A Detailed Sensory Assessment and Quality Evaluation of Hard Candy Infused with Calamansi (*Citrus microcarpa*) Leaf Extract: Exploring Its Potential as a Natural Flavoring and Functional Ingredient in Confectionery Products

Joanne P. Golocino[1*], Princess M. Dagongdong[2], Alyssa Fate A. Panganiban[3] & Leenald M. Resma[4]

[1]Research Adviser/Teacher, Department of Education, Division of Southern Leyte, Lungsodaan National High School, Lungsodaan, Hinundayan, Southern Leyte, 6609, Philippines. [2,3,4]Student, Department of Education, Division of Southern Leyte, Lungsodaan National High School, Lungsodaan, Hinundayan, Southern Leyte, 6609, Philippines. Corresponding Author (Joanne P. Golocino) Email: jgolocino4@gmail.com[*]

ABSTRACT

The study was a determination of the sensory qualities of candy formulated from calamansi (*Citrus macrocarpa*) leaves in terms of taste, texture, appearance, color, and aroma. It sought to produce and introduce an innovative and eco-friendly product by utilizing the flavor of calamansi leaves in candy-making. A descriptive-experimental research method, which is measured through a structured five-point Likert scale, was employed to the 100 respondents: 100 students and 10 teachers of Lungsodaan National High School who assessed four various formulation of the candies, namely: (1) 100g of sugar, (2) 200 gram of sugar, (3) 100g of sugar with cornstarch and food color, and (4) 200g of sugar with cornstarch and food color. The statistical evaluation involved analyzing the data with basic descriptive measures – mean and standard deviation - followed by one-way ANOVA (Analysis of Variance) and post-hoc comparison. ANOVA indicated strong statistical significance for the taste and texture overall ratings, with classroom teacher panels showing the clearest differentiation of means. In addition, the analysis identified the combination of cornstarch, added coloring, and elevated sugar level as key discarded, can indeed serve as an acceptable flavoring for confectionery applications. The outcomes encourage larger-scale trials to optimize ingredient ratios and highlight a clear market gap for distinctive, regionally manufactured sweets, thus inviting both academic and entrepreneurial follow-up.

Keywords: Calamansi Leaves; Candy; Sensory Evaluation; Food Innovation; Sweet Confectionary; Acceptability; Taste; Appearance; Aroma.
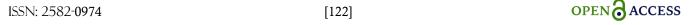
1.0. Introduction

Calamansi, is a small sour fruit that flourishes from the Philippines to Thailand and is cherished for its tangy zest and impressive range of health benefits. Kitchen and café alike frequently feature the juice, adding a fresh punch to marinades, sauces, and thirst-quenching beverages. Beyond the fruit, the glossy leaves contain a notable concentration of essential oils (Palma et al., 2019; Husni & Yeni, 2021; Mahajan, 2023) that carry a citrusy aroma prized in both flavoring and natural remedies (Cheong et al., 2012; Sujiwo et al., 2025).

Research by Nguyen et al. (2018) highlights the vitamins, minerals, and aroma compounds that give the leaves both gastronomic and pharmaceutical benefits. Their tang not only lifts dishes but is also credited with supporting the immune system and nurturing the complexion, due in part to the vitamin C they harbor.

Supporting this, Lim & Tan (2021) show that a steam-distilled essential oil from the leaves finds a place in traditional medicine for easing bronchial congestion, making calamansi a fruit multitasker in the garden and kitchen. Incorporating calamansi leaves into product innovations like tea, jam, or candies could create a unique selling point. This approach would also cater to the increasing consumer interest in natural and health-oriented flavorings.

The study evaluated the taste, texture, appearance, color, and aroma of candies flavored with calamansi leaves. By testing four formulations, the study created a new product that highlights the unique benefits of calamansi leaves while remaining palatable. The goal is to find out whether the teachers and students at Lungsodaan National High School will enjoy this new candy.

1.1. Study Objectives

1) To determine the overall sensory acceptability of hard candy infused with calamansi leaf extract.

2) To evaluate the influence of varying sugar concentrations and the inclusion of cornstarch and food color on sensory attributes.

3) To identify the formulation preferred based on taste, texture, appearance, color, and aroma.

4) To assess the potential of calamansi leaves as functional, natural flavoring ingredient for candies.

5) To promote sustainable innovation through value-added use of underutilized plant parts.

6) To provide insights for scaling up calamansi-leaf-infused candies for commercial production.

2.0. Methods

2.1. Research Design

Descriptive and experimental quantitative research designs were used in this study. The descriptive approach was used to collect and examine the candy's sensory qualities, such as taste, texture, aroma, and appearance, through a taste test. This stage was crucial to comprehending customer preferences. Using the experimental design, four different formulations' ingredient quantities were systematically changed to see how the final product's sensory attributes were impacted. The goal was to find the best ingredient balance for market readiness.

2.2. Research Participants and Sampling Technique

Ten teachers and one hundred students made up the study's respondents. Purposive sampling was utilized for the teachers, and a systematic sampling technique was utilized to choose the students, guaranteeing impartial representation from Grades 7 through 12. Using a technique called purposeful sampling, participants are selected according to traits that support the goals of the study. In this study, a purposive sampling technique was applied. This sampling strategy relies on the researcher's judgment about the respondents' suitability for the study instead of probability calculation methods (Nikolopoulou, 2022). In this case, because the study focused on the sensory evaluation of candies made from calamansi leaves, teachers with the expertise to provide accurate and insightful feedback were selected.

2.3. Research Instrument

The researchers used a structured five-point Likert scale. The researchers used this kind of research tool because it is more relevant to the study, which aims to sensory evaluate the candy flavored with calamansi leaves. The research instrument's scores and descriptions indicate that five (5) means "Like Very Much," four (4) means "Like Moderately," three (3) means "Like Slightly," two (2) means "Disliked," and one (1) means "Disliked Very Much."

2.4. Data Analysis

This study employed descriptive analysis, one-way ANOVA, and a post hoc test to analyze the respondents' ratings of the different Calamansi Leaves Flavored Candy formulations. The descriptive analysis will summarize student and teacher feedback on aspects like taste, texture, appearance, color, and aroma. By examining average ratings and the frequency of responses, the researchers will identify general trends in consumer preferences. This step is

important for understanding the overall sensory evaluation of the candy. Next, the one-way ANOVA will help to identify if there are statistically significant differences between the various candy formulations. For example, it will assist in finding out whether changing the recipe's calamansi leaf content leads to visible changes in customer satisfaction. The ANOVA test will provide a greater understanding of which variation has an impact on the consumers. If it shows significant differences where $p<0.05$, the post hoc test will be accomplished in comparing the formulations. This analysis will highlight which recipes stand out and why, and the post hoc test will specifically identify the exact changes that make a version more popular if it is significantly favored. By using these techniques, the researchers aim to grasp consumer preferences and improve the recipe. This will help ensure that the final product meets customer satisfaction.

3.0. Results and Discussion

This section presents and discusses the results of the calamansi leaves flavored candy sensory evaluation, based on the ratings from the teachers and students. The findings from the descriptive and inferential statistical analyses help us understand teachers' and students' preferences and the impact of formulation changes on their perceptions.

Table 1. Students' Acceptability of the Taste of Calamansi Leaves-Flavored Candy

Candy Formulation	Mean	Standard Deviation	Description
100 grams of sugar	4.4	0.99	*Liked Very Much*
200 grams of sugar	4.4	0.99	*Liked Very Much*
100 grams of sugar, cornstarch, and food color	4.0	0.55	*Like Moderately*
200 grams of sugar, cornstarch, and food color	4.4	0.99	*Liked Very Much*

Legend: Liked Very Much – between 4.3 and 5.0; Like Moderately – between 3.5 and 4.2; Liked Slightly – between 2.7 and 3.4; Disliked – between1.9 and 2.6; and Disliked Very Much – between 1.0 and 1.8

Three out of the four formulations, 100g of sugar, 200g of sugar, and 200g of sugar with cornstarch and food color, achieved a mean rating of 4.4, indicating a high level of agreement among participants regarding the taste quality of these formulations of calamansi leaves-flavored candy. A constant degree of variation in taste ratings is indicated by the identical standard deviation of 0.99 for these three formulations. The slightly lower standard deviation of 0.55 for the 100g sugar with cornstarch and food color formulation indicates that respondents' perceptions of its flavor were marginally more consistent than those of the other formulations. Overall, the data show that respondents strongly agreed across samples and rated all formulations favorably for taste.

Table 2. Students' Acceptability of the Appearance of Calamansi Leaves-Flavored Candy

Candy Formulation	Mean	Standard Deviation	Description
100 grams of sugar	4.2	0.69	*Like Moderately*
200 grams of sugar	4.1	0.70	*Like Moderately*
100 grams of sugar, cornstarch, and food color	3.8	0.47	*Like Moderately*
200 grams of sugar, cornstarch, and food color	4.0	0.62	*Like Moderately*

Legend: Liked Very Much – between 4.3 and 5.0; Like Moderately – between 3.5 and 4.2; Liked Slightly – between 2.7 and 3.4; Disliked – between 1.9 and 2.6; and Disliked Very Much – between 1.0 and 1.8

The 100-gram sugar formulation received the highest mean rating of 4.2, making it the most visually appealing among the samples, followed by the 200-gram sugar formulation with a mean rating of 4.1. The 100 grams of sugar with cornstarch and food color had the lowest mean rating of 3.8, indicating a lower level of visual appeal, while the 200 grams of sugar with additives scored slightly higher at 4.0. In terms of variability, the 200 grams of sugar formulation showed the highest standard deviation at 0.70, reflecting greater differences in respondents' opinions. Conversely, the 100 grams of sugar with cornstarch and food color had the lowest standard deviation at 0.47, suggesting more consistent but less favorable ratings.

Table 3. Students' Acceptability of the Texture of Calamansi Leaves Flavored Candy

Candy Formulation	Mean	Standard Deviation	Description
100 grams of sugar	4.2	0.74	*Like Moderately*
200 grams of sugar	3.7	0.42	*Like Moderately*
100 grams of sugar, cornstarch, and food color	3.8	0.47	*Like Moderately*
200 grams of sugar, cornstarch, and food color	3.9	0.47	*Like Moderately*

Legend: *Liked Very Much – between 4.3 and 5.0; Like Moderately – between 3.5 and 4.2; Liked Slightly – between 2.7 and 3.4; Disliked – between 1.9 and 2.6; and Disliked Very Much – between 1.0 and 1.8*

The formulation with 100 grams of sugar received the highest mean score of 4.2, making it the most preferred for texture, though it also showed the highest variability with a standard deviation of 0.74. The 200-gram sugar formulation had a slightly lower mean of 3.7, with a standard deviation of 3.42, indicating more consistent feedback. When cornstarch and food color were added, the formulations received moderate preferences. The 100 grams of sugar with cornstarch and food color scored a mean of 3.8, with a standard deviation of 0.47, while the 200 grams of sugar with cornstarch and food color achieved a slightly higher mean of 3.9, with the same standard deviation of 0.47. Overall, the formulation with 100 grams of sugar was the most favored for texture, although responses were less consistent across all formulations. The addition of cornstarch and food color had a minimal effect on preference, with slightly improved scores at higher sugar levels.

Table 4. Students' Acceptability of the Color of Calamansi Leaves Flavored Candy

Candy Formulation	Mean	Standard Deviation	Description
100 grams of sugar	4.5	0.5	*Liked Very Much*
200 grams of sugar	4.1	0.74	*Like Moderately*
100 grams of sugar, cornstarch, and food color	4.2	0.80	*Like Moderately*
200 grams of sugar, cornstarch, and food color	4.1	0.73	*Like Moderately*

Legend: *Liked Very Much – between 4.3 and 5.0; Like Moderately – between 3.5 and 4.2; Liked Slightly – between 2.7 and 3.4; Disliked – between 1.9 and 2.6; and Disliked Very Much – between 1.0 and 1.8*

The analysis of color ratings revealed that the 100-gram sugar formulation received the highest mean rating of 4.5 (standard deviation: 4.5), indicating a strong preference for its color. The 200 grams of sugar formulation followed with a mean rating of 4.1 (standard deviation: 0.74), suggesting positive reception but with slightly more variation in opinions. While the 200 grams of sugar with cornstarch and food color scored 4.1 (standard deviation: 0.73),

indicating mixed but still favorable opinions, the 100 grams of sugar with cornstarch and food color received a mean rating of 4.2 (standard deviation: 0.80), indicating general favorability. Overall, these results indicate that the color of the 100-gram sugar formulation was particularly favored. Favorable ratings were also given to other formulations with additional ingredients, highlighting the significance of color in candy's visual appeal.

Table 5. Students' Acceptability of the Aroma of Calamansi Leaves Flavored Candy

Candy Formulation	Mean	Standard Deviation	Description
100 grams of sugar	4.3	0.85	*Liked Very Much*
200 grams of sugar	4.2	0.75	*Like Moderately*
100 grams of sugar, cornstarch, and food color	4.1	0.70	*Like Moderately*
200 grams of sugar, cornstarch, and food color	4.3	0.87	*Liked Very Much*

Legend: Liked Very Much – between 4.3 and 5.0; Like Moderately – between 3.5 and 4.2; Liked Slightly – between 2.7 and 3.4; Disliked – between 1.9 and 2.6; and Disliked Very Much – between 1.0 and 1.8

A 100-gram sugar formulation had the highest mean rating of 4.3 and standard deviation of 0.85, according to the analysis of aroma ratings, suggesting that people strongly preferred its aroma. A 4.2 mean rating and 0.75 standard deviation, the 200-gram sugar formulation ranked second. This shows mostly positive opinions, even with some differences in responses. The formulation with 100 grams of sugar, cornstarch, and food color received a mean rating of 4.1 and a standard deviation of 0.70. This suggests that the aroma quality is acceptable, but opinions vary. A 200 serving of sugar with cornstarch and food color received the lowest rating at 4.0 (standard deviation: 0.87), reflecting mixed perceptions among respondents. Overall, these findings highlight the strong appeal of the 100-gram sugar formulation for its aroma, while the other formulations received slightly lower ratings, underscoring the importance of aroma in shaping consumer preferences for candy.

Table 6. Teachers' Acceptability of the Taste of Calamansi Leaves-Flavored Candy

Candy Formulation	Mean	Standard Deviation	Description
100 grams of sugar	4.4	0.89	*Liked Very Much*
200 grams of sugar	4.4	0.94	*Liked Very Much*
100 grams of sugar, cornstarch, and food color	3.4	0.96	*Liked Slightly*
200 grams of sugar, cornstarch, and food color	4.2	0.20	*Like Moderately*

Legend: Liked Very Much – between 4.3 and 5.0; Like Moderately – between 3.5 and 4.2; Liked Slightly – between 2.7 and 3.4; Disliked – between 1.9 and 2.6; and Disliked Very Much – between 1.0 and 1.8

The taste ratings from teachers revealed that both the 100g of sugar and 200g of sugar formulations received the highest mean ratings of 4.4, indicating they were the most favored. However, both formulations had high standard deviations (0.89 and 0.94), suggesting a wide range of opinions among teachers. The 100g of sugar with cornstarch and food color formulation received a lower mean rating of 3.4, indicating less satisfaction with its taste, although its standard deviation (0.96) was somewhat moderate. The 200g of sugar with cornstarch and food color formulation had a mean rating of 4.2 and the lowest variability in responses (0.20), suggesting a generally positive yet more consistent opinion among teachers. Overall, the sugar-only formulations were preferred for taste, while the versions with added cornstarch and food color were less popular.

Table 7. Teachers' Acceptability of the Appearance of Calamansi Leaves Flavored Candy

Candy Formulation	Mean	Standard Deviation	Description
100 grams of sugar	4	0.19	*Like Moderately*
200 grams of sugar	4.4	0.89	*Liked Very Much*
100 grams of sugar, cornstarch, and food color	3.4	0.89	*Like Moderately*
200 grams of sugar, cornstarch, and food color	3.4	0.40	*Like Moderately*

Legend: Liked Very Much – between 4.3 and 5.0; Like Moderately – between 3.5 and 4.2; Liked Slightly – between 2.7 and 3.4; Disliked – between 1.9 and 2.6; and Disliked Very Much – between 1.0 and 1.8

The 200g of sugar formulation received the highest mean appearance rating of 4.4, although there was significant variability in teacher opinions, as indicated by a standard deviation of 0.89. Both the 100g of sugar with cornstarch and food color and the 200g of sugar with cornstarch and food color formulations received lower appearance ratings of 0.4, suggesting that teachers were less impressed with their visual appeal. The standard deviations for these formulations (0.89 and 0.40) show some variability in responses. The 100g of sugar formulation had a moderate rating of 4.0, with less variability, indicating more consistent, though still varied, opinions. Overall, the sugar-only formulation was preferred for its appearance, while the addition of cornstarch and food color reduced its visual appeal.

Table 8. Teachers' Acceptability of the Texture of Calamansi Leaves Flavored Candy

Candy Formulation	Mean	Standard Deviation	Description
100 grams of sugar	4.6	0.4	*Liked Very Much*
200 grams of sugar	4.8	0.2	*Liked Very Much*
100 grams of sugar, cornstarch, and food color	3.8	0.28	*Like Moderately*
200 grams of sugar, cornstarch, and food color	3.8	0.28	*Like Moderately*

Legend: Liked Very Much – between 4.3 and 5.0; Like Moderately – between 3.5 and 4.2; Liked Slightly – between 2.7 and 3.4; Disliked – between 1.9 and 2.6; and Disliked Very Much – between 1.0 and 1.8

The 200-gram sugar formulation received the highest texture rating of 4.8, followed by the 100-gram sugar formulation with a rating of 4.6. Both of these formulations were generally well-received, though the high standard deviations (0.2 and 0.4, respectively) indicate significant variation in how teachers rated their texture. The 100-gram sugar with cornstarch and food color and 200-gram sugar with cornstarch and food color formulations had lower ratings of 3.8, suggesting less satisfaction with their texture, but with moderate variability in teacher responses (standard deviation of 0.28). In summary, the sugar-only formulations were preferred for texture, though opinions varied widely. The formulations with added cornstarch had more consistent but still lower ratings.

Table 9. Teachers' Acceptability of the Color of Calamansi Leaves Flavored Candy

Candy Formulation	Mean	Standard Deviation	Description
100 grams of sugar	4.6	0.14	*Liked Very Much*
200 grams of sugar	4.8	0.28	*Liked Very Much*
100 grams of sugar, cornstarch, and food color	4.6	0.14	*Liked Very Much*
200 grams of sugar, cornstarch, and food color	4.6	0.09	*Liked Very Much*

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Legend: Liked Very Much – between 4.3 and 5.0; Like Moderately – between 3.5 and 4.2; Liked Slightly – between 2.7 and 3.4; Disliked – between 1.9 and 2.6; and Disliked Very Much – between 1.0 and 1.8

The 200-gram sugar formulation received the highest color rating of 4.8, indicating the best visual appeal, though with some variation in teacher responses (standard deviation of 0.28). The 100 grams of sugar with cornstarch and food color formulations all earned a mean rating of 4.6, suggesting that teachers were generally pleased with their color as well. However, the variability in their ratings (standard deviations ranging from 0.09 to 0.14) indicates differing opinions. In summary, all formulations received positive ratings for color, with the 200-gram sugar formulation receiving the highest marks. Despite this, the variation in responses shows that teacher preferences for color were not entirely uniform.

Table 10. Teachers' Acceptability of the Aroma of Calamansi Leaves Flavored Candy

Candy Formulation	Mean	Standard Deviation	Description
100 grams of sugar	4.2	0.89	*Like Moderately*
200 grams of sugar	4.6	0.99	*Liked Very Much*
100 grams of sugar, cornstarch, and food color	3.8	0.60	*Like Moderately*
200 grams of sugar, cornstarch, and food color	4.4	0.94	*Liked Very Much*

Legend: Liked Very Much – between 4.3 and 5.0; Like Moderately – between 3.5 and 4.2; Liked Slightly – between 2.7 and 3.4; Disliked – between 1.9 and 2.6; and Disliked Very Much – between 1.0 and 1.8

The 200-gram sugar formulation received the highest aroma rating of 4.6, making it the most favored by teachers, though the high standard deviation of 0.99 indicates differing opinions. The 100-gram sugar formulation also received a positive rating of 4.2, but with higher variation in responses (standard deviation of 0.89). The 100 grams of sugar with cornstarch and food color formulation had a lower mean rating of 3.8, suggesting it was less popular in terms of aroma, with moderate variation in ratings (standard deviation of 0.60). The 200 grams of sugar with cornstarch and food color formulation received a slightly lower rating of 4.4, with a higher variability of 0.94. In summary, the sugar-only formulations were preferred for aroma, with the 200-gram sugar formulation being the top choice. The addition of cornstarch and food color generally led to lower aroma ratings, but there was still some variability in teachers' opinions.

Table 11. One-Way Analysis of Variance (ANOVA for Students' Ratings of Sensory Ratings of the Calamansi Leaves Flavored Candy

Source of Variation	Sum of Squares	df	Mean Square	F	p-value
Taste	4.371	3	1.457	2.924	0.036
Appearance	2.371	3	0.79	1.23	0.301
Texture	2.136	3	0.712	1.197	0.313
Color	2.364	3	0.788	1.285	0.282
Aroma	0.536	3	0.179	0.268	0.849

The only characteristic with a statistically significant difference between the groups was taste. At least one group evaluated the taste differently than the others, as indicated by the p-value of 0.036, which is less than the 0.05

threshold. In contrast, the p-values for appearance, texture, color, and aroma were all higher than 0.05, meaning no significant differences were found between the groups for these characteristics. These findings emphasize the importance of taste in consumer evaluations, which is supported by studies showing that taste plays a significant role in overall satisfaction and preference for food products (Lawless & Heymann, 2010).

Table 12. Pairwise Comparisons of Students' Sensory Ratings

Dependent Variable	Comparison (I vs J)	Mean Difference	Std. Error	p-value
Taste	1 vs 2	0	0.169	1
	1 vs 3	0.429	0.169	0.058
	1 vs 4	0.086	0.169	0.957
	2 vs 3	0.429	0.169	0.058
	2 vs 4	0.086	0.169	0.957
	3 vs 4	-0.343	0.169	0.181
Appearance	1 vs 2	-0.057	0.192	0.991
	1 vs 3	0.286	0.192	0.446
	1 vs 4	0.057	0.192	0.991
	2 vs 3	0.343	0.192	0.283
	2 vs 4	0.114	0.192	0.933
	3 vs 4	-0.229	0.192	0.632
Texture	1 vs 2	0.2	0.184	0.699
	1 vs 3	0.229	0.184	0.603
	1 vs 4	0.343	0.184	0.25
	2 vs 3	0.029	0.184	0.999
	2 vs 4	0.143	0.184	0.866
	3 vs 4	0.114	0.184	0.926
Color	1 vs 2	0.343	0.187	0.263
	1 vs 3	0.2	0.187	0.709
	1 vs 4	0.286	0.187	0.425
	2 vs 3	-0.143	0.187	0.871
	2 vs 4	-0.057	0.187	0.99
	3 vs 4	0.086	0.187	0.968
Aroma	1 vs 2	0.086	0.195	0.972
	1 vs 3	0.171	0.195	0.816
	1 vs 4	0.057	0.195	0.991
	2 vs 3	0.086	0.195	0.972
	2 vs 4	-0.029	0.195	0.999
	3 vs 4	-0.114	0.195	0.936

There was a somewhat significant change in taste between treatments 1, 2, and 3, suggesting that treatment 3 might have had a distinct flavor rating. However, as the p-value is only slightly above the standard cutoff of 0.05, no firm conclusion can be drawn. No noticeable differences were found between the treatments in terms of appearance, texture, color, and aroma. The Tukey HSD test further suggests that while the ANOVA pointed to a possible difference in taste, this difference appears to be mainly driven by a comparison between treatment 3 and the other groups, though it remains inconclusive (marginal significance). The finding that taste exhibited a nearly significant variation is consistent with studies indicating that taste is a critical factor in consumer preferences, influenced even by minor formulation changes (Lawless & Heymann, 2010).

Table 13. One-Way Analysis of Variance (ANOVA for Teachers' Ratings of Sensory Ratings of the Calamansi Leaves Flavored Candy

Source of Variation	Sum of Squares	df	Mean Square	F	p-value
Taste	5.800	3	1.933	5.156	0.011
Appearance	2.600	3	0.867	1.238	0.329
Texture	3.750	3	1.250	3.847	0.030
Color	0.150	3	0.050	0.095	0.962
Aroma	2.000	3	0.667	0.503	0.686

The p-value for taste is 0.011, which is below the standard significance level of 0.05, suggesting that the taste ratings between the treatment groups differ statistically significantly. However, there is no statistically significant difference in the treatment groups' assessments of appearance, as the p-value for appearance is 0.329, which is greater than 0.05. Similarly, the p-value for color is 0.962, indicating no discernible difference in the treatment groups' judgments of color, as it is much higher than 0.05. On the other hand, a statistically significant difference in texture ratings is indicated by the p-value of 0.030, which is less than 0.05. The p-value for aroma is 0.686, which is also higher than 0.05, showing no significant difference in aroma ratings across the treatment groups. In summary, while the characteristics of appearance, color, and aroma do not significantly vary between the treatments, taste and texture do.

Table 14. Pairwise Comparisons of Students' Sensory Ratings

Dependent Variable	Comparison (I vs J)	Mean Difference	Std. Error	p-value (Sig.)
Taste	1 vs 2	-0.4	0.387	0.733
	1 vs 3	1	0.387	0.084
	1 vs 4	0.6	0.387	0.433
	2 vs 3	1.400*	0.387	0.011
	2 vs 4	1	0.387	0.084
	3 vs 4	-0.4	0.387	0.733
Appearance	1 vs 2	-0.4	0.529	0.873
	1 vs 3	0.6	0.529	0.675
	1 vs 4	0.2	0.529	0.981

	2 vs 3	1	0.529	0.271
	2 vs 4	0.6	0.529	0.675
	3 vs 4	-0.4	0.529	0.873
Texture	1 vs 2	-1	0.361	0.059
	1 vs 3	0	0.361	1
	1 vs 4	0	0.361	1
	2 vs 3	1	0.361	0.059
	2 vs 4	1	0.361	0.059
	3 vs 4	0	0.361	1
Color	1 vs 2	-0.2	0.458	0.971
	1 vs 3	0	0.458	1
	1 vs 4	0	0.458	1
	2 vs 3	0.2	0.458	0.971
	2 vs 4	0.2	0.458	0.971
	3 vs 4	0	0.458	1
Aroma	1 vs 2	-0.6	0.728	0.842
	1 vs 3	0.2	0.728	0.992
	1 vs 4	-0.4	0.728	0.945
	2 vs 3	0.8	0.728	0.695
	2 vs 4	0.2	0.728	0.992
	3 vs 4	-0.6	0.728	0.842

The taste differences between Treatments 2 and 3 are statistically significant ($p = 0.011$), with Treatment 3 receiving a notably higher rating than Treatment 2. However, there are no significant differences in appearance, color, or aroma among the treatments. Additionally, there are marginally significant differences in texture between Treatments 1 and 2, 2 and 3, and 2 and 4, suggesting some variations in texture ratings, but none of these differences are significant enough to be considered conclusive at the 0.05 level. According to Lawless, H. T., & Heymann, H. (2010), scores for appearance, color, and aroma stayed the same across treatments, even with small formulation changes. The small but statistically insignificant texture changes match previous research showing that small adjustments may not lead to noticeable differences in how texture is perceived.

4.0. Conclusion

Teachers and students conducted detailed sensory evaluations and found that the calamansi leaves flavored candy was generally well-received across all versions. Teacher feedback indicated that taste and texture were the main factors that set the formulations apart.

The study focused on the sensory qualities of calamansi leaf-flavored candy and found key preferences of the students and teachers. The results show the improvement of taste and aroma if more sugar is utilized. For students, taste was the only attribute that significantly varied among the formulations, but this difference was small. In

contrast, teachers were more selective, showing significant differences in both taste and texture ratings. The formulations that used cornstarch and food coloring were generally less preferred, especially regarding texture. This suggests that these additives may not be needed for a desirable final product.

5.0. Future Suggestions

1) Focus on refining the sugar-only formulations (Formulations 1 and 2) since they received the highest overall ratings.

2) Test different concentrations of calamansi leaves to find the right balance between the fruit's natural tang and the candy's sweetness.

3) Conduct shelf-life studies to determine the product's stability, microbial safety, and storage conditions over time.

4) Explore alternative natural sweeteners (e.g., coconut sugar, honey) for a healthier, low-calorie version of the candy.

5) Investigate market feasibility through pilot-scale production and consumer testing.

6) Investigate the use of other plant-based extracts or herbs in combination with calamansi leaves for enhanced flavor and functionality.

7) Scale up the production process and perform cost analysis for possible commercial production.

8) A broader study with a more diverse group could offer more useful insights into consumer preferences.

Informed Consent

All participants provided written informed consent prior to their involvement in the study. They were fully briefed on the study's purpose, methods, potential risks, and their right to withdraw at any point without any negative consequences.

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