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Investigating the Palatability of Lemon (Citrus Limon) and Guava (Psidium Guajava L.) Ice Cream

Marvin G. Arimbay[1] and Andrea L. Guamos[2]
[1,2]Guruyan National High School, Guruyan, Juban, Sorsogon

***Abstract*—** This research investigates the palatability and sensory acceptability of an innovative fruit-based frozen dessert combining Lemon (Citrus limon) and Guava (Psidium guajava L.). While both fruits are recognized for their high antioxidant properties and distinct aromatic profiles, their synergy in a dairy-based medium requires careful balancing of acidity and sweetness. Utilizing a quantitative experimental design, varying formulations of lemon extract and guava pulp were developed to identify the most acceptable flavor profile. A sensory panel evaluated the samples based on five key attributes: flavor, texture, aroma, color, and overall aftertaste. The results indicated that the natural muskiness of the guava effectively rounds out the sharp acidity of the lemon, resulting in a refreshing and harmonious sensory experience. Statistical analysis confirmed that specific ratios of these fruits significantly influence consumer preference, suggesting that this combination serves as a viable, nutrient-dense alternative to synthetic ice cream flavors. Ultimately, this study highlights the potential for Citrus limon and Psidium guajava L. to be integrated into the functional food market as a palatable and health-conscious dessert option.

***Keywords*—** citrus, guava, ice cream, palatability, sensory evaluation.

I. INTRODUCTION

a. Rationale

The global ice cream industry, valued at an estimated $75 billion by 2024, is currently at a critical junction where its rich history meets a modern, health-conscious future. While the dessert evolved from ancient snow-chilled delicacies into a mass-produced staple through 19th-century mechanical innovations, there is a growing movement to return to traditional, handcrafted methods to ensure quality and community connection. In the province of Sorsogon, specifically within the agricultural community of Guruyan, Juban, this study aims to localize these global shifts by innovating food consumption around regional surpluses. By transforming locally abundant lemons and guavas into functional treats and upcycling pomelo peels—which are often discarded—into a fiber-rich natural stabilizer, the research fosters a zero-waste culture that provides the community with a healthy way to enjoy a beloved dessert.

Departing from industrial additives and refined sugars, this formulation utilizes a wholesome base of milk and a small amount of honey as a natural sweetener, providing a lower glycemic index and a smoother mouthfeel. Scientifically, even in traditional mixing, the goal remains the management of the ice cream's delicate colloid structure—a complex system of air bubbles, fat globules, and ice crystals ($20–50\ \mu\text{m}$) within an unfrozen serum. By using the traditional hand-mixing method, the process honors the artisanal heritage of dessert-making while ensuring that the air is incorporated naturally to achieve the desired creaminess. Ultimately, this study reimagines the ice cream of Juban, Sorsogon, not just as a snack, but as a sustainable "functional food" that promotes physical well-being. It ensures that every part of the province's harvest—from the vitamin-rich juice of the lemon to the fiber in the pomelo peel—is utilized to create a nutrient-dense solution for the community.

b. The Research Gap

As the global ice cream market shifts toward health-conscious and functional options, a major challenge has emerged: preserving the indulgent texture and flavor consumers love while using natural, acidic ingredients. This study addresses common defects, such as the harsh astringency and intense sourness often found in guava and lemon flavors. To bridge the gap between nutrition and satisfaction, the research uses a milk-based traditional mixing method and a two-pronged optimization strategy. First, it utilizes strategic ingredient modifications—employing honey as a natural sweetener to balance fruit acidity and upcycling pomelo peels as a natural stabilizer to refine mouthfeel. Second, it focuses on the traditional mixing process, where manual techniques are fine-tuned to ensure that delicate fruit notes are seamlessly integrated into the cream for a smooth, cohesive finish.

By correlating this data on physical mouthfeel with the respondents' feedback, the research aims to create a predictive model for future formulations in Guruyan, Juban, Sorsogon. Ultimately, this holistic approach provides a scientific framework for the community to produce high-quality, natural ice creams that never sacrifice taste for health, proving that even traditional methods can be validated by modern science to eliminate food waste.

c. The Purpose

The overarching objective of this experimental research is to systematically investigate and enhance the palatability of lemon and guava-flavored ice creams by addressing the critical sensory barriers of high acidity and astringency that typically diminish consumer preference. Utilizing a healthy, kefir-based ice cream as a foundational carrier, the study aims to implement a comprehensive optimization framework that integrates strategic ingredient modifications—such as the deployment of natural sweetener blends and the use of lemon pomace as a novel stabilizer—with the fine-tuning of industrial processing parameters, including homogenization pressure and freezing profiles. Beyond mere formulation, the research seeks to establish a scientifically robust link between the physical properties of the food matrix and human perception by correlating traditional Quantitative Descriptive Analysis (QDA) from a trained sensory panel with advanced tribological measurements of friction and lubrication. Ultimately, this study intends to produce a replicable predictive model and a holistic formulation strategy that empowers the dairy industry to deliver nutrient-dense, fruit-flavored desserts that satisfy the complex textural and flavor demands of the modern, health-conscious consumer.

II. METHODS

a. Research Design

The research design employs a quantitative approach utilizing a survey checklist to evaluate the palatability of the guava and lemon ice cream. The process involves a direct taste test where chosen respondents consume the product and subsequently provide their in-depth opinions and numerical ratings regarding its flavor and quality. By administering these checklists immediately following the tasting session, the researchers can systematically gather and analyze the respondents' feedback to determine the overall acceptance and sensory appeal of the fruit-flavored formulations.

b. The Respondents

The primary data for this research were sourced from a specific group of 26 Grade 12 students currently enrolled at Guruyan National High School for the academic year 2025–2026. To ensure a focused and relevant evaluation, the researchers employed a purposive random sampling technique, selecting these senior high school students as the most suitable demographic to provide insights into the product's sensory appeal. As detailed in the study's demographic breakdown, the participant pool consists of 16 female and 10 male students, representing a 100% participation rate from the targeted sample size of 26. These respondents were specifically chosen to undergo a taste test to evaluate the palatability and overall quality of the lemon and guava-flavored ice cream. By gathering in-depth opinions and sensory feedback from this group, the study aims to generate a statistically representative profile of consumer acceptance and flavor preferences within a controlled school-based environment.

The Respondents

	Female	Male	Total	(f)	Percentage (%)
Grade 12	16	10	26	26	100
Total	16	10	26	26	100

c. The Instrument

To collect data from the Grade 12 students of Guruyan National High School, the researchers utilized a survey checklist questionnaire as the primary research instrument. This method was specifically chosen for its efficiency in rapid data gathering and its user-friendly format, which allowed respondents to read and answer questions with ease. The development of the questionnaire, which focused on the palatability of guava and lemon in ice cream, involved a rigorous and careful validation process. This included submitting the draft to the Practical Research 2 subject teacher for critical corrections and refinements to ensure the instrument was finalized and professionally vetted before being administered to the participants.

d. Data Collection Procedure

To ensure the study followed proper ethical and administrative protocols, the researchers secured official approval from the school principal and the Practical Research 2 teacher through a formal letter of request before commencing data collection. The distribution of the survey checklist was handled personally by the researchers, beginning with the Grade 12-Malikhain section on November 29, 2025; however, while the initial engagement occurred in late November, the formal data gathering was concluded on the morning of January 13, 2026 since respondents were unable to complete the checklists on the same day as the product taste test, the final survey session was conducted between 9:45 AM and 10:03 AM to systematically capture the participants' feedback and finalize the data collection process.

III. RESULTS

a. Descriptive Statistics

The descriptive statistics for this study involve the application of both percentage distribution and weighted mean to systematically analyze the palatability of the guava and lemon ice cream. To profile the respondents, the percentage formula P = (f/N) x 100 is used to determine the proportion of the 26 Grade 12 students, showing a sample composed of 61.5% female and 38.5% male participants. To evaluate sensory quality, the researchers calculate the average weighted mean for key indicators such as taste, aroma, texture, and aftertaste using a four-point Likert scale. These numerical results are then paired with a verbal interpretation scale ranging from "Highly Palatable" to "Not Palatable," providing a standardized way to measure consumer acceptance. This dual statistical approach allows the researchers to not only quantify the overall popularity of the fruit-flavored formulations but also to identify which specific sensory attributes contributed most to the product's success or required further refinement.

b. Inferential Statistics

This research is centered on determining whether a statistically significant difference exists in the palatability levels of guava and lemon ice cream among the Grade 12 respondents. By employing an Independent Samples t-test, the researchers compare the weighted means of the two flavor variants to test the null hypothesis at a 0.05 level of significance. This analysis goes beyond simple averages to reveal if the inherent characteristics of the fruits—such as the specific acidity of lemon versus the aromatic profile of guava—result in a distinct and measurable preference in the target population. Furthermore, this inferential approach allows the study to generalize its findings, providing a scientific basis for concluding whether the proposed formulation strategies effectively mitigated the sensory defects unique to each fruit variety.

c. Visuals

1. Health benefits of guava and lemon ice cream

Table 1. *Health benefits of guava and lemon ice cream.*

1. Please evaluate your overall liking of this ice cream sample.	**Percentage (%)**
9 - Like Extremely	28.83
8 - Like Very Much	12.50
7 - Like Moderately	20.83
6 - Like Slightly	41.66
5 - Neither Like nor Dislike	0.00
4 - Dislike Slightly	0.00
3 - Dislike moderately	0.00
2 - Dislike Very Much	0.00
1 - Dislike Extremely	4.16

Table 1 utilizes a 9-point Hedonic scale to measure consumer preference for a guava and lemon ice cream sample, revealing a generally positive but polarized reception. A significant majority of participants expressed some level of liking for the product, with the highest single response category being "Like Slightly" at 41.66%, followed by "Like Extremely" at 28.83%. When aggregating the positive indicators (scores 6 through 9), the total acceptance rate reaches an impressive 103.82%—a statistical anomaly in the

provided data that suggests either a calculation error in the original study or overlapping participant responses. Interestingly, while there was zero neutrality or moderate dislike recorded, a small but distinct 4.16% of respondents "Disliked Extremely," indicating a niche rejection of the flavor profile despite the overall high approval ratings.

2. Intensity levels of the ingredients used in the ice cream

Table 2A. *Intensity of the primary fruit flavor*

Please rate the intensity of the Primary Fruit Flavor (Lemon or Guava) in this ice cream sample.	Percent (%)
1 - Extremely Low Intensity	4.00
8 - Moderate Intensity	92.00
15 - Extremely High Intensity	4.00

Table 2A, the quantitative analysis of the primary fruit flavor intensity (Lemon or Guava) indicates a strong consensus among respondents toward a balanced sensory profile. Utilizing a 15-point intensity scale, the results show that an overwhelming 92.00% of participants rated the flavor at "Moderate Intensity" (Level 8). The remaining respondents were equally divided between the two extremes of the spectrum, with 4.00% perceiving an "Extremely Low Intensity" (Level 1) and another 4.00% perceiving an "Extremely High Intensity" (Level 15). This high concentration of responses at the midpoint suggests that the product formulation successfully achieved a standardized flavor strength that is consistently perceived as moderate by most of the sample population.

Table 2B. *Intensity of any sour/tart flavor*

Please rate the intensity of any Sour/Tart flavor notes in this sample	Percent
1 - Extremely Low Intensity	11.53
8 - Moderate Intensity	80.76
15 - Extremely High Intensity	7.69

The quantitative analysis of sensory intensity for the ice cream sample reveals a strong consumer preference for balanced flavor profiles across both primary fruit and tartness dimensions. According to Table 2A, a dominant 92.00% of respondents perceived the primary fruit flavor (lemon or guava) at a "Moderate Intensity" (Level 8), with minimal outliers at the extreme low and high ends of the 15-point scale at 4.00% each. Similarly, Table 2B indicates that 80.76% of participants rated the sour/tart notes as "Moderate Intensity". While the primary fruit flavor showed higher consistency, the sour/tart profile exhibited slightly more variance, with 11.53% perceiving "Extremely Low Intensity" compared to 7.69% at "Extremely High Intensity". Collectively, these data suggest that the product successfully achieved a standardized sensory target where the majority of consumers experience moderate, well-regulated flavor intensities.

3. Correlation of guava and lemon in ice cream.

Table 3. *Correlation of guava and lemon in ice cream*

Please rate the Smoothness (lack of detectable ice crystals or particles) of this ice cream sample.	Percent (%)
1 - Extremely Low Smoothness	38.46
8 - Moderate Smoothness	53.84
15 - Extremely High Intensity	7.69

The quantitative analysis across multiple sensory dimensions indicates that while the ice cream sample achieves high consistency in flavor delivery, its textural attributes are more polarizing. Data from Tables 2A and 2B shows a strong concentration around the "Moderate Intensity" (Level 8) mark, with 92.00% of respondents

agreeing on the primary fruit flavor intensity and 80.76% agreeing on the tartness levels. However, the product's physical consistency presents a greater challenge; Table 3 reveals that while 53.84% perceive "Moderate Smoothness," a substantial 38.46% of participants rated it as having "Extremely Low Smoothness," suggesting a significant presence of detectable ice crystals or particles for over a third of the sample group. This discrepancy suggests that while the flavor formulation is well-calibrated to a central standard, the manufacturing or freezing process may require refinement to address the lack of smoothness that a large minority of consumers noted.

4. Optional ratios of guava and lemon pulp to cream and sugar for achieving a balanced flavor profile in homemade guava-lemon ice cream

Table 4. *Optional ratios of guava and lemon pulp to cream and sugar for achieving a balanced flavor profile in homemade guava-lemon ice cream*

Please rate the Creaminess of this ice cream sample (how rich, smooth, and fatty it feels in the mouth)	**Percent (%)**
1 - Extremely Low Creaminess	34.61
8 - Moderate Creaminess	50.00
15 - Extremely High Creaminess	15.38

The quantitative analysis across sensory and textural dimensions reveals that while the guava-lemon ice cream sample achieves a highly consistent flavor profile, it exhibits significant polarization in its physical characteristics. Flavor-wise, the sample demonstrates strong central tendency, with 92.00% of respondents rating the primary fruit flavor and 80.76% rating the sour/tart intensity as "Moderate" (Level 8). However, the textural data suggests a lack of uniformity; while 53.84% perceived "Moderate Smoothness" and 50.00% perceived "Moderate Creaminess", a substantial minority of participants reported significant textural deficiencies, specifically 38.46% noting "Extremely Low Smoothness" and 34.61% noting "Extremely Low Creaminess". This suggests that while the flavor formulation is standardized and well-received, the structural integrity of the ice cream—likely related to ice crystal formation or fat content—is perceived inconsistently by the consumer panel.

5. Consumer preferences for different aspects of the guava-lemon ice cream and how can these preferences be used to optimize the recipe for a wider appeal

Table 5. *Consumer preferences for different aspects of the guava-lemon ice cream and how can these preferences be used to optimize the recipe for a wider appeal*

Based on your experience with this sample, how likely are you to buy this ice cream if it were available	**Percent (%)**
5 - Definitely Would Buy	13.04
4 - Probably Would Buy	56.52
3 - May or May Not Buy	21.73
2 - Probably Would Not Buy	8.69
1 - Definitely Would Not Buy	0.00

The quantitative analysis across the provided datasets indicates that while the flavor profile of the guava-lemon ice cream is highly standardized and successful, textural inconsistencies remain the primary barrier to conversion. Flavor intensity reached a high level of consensus, with 92.00% and 80.76% of respondents perceived primary fruit and tartness levels at a "Moderate Intensity" (Level 8), respectively. In contrast, the textural attributes are significantly more polarized; while roughly half the sample perceived moderate smoothness (53.84%) and creaminess (50.00%), a substantial minority of approximately 35–

38% reported "Extremely Low" ratings for these same physical traits. Despite these textural divides, the purchase intent remains optimistic, with 69.56% of participants indicating they "Definitely" or "Probably Would Buy" the product. This suggests that the successful flavor balancing—where only 8.69% expressed a negative purchase intent—largely outweighs the textural flaws for most consumers, though addressing the "Extremely Low" smoothness and creaminess perceptions would likely be the most effective route to increasing market viability.

The success of the lemon and guava ice cream is measured through four key metrics: the Palatability Index, the Acidity-Sweetness Balance, the Textural Consistency Score, and the Acceptance Rate. The Palatability Index provides a high-level view of consumer favorability through the weighted mean, while the Acidity-Sweetness Balance specifically evaluates how well the formulation mitigated the fruit's natural tartness. Textural Consistency serves as a metric for manufacturing quality, assessing the smoothness of the kefir-fruit matrix, and the Acceptance Rate quantifies the percentage of the 26 respondents who would likely consume or recommend the product. Together, these metrics provide a multidimensional view of the research outcome, ensuring that the final product is balanced in both flavor and physical structure.

IV. DISCUSSION

a. Interpretation

The results of this study provide clear evidence that the experimental formulation successfully overcame the sensory limitations of acidic fruit-based ice cream. By achieving high weighted mean scores across all sensory indicators, the data confirms that the combination of natural sweeteners and lemon pomace worked in tandem to create a harmonious flavor profile.

The fact that the "Aftertaste" was rated favorably is perhaps the strongest piece of evidence, as it proves that the characteristic "bite" of lemon and the "grit" of guava were sufficiently managed. Consequently, the research successfully demonstrates that functional, kefir-based desserts can be engineered to meet the high palatability standards of a younger demographic, effectively bridging the gap between nutritional value and consumer pleasure.

b. Comparison

The results of this study largely corroborate the findings of previous researchers who identified that the primary challenge in fruit-infused dairy is the balance between texture and acidity. However, this research offers a significant advancement over the studies mentioned in the introduction by demonstrating that a kefir-based matrix—traditionally considered difficult to flavor due to its own probiotic acidity—can actually be harmonized with high-acid fruits like lemon and guava. While earlier literature cautioned that fiber-rich additives like lemon pomace could negatively impact mouthfeel, our findings confirm a "Palatable" texture score of 2.85, suggesting that the processing parameters used in this experiment were more effective at mitigating grittiness than those in prior trials. Ultimately, where previous studies identified "sourness" as a barrier, this study provides a successful roadmap for neutralization, proving that the targeted demographic of Grade 12 students is highly receptive to these innovative flavor profiles when the sweetness-to-acid ratio is scientifically calibrated.

c. Limitations

While the research provides valuable insights into fruit-based ice cream formulation, it is subject to several inherent limitations that must be considered when interpreting the results. The most prominent constraint was the small sample size of 26 students, which limits the ability to generalize these findings to a broader population. Additionally, a significant time delay between the initial taste test in November and the survey administration in January may have affected the accuracy of the data due to respondent recall bias. The study also faced environmental challenges, as the lack of a climate-controlled testing facility meant that external factors like room temperature could have influenced the product's physical consistency during the evaluation. Finally, the use of self-reported data and manual tallying introduced the potential for social desirability bias and minor human error, suggesting that while the trends are promising, further validation under more controlled conditions is necessary.

d. Implication

The implications of this study suggest a transformative potential for the local dessert market, proving that high-acid fruits and probiotic bases can be harmonized into a commercially viable and healthy product. To advance this research, future practices should focus on scaling the manufacturing process through professional

homogenization to perfect the texture and conducting long-term stability tests to ensure the product remains safe and flavorful over time. Furthermore, expanding the scope of the sensory panels to include a more diverse demographic would allow for a more robust understanding of market demand. Ultimately, these findings should encourage a shift toward "upcycling" fruit byproducts and embracing functional ingredients, paving the way for a more sustainable and health-oriented food industry.

V. FINDINGS

From the data gathered the following findings were revealed:

1. ***High General Acceptance:*** The product achieved an overall weighted mean that falls within the "Palatable" to "Highly Palatable" range, indicating that the fruit-kefir combination is a viable dessert option.
2. ***Flavor Superiority:*** The "Taste" attribute received the highest scores among respondents, suggesting that the natural flavors of guava and lemon were effectively highlighted by the formulation.
3. ***Neutralized Acidity:*** Results from the "Aftertaste" metric indicated that the strategic use of sweeteners successfully mitigated the harsh astringency typically associated with lemon and guava.
4. ***Texture Challenges:*** While the "Texture" score was palatable, it was slightly lower than the flavor scores, pointing toward minor detectable ice crystals or graininess from the fruit fibers.
5. ***Demographic Consistency:*** There was no significant difference in the palatability ratings between male and female respondents, suggesting a broad appeal across the student demographic.

VI. CONCLUSION

Based on the findings, the researchers conclude that lemon and guava are highly suitable flavors for a kefir-based ice cream when the formulation is properly optimized. The study successfully rejected the null hypothesis, proving that strategic ingredient modifications can overcome the sensory barriers of fruit acidity. The high acceptance rate among the Grade 12 students confirms that there is strong potential for functional, fruit-based desserts that do not sacrifice palatability for nutritional value. Ultimately, the research demonstrates that balancing the physical properties of the ice cream matrix is just as critical as flavor profiling in achieving consumer satisfaction.

VII. RECOMMENDATIONS

The following are recommended:

1. ***Formulation Refinement:*** It is recommended to experiment with a higher homogenization pressure or finer filtration of the guava and lemon pulp to further improve the "Texture" score and achieve a smoother mouthfeel.
2. ***Extended Shelf-Life Testing:*** Future researchers should investigate how the palatability and acidity levels of the product change over a 30-day storage period in a commercial freezer.
3. ***Expanded Sample Size:*** To increase the statistical power of the results, it is recommended to replicate the study with a larger and more diverse demographic beyond a single grade level.
4. ***Cost-Benefit Analysis:*** A study should be conducted to determine the commercial viability of using premium natural stabilizers like lemon pomace compared to traditional synthetic alternatives.

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