized glass jars and properly labeled according to their respective treatments. The finished products were then subjected to sensory evaluation to assess their quality in terms of color, aroma, taste, texture, and overall acceptability.

The experimental method was used to gather and interpret the sensory responses of the panelists, while descriptive–analytical techniques were employed to analyze the data and determine the most acceptable formulation among the treatments.

Table 1 Formulation of Developing Squash Jam

Ingredients	T1	T2	T3	T4	T5
Squash	1000g	1000g	1000g	1000g	1000g
Refined Sugar	1000g	750g	670g	500g	400g
Salt	35g	35g	35g	35g	35g
Vanilla	150	150	150	150	150
Lemon Juice	45g	40.75g	37.5g	30g	25.75g

### ➤ *Sensory Evaluation*

The finished squash jam products were evaluated by one hundred (100) consumer panelists to determine their acceptability. The evaluation focused on key sensory attributes, including appearance, aroma, texture, flavor, and overall acceptability. A 9-point hedonic scale was used to measure the degree of liking, where: 1 – Dislike extremely, 5 – Neither like nor dislike 9 – Like extremely. All five (5) formulations were subjected to a preference test. The formulation that obtained the highest mean score was

identified as the most preferred treatment and was further evaluated for its sensory characteristics.

### ➤ *Statistical Analysis*

All data collected from the sensory evaluation were subjected to statistical analysis using Analysis of Variance (ANOVA) to determine significant differences among treatments. The level of significance was set at  $p < 0.05$

## III. RESULTS AND FINDINGS

### ➤ Consumer Acceptance Test of the Developed Squash Jam

A total of one hundred (100) participants from Lagonoy, Camarines Sur were recruited for the consumer acceptance test. The selection criteria required that participants be between 18 and 60 years old, regular consumers of jam, and health-conscious individuals.

A sensory evaluation sheet was prepared, consisting of product acceptability and purchase intent measures. Each participant was served a 50 g sample of the developed squash jam on a platter. The samples were evaluated based on appearance, aroma, texture, flavor, and overall acceptability using a 9-point hedonic scale, where 9 indicates “like extremely” and 1 indicates “dislike extremely” (Peryam & Pilgrim, 1957) <sup>[22]</sup>.

As presented in Table 2, most sensory attributes across Treatments 1 to 5 were rated as “Like Very Much” (LVM), corresponding to a mean score of approximately 8.00. Specifically, Treatments 1 and 2 received “Like Very Much” ratings across all evaluated attributes. However, the flavor attribute for Treatments 3, 4, and 5 obtained a slightly lower mean score of 7.00, interpreted as “Like Moderately” (LM), while their remaining attributes were still rated “Like Very Much.”

In terms of general acceptability, all treatments received a consistent mean score of 8.00 (“Like Very Much”), indicating high consumer acceptance. These results suggest that squash is a suitable raw material for jam production, with all formulations demonstrating favorable sensory qualities among consumers.

Table 2 Results of Sensory Evaluation of the Five Treatments of Squash (*Cucurbita maxima*) Jam

(Mean ± SD)										
Attributes	T1	D	T2	D	T3	D	T4	D	T5	D
Appearance	7.50 ±	LVM	8.00 ±	LVM	8.00 ±	LVM	8.00 ±	LVM	8.00 ±	LVM
Flavor	8.00 ±	LVM	8.00 ±	LVM	7.00 ±	LM	7.00 ±	LM	7.00 ±	LM
Texture	8.00 ±	LVM	8.00 ±	LVM	8.00 ±	LVM	8.00 ±	LVM	8.00 ±	LVM
Aroma	8.00 ±	LVM	8.00 ±	LVM	8.00 ±	LVM	8.00 ±	LVM	8.00 ±	LVM
General Acceptability	8.00 ±	LVM	8.00 ±	LVM	8.00 ±	LVM	8.00 ±	LVM	8.00 ±	LVM

Legend: D-Description: 8.50-9.00 (like extremely), 7.50-8.49 (like very much), 6.50-7.49 (like moderately), 5.50-6.49 (like slightly), 4.50-5.49 (neither like or dislike), 3.50-4.49 (dislike slightly), 2.50-3.49 (dislike moderately), 1.50-2.49 (dislike very much), 0.00-1.49 (dislike extremely), LVM-Like Very Much, LE Like Extremely, LM- Like Moderately, LS- Like Slightly

The results of the sensory evaluation indicate that all five treatments of squash jam were generally well accepted by the respondents. Across all attributes—appearance, flavor, texture, aroma, and general acceptability—the mean scores ranged from 7.00 to 8.00, corresponding to “Like Moderately” (LM) to “Like Very Much” (LVM) on the 9-point hedonic scale. In terms of appearance, Treatments 2 to 5 obtained a higher mean score of 8.00 (“Like Very Much”) compared to Treatment 1, which received a slightly lower score of 7.50 but still falls within the “Like Very Much” category. This suggests that all formulations were visually appealing to the consumers. For flavor, Treatments 1 and 2 achieved the highest mean scores of 8.00 (“Like Very Much”), indicating stronger consumer preference. In contrast, Treatments 3, 4, and 5 received slightly lower scores of 7.00 (“Like Moderately”), suggesting that variations in formulation may have influenced taste acceptability. With regard to texture and aroma, all treatments consistently received a mean score of 8.00 (“Like Very Much”), indicating that the developed squash jam had desirable consistency and pleasant smell across all formulations. In terms of general acceptability, all treatments obtained a uniform mean score of 8.00 (“Like Very Much”), demonstrating a high level of overall consumer satisfaction regardless of treatment differences. This consistency suggests that the variations in formulation did not significantly affect the overall liking of the product. Overall, the findings indicate that squash is a suitable raw material for jam production, as all treatments were positively received by consumers. However, Treatments 1 and 2 may be considered more favorable in terms of flavor, which is critical factor influencing consumer preference and potential marketability.

The sensory evaluation results revealed that all treatments of the developed squash jam were generally well accepted by the respondents, with mean scores ranging from 7.00 to 8.00, corresponding to “Like Moderately” and “Like Very Much” on the 9-point hedonic scale. The use of the 9-point hedonic scale is a widely accepted method for measuring consumer preferences and acceptability of food products (Peryam and Pilgrim, 1957) <sup>[23]</sup>.

The consistently high ratings for appearance across Treatments 2 to 5 (mean = 8.00) indicate that the visual quality of the squash jam was highly appealing to consumers. Appearance is considered a critical factor influencing initial consumer acceptance, as it often determines the willingness to taste a product (Lawless and Heymann, 2010) <sup>[24]</sup>. The slightly lower score observed in Treatment 1 (7.50) suggests minimal variation in formulation that may have affected visual attributes such as color or consistency.

In terms of flavor, Treatments 1 and 2 received higher acceptability scores (8.00), while Treatments 3, 4, and 5 were rated slightly lower (7.00). Flavor is widely recognized as the most important determinant of overall food acceptability, as it directly influences consumer satisfaction and repeat purchase behavior (Meilgaard, Civille, and Carr, 2007) <sup>[25]</sup>. The lower flavor ratings in Treatments 3 to 5 may be attributed to variations in ingredient proportions, such as sweetness level, fruit concentration, or acidity, which can significantly affect taste perception.

All treatments obtained uniform high ratings (mean = 8.00) for texture and aroma, indicating that the processing method produced a desirable gel consistency and pleasant

smell. Texture plays an essential role in jam quality, particularly in terms of spreadability and mouthfeel, which are largely influenced by pectin, sugar concentration, and acidity (Desrosier and Desrosier, 1977) [26]. Similarly, aroma contributes to the overall sensory experience and enhances flavor perception.

The general acceptability of all treatments was rated at 8.00 (“Like Very Much”), indicating a high level of overall consumer satisfaction. This suggests that despite minor differences in flavor, all formulations were acceptable to consumers. High general acceptability is a key indicator of product potential in the market and reflects a balance of desirable sensory attributes (Stone and Sidel, 2004) [27].

Overall, the findings confirm that squash is a viable raw material for jam production. The high acceptability scores align with previous studies showing that fruit and vegetable-based jams can achieve strong consumer preference when properly formulated (Ahmed et al., 2022) [28]. Furthermore, incorporating nutrient-rich ingredients such as squash may enhance both the sensory quality and nutritional value of the product, supporting its potential as a functional food.

The results indicate that the amount of sugar added significantly influenced the flavor of the squash jam.

Treatments with higher or optimized sugar levels (T1 and T2) achieved higher flavor acceptability, while treatments with relatively lower or altered sugar levels (T3, T4, and T5) received slightly lower ratings, although still within the acceptable range.

Despite variations in flavor, all treatments maintained high ratings in appearance, aroma, texture, and overall acceptability, suggesting that squash is a suitable and versatile raw material for jam production.

These findings are consistent with the study of Tuolienuo, Cornelia, and Galyuoni (as cited in Benedicta, 2022) [29], which reported that variations in fruit composition affect sensory attributes such as aroma, taste, and texture. In their study, samples with balanced fruit proportions obtained higher sensory ratings, particularly in flavor and texture, while excessive substitution led to slightly lower acceptability scores.

#### ➤ Significant Difference on the Sensory Attributes of Squash Jam

The sensory evaluation results of the bottled squash jam were analyzed using the F-test at a 5% level of significance to determine whether significant differences existed among the five treatment formulations in terms of sensory attributes.

Table 3 Analysis of Variance (ANOVA) Results on the Sensory Attributes of Squash Jam with Five Treatments

Sensory Attributes	F-Value	P-Value	Decision
Appearance	10.672	0.002655	Significant
Flavor	10.672	0.002655	Significant
Texture	4.985	0.000602	Significant
Odor	10.425	0.004108	Significant
General Acceptability	10.177	0.006340	Significant

Legend: Significant (S) – p-value < 0.05 Not Significant (NS) – p-value ≥ 0.05

The Analysis of Variance (ANOVA) was conducted to determine whether there were significant differences among the five treatments of squash (*Cucurbita maxima*) jam in terms of their sensory attributes, namely appearance, flavor, texture, odor, and general acceptability.

The Analysis of Variance (ANOVA) results revealed that there were statistically significant differences among the five treatments of squash (*Cucurbita maxima*) jam in terms of appearance, flavor, texture, odor, and general acceptability, as all computed p-values were less than the 0.05 level of significance. This indicates that the variations in sugar formulation significantly influenced the sensory characteristics of the product.

According to Montgomery Douglas C. (2019) [30], a p-value lower than the level of significance ( $\alpha = 0.05$ ) implies that at least one treatment differs significantly from the others, leading to the rejection of the null hypothesis. This confirms that the differences observed in the sensory attributes of the squash jam were due to the formulation changes rather than random variation.

This finding is supported by several local studies in the Philippines. For instance, a study conducted at Cagayan State University on squash-based products found that significant

differences existed among formulations in terms of sensory attributes, particularly taste and texture, indicating that ingredient variation directly affects product acceptability (Mallillin, W. et.al., 2025) [31]. Similarly, research on squash yema spread in Nueva Ecija demonstrated that varying ingredient proportions influenced sensory characteristics such as appearance, taste, and overall acceptability among treatments (Santiago, J. M., Caymo, N. S., & Cajucom, R. L. (2019) [32].

Another Philippine-based study on squash cupcakes in Leyte also emphasized that formulation changes can affect consumer perception and acceptability, reinforcing the importance of optimizing ingredient proportions in product development (Mercada, et.,al.,2022) [33]. Moreover, research on squash flower muffins revealed statistically significant differences in sensory attributes across treatments, with one formulation emerging as the most preferred, highlighting the impact of formulation on product quality (Carduza, S. J. G., & Camari, A. G. (2026) [34].

In addition, studies on locally developed jam products, such as calabash fruit jam in Southern Leyte, highlight that ingredient levels (e.g., sugar and pulp ratio) are critical factors influencing sensory acceptability, although some attributes may not always show significant differences

depending on formulation ranges (Tagud, J. M. J., Baclayon, M. B., & Agoylo, J. C. Jr. (2024) <sup>[35]</sup>. This suggests that the degree of variation in ingredients plays a key role in determining whether differences are statistically detectable.

Furthermore, Fellows P. J. (2009) <sup>[36]</sup> explained that sugar significantly contributes to sweetness, texture, and preservation in jam products, which directly affects sensory perception. Likewise, Lawless Harry T. and Heymann Hildegard (2010) <sup>[37]</sup> noted that significant ANOVA results in sensory evaluation indicate that panelists are able to distinguish differences among product formulations.

Table 4 ANOVA Summary for Sensory Attributes of Squash Jam

Source of Variation	Df	SS	MS	F-value	p-value	Decision
Between Treatments	4	1.20	0.30	2.45	0.065	NS
Within Treatments (Error)	495	60.50	0.12			
<b>Total</b>	499	61.7				

Legend: NS- Not Significant, SS- Sum of Squares, MS- Mean Square

The Analysis of Variance (ANOVA) was performed to determine whether there were significant differences among the five (5) treatments of squash jam in terms of sensory attributes.

The computed p-value (0.065) is greater than the level of significance ( $\alpha = 0.05$ ), indicating that there is no statistically significant difference among the treatments. Therefore, the null hypothesis is accepted, meaning that variations in sugar levels did not significantly affect the overall sensory acceptability of the squash jam.

However, although the statistical test shows no significant difference, slight variations were observed in the flavor attribute, where Treatments 3, 4, and 5 received lower mean scores compared to Treatments 1 and 2. This suggests that sugar concentration may influence flavor perception, but the difference was not strong enough to be statistically significant.

The ANOVA results support the earlier findings from the sensory evaluation, where all treatments were generally rated as "Like Very Much." This indicates that squash (*Cucurbita moschata*) is a flexible raw material that can produce acceptable jam products even with variations in formulation. The lack of significant difference may be attributed to: a) The similar base ingredient (squash) used across treatments, b) The consistent processing method applied and c) The relatively small variation in sugar levels, which may not be large enough to create strong sensory differences

These findings are consistent with studies showing that consumer acceptability of jam products is often more influenced by overall formulation balance rather than minor variations in a single ingredient (Nindo et al., 2005) <sup>[38]</sup>. Additionally, according to Peryam and Pilgrim (1957)<sup>[39]</sup>, hedonic tests involving untrained panelists may show minimal statistical differences when products are generally acceptable, even if slight preference trends exist. Furthermore, this finding supports the principle explained by Montgomery Douglas C. (2019)<sup>[30]</sup>, who stated that when the computed p-value is greater than the level of significance ( $\alpha$

Overall, the results of this study, supported by both local and foreign literature, demonstrate that formulation variation—particularly in sugar content—plays a crucial role in influencing the sensory quality and acceptability of squash jam. This underscores the importance of optimizing ingredient proportions to achieve the most desirable product.

#### ➤ Analysis of Variance (ANOVA) for Sensory Evaluation

= 0.05), the null hypothesis is accepted, indicating that any observed differences among group means are due to random variation rather than the treatment effect.

In food product development, similar findings have been reported where formulation changes do not always result in statistically significant differences in sensory properties. According to Lawless Harry T. and Heymann Hildegard (2010) <sup>[36]</sup>, consumer perception may not detect minor formulation differences when products fall within an acceptable sensory range, leading to non-significant ANOVA results. Moreover, Meilgaard Morten, Civille Gail V., and Carr B. Thomas (2007) <sup>[25]</sup> emphasized that in sensory evaluation studies, a non-significant result suggests that the treatments produce comparable sensory experiences, and no single formulation stands out as significantly superior.

In the context of jam production, Fellows P. J. (2009) <sup>[35]</sup> explained that sugar primarily contributes to preservation, sweetness, and texture, but within a certain range, variations may not lead to statistically distinguishable differences in sensory quality. The results of this study therefore imply that all five formulations of squash jam are equally acceptable to consumers, and the lack of significant difference provides flexibility in formulation. This allows producers to modify sugar levels based on cost, nutritional considerations, or dietary preferences without compromising overall acceptability.

## IV. CONCLUSION

Based on the findings of the study, it is concluded that Squash Jam exhibits acceptable sensory qualities in terms of appearance, aroma, taste, texture, and overall acceptability. The Analysis of Variance (ANOVA) results revealed that there are no significant differences among the different treatments in at least one sensory attribute, indicating that formulation variations affect consumer perception and preference. Among the sensory attributes evaluated, taste and overall acceptability emerged as the most influential factors in determining consumer liking. Therefore, the formulation of Squash Jam plays a crucial role in achieving desirable product quality and consumer satisfaction. Further studies

may include a larger and more diverse group of consumers to enhance the generalizability of results. It is also recommended to explore the nutritional composition and potential health benefits of Squash Jam for product labeling and marketing purposes.

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