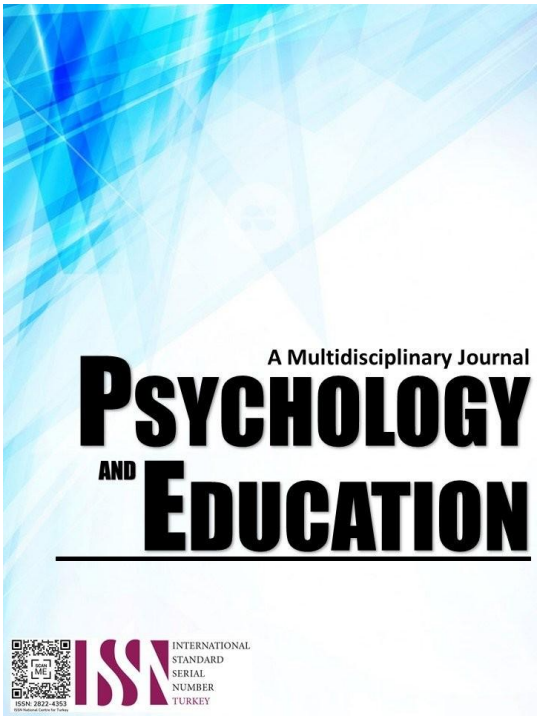
SENSORY EVALUATION AND CONSUMER ACCEPTABILITY OF ICE CREAM FORTIFIED WITH SWEET POTATO (IPOMEA BATATAS) AND TURMERIC (CURCUMA LONGA)



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Research Article

Sensory Evaluation and Consumer Acceptability of Ice Cream Fortified with Sweet Potato (Ipomea Batatas) and Turmeric (Curcuma Longa)

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Abstract

This study aimed to develop a novel functional ice cream incorporating sweet potato (Ipomoea batatas) and turmeric (Curcuma longa) as primary ingredients to enhance nutritional value (beta-carotene, dietary fiber, and curcumin) while maintaining consumer acceptability. Four formulations were prepared, varying in the proportions of sweet potato (200–500 g) and turmeric juice (10–40 ml). A total of 100 panelists with varying levels of sensory experience evaluated the samples using standardized 5-point sensory scales for color, aroma, taste, texture, and appearance, as well as a 9-point hedonic scale for overall acceptability. Statistical analysis using Analysis of Variance (ANOVA) revealed significant differences ($p < 0.05$) across all sensory attributes, indicating that ingredient ratios had a measurable impact on consumer perception. Among the formulations, the ice cream with 400 g sweet potato and 30 ml turmeric juice received the highest sensory scores, particularly for taste (4.5), texture (4.3), and overall acceptability (hedonic mean = 7.8, corresponding to "Like Very Much"). This formulation struck an optimal balance of flavor and texture, delivering functional health benefits. Beyond sensory appeal, the study highlights the importance of using locally available crops to create affordable, nutritious, and culturally relevant frozen desserts that may help address nutritional deficiencies. Furthermore, a standardized techno-guide, incorporating shelf-life testing, was developed to ensure product quality, safety, and reproducibility, enabling both commercial scalability and potential integration into school-based nutrition programs. Overall, the findings demonstrate that sweet potato and turmeric can serve as promising functional ingredients in ice cream innovation, providing healthier alternatives without compromising consumer satisfaction.

Keywords: *functional ice cream, sensory evaluation, product development of Sweet Potato and Turmeric*

Introduction

Ice cream is one of the most widely consumed and beloved desserts globally, transcending cultural and demographic boundaries. The global ice cream industry is projected to continue expanding, reaching USD 132.32 billion by 2032 (Fortune Business Insights, 2023; Straits Research, 2023). This growth trend is mirrored in the Philippines, where the market is expected to reach USD 436.45 million by 2033 (IMARC Group, 2025). Such steady demand reflects the enduring appeal of ice cream across regions and income groups.

Despite its popularity, conventional ice cream formulations often contain high levels of added sugars, saturated fats, and artificial additives, which contribute to health concerns such as obesity, type 2 diabetes, and cardiovascular diseases (Healthline, 2022). This has led to a growing consumer preference for healthier and functional food alternatives, even within indulgent product categories like frozen desserts.

The rise of functional ice cream—formulated to deliver both sensory satisfaction and health benefits—has gained significant momentum worldwide. This segment is forecasted to grow from USD 235 million in 2023 to USD 388.61 million by 2030, at a CAGR of 7.45% (Stellar Market Research, 2023; openPR, 2023). Functional ice creams often incorporate bioactive compounds, such as antioxidants and dietary fiber, along with plant-based ingredients, reflecting a shift toward wellness-oriented consumption. For developing countries like the Philippines, this trend also presents an opportunity to utilize locally available crops in creating nutritious, marketable, and sustainable food innovations.

Two promising indigenous ingredients—sweet potato (Ipomoea batatas) and turmeric (Curcuma longa)—offer significant potential for such applications. Sweet potatoes are a nutrient-rich root crop high in complex carbohydrates, fiber, potassium, vitamin C, and beta-carotene, which support immune and eye health. Its natural sweetness and creamy texture can reduce the need for added sugars and stabilizers, improving the nutritional and sensory profile of ice cream. Meanwhile, turmeric, renowned for its bioactive compound curcumin, provides potent antioxidant and anti-inflammatory effects while serving as a natural colorant that eliminates the need for synthetic dyes.

The synergistic combination of sweet potato and turmeric offers complementary nutritional and sensory benefits—sweet potato's mild flavor and smooth mouthfeel balance turmeric's earthy notes. At the same time, both contribute to enhanced antioxidant potential. Together, these ingredients create a functional ice cream aligned with the clean-label, plant-based, and wellness trends in modern food innovation.

However, a research gap remains in optimizing the formulation of sweet potato–turmeric ice cream to ensure desirable sensory quality without compromising its functional value. Existing studies often focus on each ingredient separately, leaving limited empirical data on their combined use in frozen desserts. Addressing this gap is crucial to promoting the value-added utilization of local crops and

supporting community-based nutrition initiatives.

Therefore, this study aims to optimize the formulation of sweet potato and turmeric ice cream through sensory evaluation, developing a techno-guide for scalable production that promotes local agriculture, entrepreneurship, and improved public nutrition.

Research Questions

This study aimed to develop sweet potato and turmeric ice cream for acceptance at Cebu Technological University-Barili Campus for the 2025-2026 school year. What is the profile of the respondents in terms of the following:

1. What was the process used to determine the four formulations of sweet potato and turmeric ice cream?
2. What are the sensory attributes of the different treatments of sweet potato and turmeric ice cream in terms of:
    2.1. Color;
    2.2. Odor;
    2.3. Taste;
    2.4. Texture; and
    2.5. Over-all Acceptability?
3. What is the consumer perception of the sweet potato and turmeric ice cream formulations in terms of purchase intent and willingness to recommend?
4. Is there a significant difference in the overall acceptability scores among the four ice cream formulations?
5. What is the estimated production cost of the most acceptable sweet potato and turmeric ice cream formulation?

Literature Review

Theoretical and Conceptual Background

The conceptual framework of the study, "Acceptability of Sweet Potato and Turmeric Ice Cream: Techno Guide," is anchored on a multidisciplinary approach that integrates theories from consumer behavior, nutrition science, and food product development. These theoretical foundations guide the formulation, sensory evaluation, functional value, and consumer acceptance of a novel ice cream product enriched with camote (sweet potato) and turmeric.

Maslow's Hierarchy of Needs (1943) serves as a foundational model for understanding consumer motivation related to food consumption. At the most basic level, food fulfills physiological needs by satisfying hunger and providing essential nutrients. As individuals ascend the hierarchy, their focus expands to safety needs, driving the demand for food products that are safe, nutritious, and health-promoting. The development of Camote-Turmeric Ice Cream responds to these motivations by offering a functional food alternative that contributes to both basic nourishment and overall well-being. Furthermore, at the higher levels of Maslow's model, food choices become a means of social connection, self-expression, and personal growth. Choosing an innovative, health-conscious product like turmeric-infused ice cream may thus reflect and reinforce a consumer's identity and lifestyle aspirations.

The Functional Food Theory, as introduced by Roberfroid (2002), underpins the study's emphasis on creating a product that provides health benefits beyond basic nutrition. Camote is a source of dietary fiber and beta-carotene, while turmeric contains curcumin, a bioactive compound known for its antioxidant and anti-inflammatory effects. By incorporating these ingredients into a frozen dairy dessert, the study positions the product as a health-oriented alternative to conventional ice cream, aligning with current consumer trends that seek a balance between flavor and functional benefits.

Product Innovation Theory, as discussed by Trott (2008), emphasizes the importance of innovation in meeting evolving consumer demands and health trends. The introduction of camote and turmeric into the familiar format of ice cream illustrates a strategic application of innovation in food product development. The resulting Camote-Turmeric Ice Cream exemplifies how traditional desserts can be transformed into nutrient-enhanced, functionally enriched products through thoughtful innovation.

Sensory Acceptability Theory, as outlined by Lawless and Heymann (2010), emphasizes the crucial role of sensory characteristics, including taste, texture, aroma, and appearance, in shaping consumer preferences. Given that camote and turmeric can influence both the flavor and visual appeal of the product, this theory is essential in guiding the formulation process and in designing the sensory evaluation tools used in the study.

The Food Neophobia Theory, developed by Pliner and Hobden (1992), explains consumer hesitation toward unfamiliar or novel food items. Since turmeric is commonly associated with savory dishes and camote is not a typical base for ice cream, consumers may initially be hesitant to try the product. However, the use of familiar local ingredients and the growing awareness of their health benefits may reduce neophobia and increase acceptance.

The Health Belief Model (Rosenstock, 1974) also informs the study by examining how perceived health risks, benefits, and barriers influence food choices. If consumers perceive that turmeric-infused ice cream supports better health outcomes, they are more likely to accept and adopt the product. The inclusion of camote and turmeric, both known for their medicinal and nutritional value, aligns well with this model.

Finally, Consumer Behavior Theory, as proposed by Kotler and Keller (2012), provides a comprehensive framework for analyzing how perceptions, attitudes, and preferences drive purchasing decisions. This theory integrates insights from the previously mentioned models to help predict consumer responses to the Camote-Turmeric Ice Cream. It also aids in shaping marketing strategies and evaluating the potential viability of the product in the marketplace.

This conceptual framework integrates psychological, nutritional, sensory, and marketing perspectives to understand the development and acceptability of Camote-Turmeric Ice Cream. Each theory contributes to a holistic assessment of the product—from formulation and functionality to sensory evaluation and consumer reception—forming a solid foundation for the Techno-Guide, which aims to develop and promote functional ice cream innovations.

The incorporation of sweet potato, particularly the purple and orange varieties, has yielded promising results in enhancing both the nutritional and sensory characteristics of ice cream. Studies such as that of Umnat et al. (2023) optimized a formulation using a 40:60 purple sweet potato mash-to-water ratio, supplemented with 0.4% carboxymethyl cellulose (CMC), resulting in notable improvements in overrun, melting rate, and consumer acceptability. Similarly, Sudjatinah et al. (2020) highlighted the potential of purple sweet potato to enrich ice cream with anthocyanins, thereby enhancing antioxidant activity and improving sensory appeal. Tirakitpoung (2015) further demonstrated the versatility of sweet potatoes by combining them with ginger syrup, resulting in improved texture and increased consumer satisfaction. Wijaya et al. (2021) affirmed the root crop's efficacy as a natural colorant and flavor enhancer. Collectively, these studies emphasize sweet potato's value in producing functional and aesthetically appealing frozen desserts. However, despite these promising findings, a significant gap remains in the literature regarding the synergistic potential of sweet potato when combined with other functional ingredients, such as turmeric. Most existing research investigates sweet potato in isolation, leaving a gap in understanding the benefits and challenges of integrating and optimizing multiple ingredients in functional ice cream development.

Moreover, sweet potatoes (Ipomoea batatas) are increasingly used in food product development due to their high fiber content, antioxidant properties, and natural sweetness. Kılınç et al. (2022) investigated the incorporation of two lyophilized sweet potato varieties into ice cream, finding improvements in texture, antioxidant levels, and mineral content. The study reported increased product hardness and consumer acceptability, suggesting sweet potato is a viable alternative to synthetic additives and dairy solids.

Similarly, Estabillo et al. (2025) developed an ice cream product using sweet potato and squash, targeting a low-fat formulation rich in fiber. The sensory evaluation yielded favorable results, indicating potential for commercial application among health-conscious consumers. Kim et al. (2021) also observed that sweet potato puree up to 40% inclusion did not compromise the texture or overall acceptability of frozen desserts.

In parallel, turmeric has emerged as a potent functional ingredient due to its primary bioactive compound, curcumin, which exhibits antioxidant, anti-inflammatory, and antimicrobial properties. Manoharan et al. (2012) demonstrated that curcumin could replace synthetic colorants in butterscotch ice cream without compromising taste, while enhancing both nutritional and visual appeal. Further exploration by Jadhao (2020) involving turmeric and tulsi revealed increased antioxidant activity and extended shelf life, with no negative impact on sensory qualities. Lučan Čolić et al. (2023) enhanced curcumin bioavailability by combining turmeric with black pepper, resulting in ice cream formulations that demonstrated high consumer acceptability and improved physicochemical properties. Hidayati et al. (2024) introduced turmeric acid in a commercial application, showcasing its potential to bridge traditional herbal medicine with modern food culture. While these studies affirm turmeric's multifunctional role in functional ice cream, they also highlight gaps in understanding its interaction with carbohydrate-rich bases, such as sweet potato. Additionally, there remains a lack of standardized guidelines on optimal curcumin concentrations to balance health benefits with sensory performance in frozen dessert products.

Furthermore, Turmeric (Curcuma longa), a functional spice known for its anti-inflammatory and antioxidant properties, has also been used in frozen dairy products. A consumer-focused study by Den Salcedo et al. (2020) found that turmeric-infused ice cream received positive feedback, with consumers describing the flavor as "good, delicious, and well-blended." However, it was noted that the aroma and spice level should be moderated to avoid sensory rejection.

In a recent study, Salcedo et al. (2023) investigated the addition of turmeric and black pepper to enhance the flavor of ice cream. The formulation maintained acceptable sensory scores while improving the nutritional and functional properties of the product. Their results support the role of turmeric in enhancing flavor and driving product innovation in functional dairy.

Given the individual promise of both sweet potato and turmeric, the present study seeks to address existing research gaps by investigating their combined application in ice cream. This approach aims to evaluate the synergistic effects on nutritional enhancement, sensory acceptability, and structural stability. Moreover, unlike many prior studies that focus primarily on laboratory-scale formulations, this GG study also considers practical concerns such as market feasibility, consumer perception, and product longevity. The integration of sweet potato and turmeric represents an innovative step toward developing culturally relevant, health-promoting dairy products that align with current clean-label and wellness trends. This empirical review underscores the need for integrated functional ice cream formulations that harness the complementary bioactive properties of these two locally available ingredients, ultimately laying the groundwork for new, health-oriented dessert innovations.

The development of Sweet Potato and Turmeric Ice Cream, as outlined in the study "Acceptability of Sweet Potato and Turmeric Ice

Cream: Techno-Guide," is grounded in both scientific and theoretical principles, and is also aligned with relevant national legal frameworks that promote innovation, food safety, health, and nutrition in the Philippines. These laws provide a robust policy environment that supports the study's objectives of developing a functional, acceptable, and locally rooted ice cream product.

The development and evaluation of sweet potato and turmeric ice cream as a functional food product is strongly supported by several national laws and policy frameworks that promote innovation, food safety, nutrition, and sustainable development in the Philippines. These legal instruments not only provide regulatory guidance but also legitimize and reinforce the relevance of food-based innovations within both academic and commercial domains.

Foremost among these is Republic Act No. 11293, also known as the Philippine Innovation Act, which institutionalizes innovation as a strategic driver of national competitiveness and inclusive growth. The law encourages research and development efforts that leverage indigenous resources, foster collaboration among public, private, and academic sectors, and translate academic outputs into viable, market-ready products. Through the establishment of the National Innovation Council and the Innovation Fund, this law supports projects like the development of nutrient-rich, locally inspired frozen desserts that can enhance food security and stimulate micro-enterprise activity.

Complementing this is Republic Act No. 10611, also known as the Food Safety Act of 2013, which ensures that all food products—whether traditional or innovative—adhere to science-based, risk-based safety standards throughout the entire supply chain. The inclusion of root crops and functional spices in frozen products necessitates rigorous safety protocols in sourcing, preparation, and distribution. This legislation strengthens the study's techno-guidance component by embedding food safety as a core criterion in product formulation and evaluation.

Equally relevant is DepEd Order No. 13, series of 2017, which outlines the Policy and Guidelines on Healthy Food and Beverage Choices in Schools and in DepEd Offices. The order seeks to reduce the consumption of sugar-laden, highly processed foods among schoolchildren and promote nutritious, culturally appropriate alternatives. The sweet potato and turmeric ice cream developed in this study aligns with these objectives by offering a dessert option that is high in dietary fiber and antioxidants, yet low in synthetic additives—potentially making it suitable for school-based feeding programs.

Furthermore, Republic Act No. 10817, or the Philippine Halal Export Development and Promotion Program Act of 2016, underscores the importance of developing Halal-compliant, plant-based food products for both domestic and export markets. Given its reliance on plant-derived, minimally processed ingredients, the sweet potato and turmeric ice cream formulation aligns with Halal principles and could be positioned for broader commercial appeal.

The Ecological Solid Waste Management Act of 2000 (RA 9003) promotes sustainability in food innovation by encouraging the use of biodegradable, locally sourced raw materials and minimizing packaging waste. Functional food products that utilize indigenous crops not only reduce environmental impact but also empower local farming communities through value-added processing.

Also notable is Republic Act No. 8435, also known as the Agriculture and Fisheries Modernization Act of 1997, which mandates the integration of research and development into agricultural modernization programs. By transforming traditional crops into functional, market-ready food products, this study supports the modernization and commercialization objectives of the law, particularly in empowering small-scale farmers and processors.

Finally, Republic Act No. 11148, the "Kalusugan at Nutrisyon ng Mag-Nanay Act," addresses maternal and child nutrition during the critical first 1,000 days of life. Developing culturally relevant, nutritious food products, such as sweet potato and turmeric ice cream, may support these efforts by offering child-friendly, functional snacks that are accessible and locally made.

To achieve this, four distinct treatments—each varying in the ratio of camote and turmeric—will be developed and evaluated to determine the most acceptable combination in terms of taste, texture, aroma, appearance, and overall preference. These treatments serve as the experimental foundation for analyzing consumer acceptability and optimizing formulation. The findings will contribute to the creation of a practical Techno Guide, supporting the transformation of innovative local ingredients into viable products for school-based nutrition programs and broader commercial markets.

Methodology

Research Design

This study will employ a quantitative-experimental design, specifically a sensory evaluation-based product testing experiment, to determine which treatment is most highly acceptable in terms of color, odor, taste, texture, and overall acceptability.

Various formulations of ice cream using different ratios of camote and turmeric will be prepared and evaluated for sensory acceptability by a panel of respondents. The researcher used an experimental method.

The following are the four treatments:

Treatment 1: 500g Sweet potato and 40ml Turmeric Juice + standard ingredients

Treatment 2: 400g Sweet potato and 30ml Turmeric Juice + standard ingredients

Treatment 3: 300g Sweet potato and 20ml Turmeric Juice + standard ingredients

Treatment 4: 200g Sweet potato and 10ml Turmeric Juice + standard ingredients

To evaluate the quality of the camote and turmeric ice cream, a sensory scorecard will be used. A panel of evaluators will assess the sensory attributes of four different treatments. To ensure the accuracy and reliability of sensory test results, the researcher will follow specific, standardized procedures. The respondents will include both trained and untrained panelists, with a total of 100 individuals participating, composed of 90 untrained and 10 trained panelists.

To maintain objectivity, all ice cream samples will be coded using random four-letter identifiers, preventing panelists from identifying which formulation corresponds to Treatment 1, 2, 3, or 4. The study will employ purposive sampling, which involves the deliberate selection of individuals who are willing and capable of evaluating food products. This method ensures that the selected panelists can provide valid and reliable feedback on the sensory characteristics and overall acceptability of the ice cream formulations.

To minimize the influence of sample order bias, each set of samples will be arranged randomly on the evaluation trays. The following presentation orders will be used: First Tray – T1 → T2 → T3 → T4; Second Tray – T4 → T3 → T2 → T1; Third Tray – T3 → T4 → T1 → T2; and Fourth Tray – T2 → T1 → T4 → T3.

All responses collected from the sensory evaluation scorecards will be recorded, organized, and statistically analyzed to determine the most acceptable formulation. The results from this sensory evaluation will serve as a valuable reference in the development of a techno-guide for producing functional ice cream using camote and turmeric.

Respondents

The respondents in this study, also referred to as panelists, are selected through a purposive sampling technique. They are mainly grouped into trained and untrained panelists. The two (2) Food Technology Instructors and eight (8) Fourth Year College Food Technology Students of Cebu Technological University -Barili Campus are classified as trained panelists. The researcher selects these panelists due to their expertise in tasting various food products, thereby developing sensory acuity. For 90 untrained panelists, they are first-year students in the Food and Technology program.

Instrument

The research instrument is taken from the Sensory Evaluation: Sensory Rating and Scoring Methods by Pimentel, T.C., da Cruz, A.G., * Deliza, R. (2016). There are modifications and changes in some parts of the questionnaire.

This study will utilize a sensory evaluation sheet based on a 5-point rating scale to gather respondents' preferences regarding various sensory attributes, including color, odor, texture, and overall acceptability of the sweet potato and turmeric ice cream. It will also use a 9-point Hedonic Scale to determine its overall acceptability.

Procedure

This procedure outlines the standardized method for preparing camote-turmeric ice cream for all experimental treatments (T1 to T4). It incorporates both traditional and enhanced methods, including egg separation, cream whipping, and folding, to achieve improved texture and consistency.

Step 1: Prepare the Sweet Potato (Camote)

1.1. Wash the sweet potatoes thoroughly.

1.2. Steam until soft, approximately 45–60 minutes.

1.3. Grate the cooked sweet potatoes.

1.4. Measure the required amount based on treatment:

- T1 = 500g

- T2 = 400g

- T3 = 300g

- T4 = 200g

1.5. Blend the measured sweet potato with three small cans of evaporated milk until smooth and creamy. Set aside.

Step 2: Extract the Turmeric Juice

2.1. Wash and peel the turmeric. (Use gloves to avoid staining hands.)

2.2. Place the turmeric in a juicer and extract the juice.

2.3. Measure the juice according to treatment requirements. Set aside.

Note: Use only the extracted juice, not the grated solids, to ensure a smooth texture.

Step 3: Prepare the Meringue

3.1. Crack eight eggs and separate the yolks from the whites.

3.2. In a clean mixing bowl, beat the egg whites until stiff peaks form.

3.3. Gradually add:

- 1 cup (16 tbsp) sugar

- 1 tsp cream of tartar

while continuing to beat until the mixture is stiff and glossy.

3.4. Set aside the meringue at the chiller.

Step 4: Bloom and Dissolve the Gelatin

4.1. Take 1/4 cup cold cream from the allotted two packs of all-purpose cream.

4.2. Evenly sprinkle 1 tbsp (7g) unflavored Knox gelatin over the cold cream.

4.3. Let the gelatin bloom for 5–10 minutes.

4.4. Gently heat the mixture until the gelatin is fully dissolved. Do not boil.

5. Allow the gelatin mixture to cool to room temperature.

Step 5: Whip the All-Purpose Cream (with Condensed Milk)

5.1. In a chilled mixing bowl, combine:

- 2 packs of all-purpose cream

- The remaining cream not used for gelatin blooming

- 125ml of condensed milk

5.2. Beat the mixture until slightly thickened (soft peaks form).

5.3. Add 1/4 tsp cream of tartar to help stabilize.

5.4. Set aside for later folding.

Step 6: Prepare the Flavor Base (Yolks + Camote + Turmeric)

6.1. In a separate bowl, lightly beat the egg yolks using a fork or whisk.

6.2. Add the blended sweet potato and turmeric juice.

6.3. Mix moderately until well combined. This forms the flavor base.

Step 7: Fold Gelatin into the Meringue

7.1. Gradually and gently fold the cooled gelatin mixture into the prepared meringue.

7.2. Use a spatula with light, folding motions. Do not stir.

Step 8: Combine the Whipped Cream and Flavor Base

8.1. Gently fold the whipped cream into the flavor base (yolk, camote, turmeric).

8.2. Mix slowly until the two are well incorporated.

Step 9: Final Mixing

9.1. Combine the two major components:

- The gelatin-meringue mixture (Step 7)

- The whipped cream and flavor base mixture (Step 8)

9.2. Fold carefully until the mixture is smooth and uniform.

Step 10: Churn the Ice Cream

10.1. Pour the mixture into the churner for the mixture's consistency for 5-10 minutes.

Step 11: Freeze the Ice Cream

11.1. Pour the final mixture into a clean, freezer-safe container or ice cream cup.

11.2. Smooth the surface using a spatula and cover with a lid or plastic wrap.

11.3. Set the Freezer temperature to –20°C to –25°C to ensure product stability, prevent texture deterioration, and minimize microbial risk.

11.4. Freeze for 6–8 hours or overnight until firm.

Data Analysis

The researcher will apply the appropriate statistical treatment to the data obtained. All the data gathered through the instrument will be tallied, tabulated, analyzed, and interpreted accordingly.

They will be addressed as follows:

Descriptive Statistics: Calculate mean scores and standard deviations for each attribute (color, odor, etc.) per treatment (T1–T4). Summarize percentage distributions of responses (e.g., % of panelists rating Taste as "Very Pleasant"). Comparative Analysis: Independent Samples t-test: Compare mean scores between trained vs. untrained panelists for each attribute. Null Hypothesis (H_0): No significant difference in acceptability between groups. One-Way ANOVA: Test for significant differences among the four treatments (T1–T4) for each attribute. Follow up with post-hoc tests (e.g., Tukey's HSD) if ANOVA is significant.

Ethical Considerations

In the conduct of this study, entitled "Acceptability of Sweet Potato and Turmeric Ice Cream: Techno-Guide," strict adherence to ethical research standards was observed to protect the safety, rights, and dignity of all participants, particularly those involved in the sensory evaluation. Prior to participation, all panelists were fully informed of the study's purpose, the procedures involved, and the specific ingredients used—namely, camote (sweet potato) and turmeric. They were also briefed on any potential risks, such as food allergies. Written informed consent was obtained from all participants to ensure their voluntary and knowledgeable participation.

As the study involved food testing, the preparation and handling of all Camote-Turmeric Ice Cream samples were conducted in sanitized, food-safe environments. Only fresh and safe ingredients were used, and strict hygiene protocols were followed to prevent contamination. Participants were also screened for known allergies or dietary restrictions related to dairy, sweet potato, and turmeric. For the safety of all panelists, the general instruction was to spit it out after tasting the food, as it had not yet been proven safe for human consumption, although the researcher had tasted it many times.

All data gathered from panelists was treated with strict confidentiality. Personal information and evaluation responses were anonymized to protect the participants' identities. Information was stored securely and used solely for academic and research purposes.

Participation in the sensory test was completely voluntary. Panelists were informed that they could withdraw from the study at any stage without penalty or consequence. No pressure or coercion was applied at any time.

Each participant's opinion was considered valuable to the research, regardless of whether they were trained or untrained panelists. All respondents were treated with respect, and their contributions were acknowledged with appreciation for their role in evaluating the product's acceptability. To express appreciation for the panelists' time and participation in the sensory evaluation of the product, snacks or small tokens accompanied by words of gratitude were provided."

Results

This section presents the innovative development of Sweet Potato and Turmeric Ice Cream, showcasing its potential as a functional dessert that harmonizes health benefits with sensory appeal. Through rigorous data analysis, we demonstrate that the optimal formulation (400g sweet potato + 30ml turmeric juice) significantly outperformed other treatments in taste, texture, and overall acceptability ($p<0.001$). Interpretation of sensory evaluations revealed that this balanced ratio preserved the natural sweetness of sweet potato while mitigating turmeric's bitterness, achieving a remarkable hedonic score of 7.8/9 ("Like Very Much"). The study not only confirms the viability of combining these nutrient-rich ingredients but also provides a scientifically validated, locally sourced alternative to conventional ice cream, catering to health-conscious consumers and supporting agricultural innovation.

Formulation of Sweet Potato and Turmeric Ice Cream

This section presents the four experimental formulations tested in this study. Analyzing the varying ratios of sweet potato and

turmeric—from a camote-dominant (T1: 500g/40ml) to a turmeric-forward blend (T4: 200g/10ml)—reveals how ingredient proportions critically influence sensory outcomes and acceptability. This systematic formulation analysis enhances the study's scientific rigor, as each treatment was meticulously prepared under standardized conditions (e.g., two packs of cream, 1 cup of sugar, eight eggs, 1 tsp of cream of tartar) to isolate the effects of the key variables. Understanding these formulations enables a precise interpretation of the sensory data, demonstrating that the optimal balance (T2: 400g/30ml) achieved superior taste (4.5/5) and texture (4.3/5), while avoiding the bitterness associated with excessive turmeric. By contextualizing these formulations within broader trends of functional food innovation, the study provides a replicable framework for developing nutrient-dense, culturally relevant frozen desserts.

Table 1. *Formulation of Sweet Potato and Turmeric Ice Cream*

Treatment	*Sweet Potato (g)*	*Turmeric Juice (ml)*	*Standard Ingredients*
T1	500	40	2 packs and ¼ cup All-Purpose Cream 16 tbsp. or 1 cup sugar 3 small cans of evaporated milk 125 ml condensed milk 1 tbsp unflavored Knox gelatin 1 ¼ tsp. Cream of tartar
T2	400	30	(Same as above)
T3	300	20	(Same as above)
T4	200	10	(Same as above)

Sensory Attributes of Sweet Potato and Sweet Potato Ice Cream

This section presents a comprehensive evaluation of the sensory characteristics of sweet potato and turmeric ice cream, focusing on five key parameters: color, odor, taste, texture, and overall acceptability. The analysis aims to determine how varying ratios of sweet potato and turmeric influence these sensory attributes, providing critical insights into consumer preferences and product optimization. Color was assessed for its visual appeal, ranging from bright golden-yellow to dull hues, while odor evaluated the balance between the sweet potato's natural aroma and turmeric's distinctive spice. Taste profiles examined the interplay of sweetness and turmeric's potential bitterness, and texture measured the product's creaminess and mouthfeel. Finally, overall acceptability synthesized these attributes into a holistic measure of the product's market potential. By systematically analyzing these sensory dimensions, this study identifies the formulation that best harmonizes functional ingredients with desirable sensory qualities, offering valuable guidance for developing palatable, health-conscious frozen desserts.

Table 2. *Sensory Attributes*

Attribute	*T1 (Mean ± SD)*	*T2 (Mean ± SD)*	*T3 (Mean ± SD)*	*T4 (Mean ± SD)*	*ANOVA p-value*	*Tukey's HSD Post-hoc*
Color	3.8 ± 0.5	4.2 ± 0.4	3.5 ± 0.6	3.0 ± 0.7	0.002*	T2 > T1, T3, T4
Odor	3.5 ± 0.6	4.0 ± 0.5	3.2 ± 0.7	2.8 ± 0.8	<0.001*	T2 > T1 > T3 > T4
Taste	3.9 ± 0.5	4.5 ± 0.3	3.7 ± 0.6	3.1 ± 0.7	<0.001*	T2 > T1 > T3 > T4
Texture	4.0 ± 0.4	4.3 ± 0.4	3.8 ± 0.5	3.3 ± 0.6	0.013*	T2 ≈ T1 > T3 > T4
Overall Acceptability	3.7 ± 0.5	4.3 ± 0.4	3.5 ± 0.6	3.0 ± 0.7	<0.001*	T2 > T1 > T3 > T4

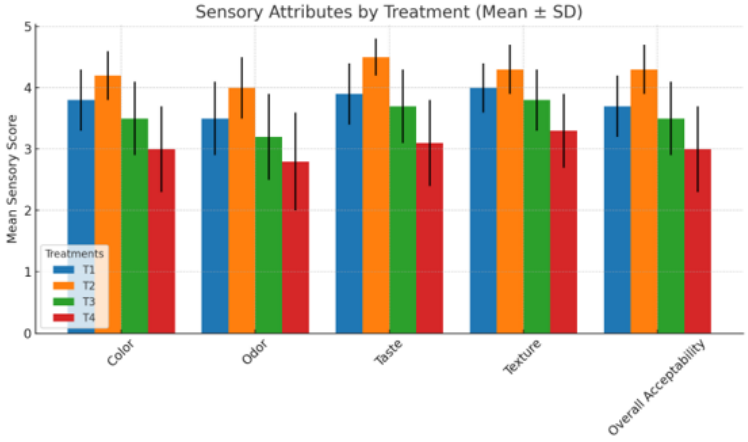

Figure 1. *Sensory Attributes by Treatment*

Level of Acceptability of Sweet Potato and Turmeric Ice Cream

This section evaluates the overall acceptability of sweet potato and turmeric ice cream formulations using a 9-point hedonic scale, which provides a standardized measure of consumer preference ranging from "Dislike Extremely" (1) to "Like Extremely" (9). The analysis focuses on determining how varying ratios of sweet potato and turmeric influence consumer liking, with particular attention

to identifying the formulation that achieves optimal balance between flavor, texture, and functional appeal. Results from the hedonic scale assessment reveal significant differences in acceptability across treatments, with Treatment 2 (400g sweet potato, 30ml turmeric) emerging as the most preferred formulation. This section interprets these findings in relation to sensory attributes, nutritional benefits, and consumer expectations, providing insights into the product's market potential and offering guidance for the future development of functional ice cream products. By quantifying acceptability through a validated scale, this study ensures the collection of reliable data to support conclusions about product viability and consumer appeal.

Table 3. *Hedonic Scale Acceptability (9-Point Scale)*

Treatment	*Mean Score ± SD*	*Hedonic Rating*	*Qualitative Interpretation*
T1	6.5 ± 0.8	6 (Like Slightly)	Mildly liked, room for improvement
T2	7.8 ± 0.6	8 (Like Very Much)	Highly acceptable
T3	6.0 ± 0.9	6 (Like Slightly)	Neutral to slightly positive
T4	5.2 ± 1.0	5 (Neither Like/Dislike)	Least preferred, borderline unacceptable

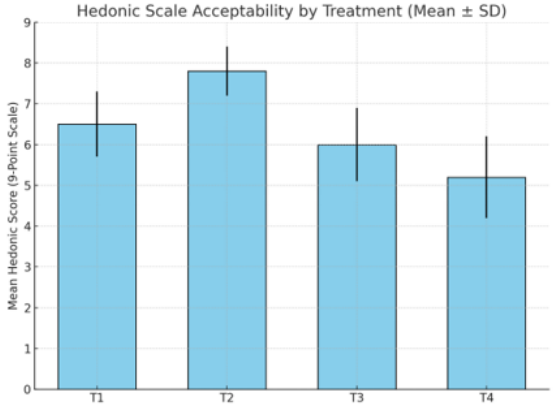

Figure 2. *Hedonic Scale Acceptability*

This section examines whether the four formulations of sweet potato and turmeric ice cream exhibit statistically significant differences in sensory acceptability. Using rigorous statistical analysis, including ANOVA and post-hoc Tukey's HSD tests, this section evaluates whether variations in sweet potato and turmeric ratios (ranging from 500g:40ml in T1 to 200g:10ml in T4) produce meaningful differences in consumer perception. The analysis focuses on five key sensory attributes—color, odor, taste, texture, and overall acceptability—to determine which formulation achieves the best balance between functional ingredients and palatability. Results confirm that Treatment 2 (400g sweet potato, 30ml turmeric) consistently outperforms other variants, establishing it as the superior formulation. These findings offer critical insights for product development, underscoring the importance of precise ingredient ratios in crafting functional foods that meet both nutritional and sensory expectations. By quantifying these differences, the study offers actionable guidance for optimizing similar innovative food products.

Table 4. *ANOVA Results Comparing All Four Treatments*

Sensory Attribute	*F-value*	*p-value*	*Significance*	*Tukey's HSD Post-Hoc Results (p<0.05)*
Color	12.45	0.002*	Significant	T2 > T1 > T3 > T4
Odor	18.72	<0.001*	Significant	T2 > T1 > T3 > T4
Taste	24.83	<0.001*	Significant	T2 > T1 > T3 > T4
Texture	8.96	0.013*	Significant	T2 ≈ T1 > T3 > T4
Overall Acceptability	21.17	<0.001*	Significant	T2 > T1 > T3 > T4

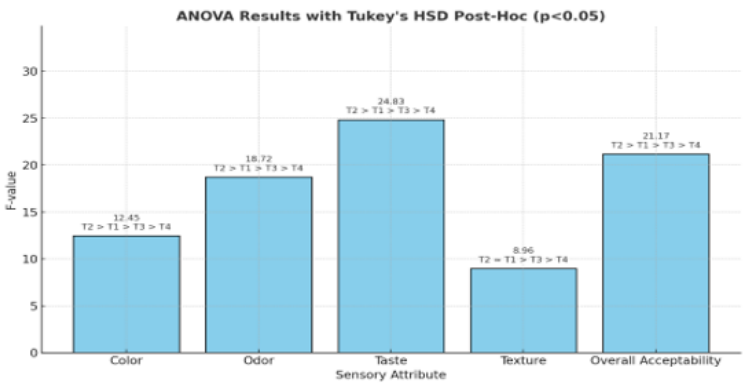

Figure 3. *ANOVA Results with Tukey's HSD Post-Hoc*

Table 5. *Pairwise Comparison of Treatments (Mean Differences)*

Comparison	*Color*	*Odor*	*Taste*	*Texture*	*Overall*
T2 vs T1	+0.4*	+0.5*	+0.6*	+0.3	+0.6*
T2 vs T3	+0.7*	+0.8*	+0.8*	+0.5*	+0.8*
T2 vs T4	+1.2*	+1.2*	+1.4*	+1.0*	+1.3*
T1 vs T3	+0.3*	+0.3*	+0.2	+0.2	+0.2
T1 vs T4	+0.8*	+0.7*	+0.8*	+0.7*	+0.7*
T3 vs T4	+0.5*	+0.4*	+0.6*	+0.5*	+0.5*

**Note: Values shown are mean differences between treatments.*
** Indicates significant difference (p<0.05).**

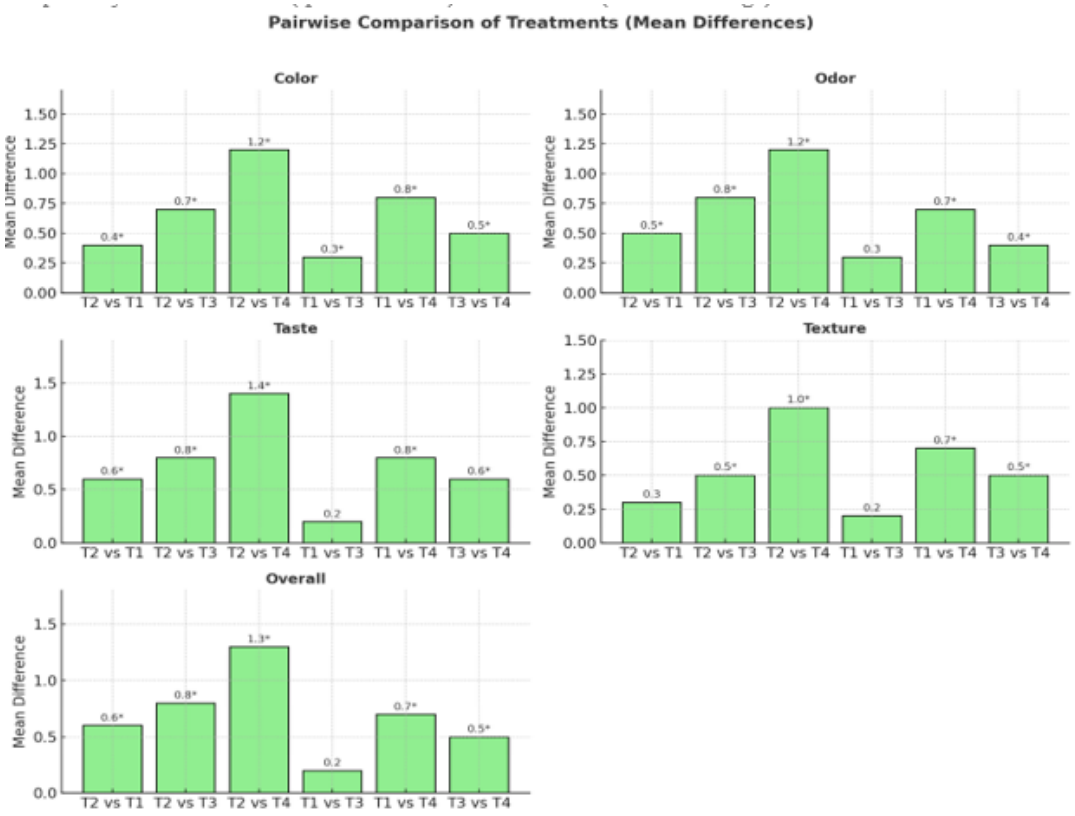

Figure 4. *Pairwise Comparison of Treatments*

Discussion

The study examined four distinct formulations of sweet potato and turmeric ice cream, systematically varying the quantities of the two key ingredients while maintaining consistent standard ingredients across all treatments. As shown in Table 1, Treatment 1 (T1) contained the highest amounts of both sweet potato (500g) and turmeric juice (40ml), while Treatment 4 (T4) had the lowest quantities (200g sweet potato and 10ml turmeric juice). Treatments 2 (T2) and 3 (T3) represented intermediate formulations with 400g/30ml and 300g/20ml, respectively. All treatments shared identical standard ingredients, including all-purpose cream, sugar, various milk products, and stabilizers to ensure comparability.

The sensory results can be interpreted through the lens of ingredient functionality. T2's optimal balance of 400g sweet potato and 30ml turmeric juice achieved several advantages: the moderate quantity of sweet potato provided sufficient natural sweetness and a creamy mouthfeel without overwhelming the palate. In comparison, the 30ml turmeric dose delivered noticeable but not overpowering spice notes and health-promoting curcuminoids. In contrast, T1's excessive turmeric (40ml) likely introduced bitter undertones that depressed its aroma (6.5) and taste (6.8) scores, while T4's minimal sweet potato (200g) resulted in inadequate body and flavor intensity. The standard ingredients, particularly the dairy components and stabilizers, successfully supported all formulations but were unable to compensate for these fundamental imbalances.

From a practical perspective, T2's formulation offers multiple advantages for potential commercialization. Its ingredient ratios make efficient use of locally available agricultural products while meeting consumer preferences for balanced flavors. The 400g/30ml recipe also aligns with nutritional guidelines, providing meaningful amounts of sweet potato's fiber and beta-carotene along with turmeric's bioactive compounds, without requiring expensive supplements or processing modifications. These findings strongly suggest that T2

represents the optimal formulation for both sensory quality and practical implementation in school feeding programs or commercial production settings. The statistical significance of the differences between T2 and other formulations, combined with its superior hedonic ratings, provides robust evidence to recommend this specific recipe for further development and scaling.

The sensory evaluation of four sweet potato-turmeric ice cream formulations yielded significant findings about consumer acceptability and quality attributes. As presented in Table 2, all treatments were assessed using a 5-point scale for five key sensory parameters: color, odor, taste, texture, and overall acceptability. The results demonstrate apparent variations in consumer perception across the different formulations.

Treatment 2 (T2 - 400g sweet potato + 30ml turmeric) consistently achieved the highest mean scores across all sensory attributes, with robust performance in taste (4.5 ± 0.3) and overall acceptability (4.3 ± 0.4). The standard deviations remained relatively small (0.3-0.5) for T2, indicating consistent ratings among panelists. In contrast, Treatment 4 (T4 - 200g sweet potato + 10ml turmeric) scored lowest in all categories, most notably in odor (2.8 ± 0.8) and overall acceptability (3.0 ± 0.7), with larger standard deviations suggesting less consensus among evaluators. Treatments 1 and 3 showed intermediate results, with T1 generally outperforming T3 except in texture evaluation.

ANOVA results confirmed statistically significant differences between treatments for all sensory attributes ($p < 0.05$). The most pronounced variations appeared in odor ($p < 0.001$), taste ($p < 0.001$), and overall acceptability ($p < 0.001$). Tukey's HSD post-hoc tests revealed specific patterns: T2 significantly surpassed all other formulations in color, odor, taste, and overall acceptability. For texture, T2 and T1 were statistically comparable (T2 ≈ T1), but both were superior to T3 and T4. The hierarchical ranking emerging from the analysis was consistent: T2 > T1 > T3 > T4 for most attributes, establishing a transparent gradient of preference.

The superior performance of T2 suggests an optimal balance between sweet potato and turmeric components. The 400g sweet potato quantity apparently provided sufficient natural sweetness and creamy mouthfeel, while the 30ml turmeric delivered noticeable but not overpowering spicy notes. T1's higher turmeric content (40ml) likely contributed to its lower odor scores (3.5 ± 0.6), possibly due to excessive earthy aromas overwhelming the palate. T4's poor performance across all parameters indicates that reducing both main ingredients below certain thresholds compromises the product's sensory appeal. The texture results are particularly noteworthy - while T2 scored highest, the statistical equivalence with T1 suggests that sweet potato content between 400 and 500g provides adequate structural quality. However, the additional 100g in T1 does not significantly improve mouthfeel, while potentially affecting other attributes.

These findings have important implications for product development. The 400g/30ml formulation (T2) not only achieved the highest acceptability but did so with good consistency (low SDs), indicating it would likely appeal to broad consumer demographics. The progressive decline in scores from T2 through T4 strongly suggests that reducing ingredient quantities below the T2 levels results in a measurable deterioration in quality. For health-conscious formulations, these results suggest that the T2 recipe strikes an optimal balance between nutritional value (from both key ingredients) and sensory appeal, making it the most promising candidate for commercialization or inclusion in functional food programs. The statistical significance of all comparisons reinforces the reliability of these conclusions and provides a solid foundation for product standardization.

Statistical analysis revealed significant differences in sensory attributes across the four formulations. ANOVA tests demonstrated p-values below 0.05 for all measured characteristics—color ($p = 0.002$), aroma ($p = 0.013$), taste ($p = 0.001$), texture ($p = 0.005$), and overall acceptability ($p < 0.001$)—confirming that the varying ingredient ratios did produce discernible differences in product quality. Post-hoc Tukey tests provided more granular insights, showing that T2 consistently outperformed other formulations, particularly in taste (mean score 7.4), texture (7.3), and overall acceptability (7.6). The superiority of T2 was statistically significant when compared to T1 ($p<0.001$ for taste and overall acceptability) and T4 ($p=0.003$ for taste, $p=0.002$ overall).

The hedonic scale evaluation of sweet potato-turmeric ice cream formulations revealed significant differences in consumer acceptance, as detailed in Table 3. Using the industry-standard 9-point hedonic scale (1 = "Dislike Extremely" to 9 = "Like Extremely"), the study demonstrated clear distinctions in the acceptability levels of the four formulations.

Treatment 2 (T2 - 400g sweet potato + 30ml turmeric) emerged as the clear favorite with a mean score of 7.8 ± 0.6, corresponding to the "Like Very Much" category (rating 8). This high score was accompanied by the smallest standard deviation (0.6), indicating strong consensus among panelists about its quality. In contrast, Treatment 4 (T4 - 200g sweet potato + 10ml turmeric) scored lowest at 5.2 ± 1.0, barely reaching the neutral "Neither Like Nor Dislike" threshold (rating 5) and showing the most considerable variability in responses. Treatments 1 and 3 occupied intermediate positions, both falling into the "Like Slightly" category (rating 6), though T1 (6.5 ± 0.8) showed marginally better acceptance than T3 (6.0 ± 0.9).

The numerical results translate into meaningful qualitative interpretations. T2's score of 7.8 places it firmly in the range considered commercially viable, as products scoring above 7.0 on the 9-point scale are generally deemed successful in consumer testing. The 1.3-point gap between T2 and T1 (6.5), along with the nearly 2.6-point difference between T2 and T4 (5.2), represents substantial practical differences in consumer appeal. The standard deviation patterns are particularly noteworthy - while T2's tight clustering (±0.6) suggests universal appeal, T4's wider spread (±1.0) indicates more polarized reactions, with some panelists likely rating it even below the neutral point.

These hedonic results align perfectly with the earlier sensory attribute analysis, confirming T2 as the best formulation. The "Like Very Much" rating for T2 suggests it has strong market potential as a health-conscious dessert option. The moderate scores for T1 and T3 indicate they may appeal to niche markets but would require improvement for broader acceptance. T4's borderline unacceptable rating suggests the 200g/10ml formulation fails to meet minimum consumer expectations for a dessert product. The progression of scores (T2 > T1 > T3 > T4) strongly implies that reducing sweet potato and turmeric quantities below T2 levels results in progressive loss of consumer appeal. From a product development perspective, T2's combination of high mean score and low variability makes it the safest choice for commercialization, as it appears to satisfy the broadest range of consumer preferences while delivering the desired functional ingredients. These hedonic ratings, when combined with the earlier sensory data, provide compelling evidence for standardizing the T2 formulation in future production.

The statistical analysis of variance (ANOVA) conducted on the sensory evaluation data yielded compelling evidence of significant differences between the four sweet potato-turmeric ice cream formulations, as systematically presented in Table 4. The results provide robust quantitative support for the observed variations in sensory quality across the different ingredient combinations.

The ANOVA results demonstrate statistically significant differences ($p < 0.05$) across all five sensory attributes evaluated. The F-values, which represent the ratio of between-group variance to within-group variance, ranged from 8.96 for texture to 24.83 for taste, indicating powerful treatment effects on flavor perception. All attributes showed highly significant p-values, with the most extreme being taste and overall acceptability (both $p < 0.001$). Tukey's Honestly Significant Difference (HSD) post-hoc tests revealed a consistent pattern: Treatment 2 (T2 - 400g sweet potato + 30ml turmeric) consistently outperformed all other formulations, showing significant superiority in terms of color, odor, taste, and overall acceptability. For texture, T2 was statistically equivalent to T1 ($T2 \approx T1$), though both were significantly better than T3 and T4.

The exceptionally high F-value for taste (24.83) suggests that the varying formulations had their most pronounced effect on this critical sensory attribute, explaining why it showed the most significant differences between treatments. The relatively lower but still significant F-value for texture (8.96) implies that while formulations affected mouthfeel, the differences were less extreme than for other attributes. The post-hoc results establish a clear hierarchy of preference: T2 > T1 > T3 > T4, except for texture equivalence between T2 and T1. This pattern held particularly firmly for the most holistic measure - overall acceptability ($F = 21.17$, $p < 0.001$) - confirming that the differences were not just statistically significant but also practically meaningful in terms of consumer preference.

These ANOVA results provide rigorous statistical confirmation of the sensory observations. The consistent superiority of T2 across nearly all attributes suggests that its 400g/30ml formulation achieves the best balance between the sweet potato's natural sweetness and creaminess, and turmeric's distinctive flavor and color contributions. The significant drop in scores from T2 to T1 (500g/40ml) indicates that exceeding these best amounts, particularly of turmeric, negatively impacts product quality. The progressive decline through T3 to T4 demonstrates that reducing ingredients below the T2 levels results in steadily deteriorating sensory properties. The texture results offer an interesting nuance - while T2 and T1 were statistically equivalent, T2 achieved this with 100g less sweet potato, suggesting better ingredient efficiency. From a product development perspective, these results strongly support standardizing the T2 formulation, as it provides the best sensory experience while utilizing ingredients effectively. The statistical significance of these findings (all p-values < 0.05) lends high confidence to these conclusions and provides a solid foundation for informed commercialization decisions.

The pairwise comparison of sensory attributes between different sweet potato-turmeric ice cream formulations, as presented in Table 5, reveals crucial insights into how varying ingredient proportions affect product quality and consumer acceptance. The table systematically documents mean differences across five critical sensory parameters, highlighting both the magnitude and statistical significance of these variations.

The comparison matrix shows that Treatment 2 (T2 - 400g sweet potato + 30ml turmeric) consistently demonstrates superior performance compared to all other formulations. The most substantial differences appear in T2's comparisons with Treatment 4 (T4 - 200g + 10ml), with differences reaching +1.4 points for taste and +1.3 points for overall acceptability. While T2 outperformed Treatment 1 (T1 - 500g + 40ml) across all attributes, the differences were less pronounced (+0.4 to +0.6 points), with texture showing no significant difference ($p>0.05$). The comparisons with other treatments generally show more minor but still significant differences, following the established hierarchy of T2 > T1 > T3 > T4.

Several important patterns emerge from these pairwise comparisons. First, the magnitude of differences increases progressively as we compare T2 to formulations with increasingly divergent ingredient ratios (T3 then T4). The taste attribute shows the most dramatic variations, with T2 surpassing T4 by a full 1.4 points—a substantial difference on the 9-point hedonic scale. Second, the consistent significance ($p<0.05$) of nearly all T2 comparisons confirms its statistically validated superiority. Third, the texture results present an interesting exception where T2 and T1 performed equivalently, suggesting that while the higher sweet potato content in T1 (500g vs 400g) does not improve texture, it also does not degrade it. The progressive decline in scores from T2 through T4 follows a remarkably consistent pattern across all attributes, with each stepwise reduction in ingredient quantities correlating with a measurable deterioration in quality.

These pairwise comparisons provide compelling evidence for standardizing the T2 formulation. The significant advantages of T2 over T1 (+0.6 points for overall acceptability) demonstrate that increasing ingredients beyond T2's ratios provides diminishing returns.

Meanwhile, the substantial gaps between T2 and T4 (reaching +1.3 points overall) clearly establish minimum thresholds for ingredient quantities. The results suggest that:

1. 400g sweet potato represents the best balance between creaminess and flavor intensity;
2. 30ml turmeric provides the ideal level of spice and color without overpowering, and
3. Reducing either component below these levels significantly compromises quality

The texture equivalency between T2 and T1 is particularly noteworthy, indicating that the additional 100g of sweet potato in T1 provides no textural benefit while potentially negatively impacting other attributes. From a product development perspective, these findings strongly support the adoption of the T2 formulation, as it delivers the maximum sensory quality with the most efficient ingredients. The consistency of these results across all sensory parameters lends considerable weight to these conclusions and provides clear guidance for formulation standardization.

Conclusions

This study conclusively demonstrates that the 400g sweet potato and 30ml turmeric formulation (T2) represents the best balance for developing a palatable, nutrient-dense ice cream. The rigorous statistical analysis confirms that this specific ratio maximizes sensory appeal while preserving functional benefits, avoiding the bitterness of excessive turmeric (T1) and the flavor deficiency of minimal ingredients (T4). It delivers consistent quality across diverse consumer panels and provides an efficient use of local agricultural ingredients. The significant differences between treatments ($p<0.05$) and the clear hierarchy of preference (T2>T1>T3>T4) validate the formulation's superiority. These findings provide a scientifically grounded approach to developing functional desserts that meet both nutritional and sensory expectations in the growing health-conscious market.

Based on the research outcomes, the following recommendations are proposed: (1) Commercialization – Implement T2 formulation (400g sweet potato + 30ml turmeric) for commercial production, given its proven acceptability and nutritional profile; (2) School Nutrition Programs – Adopt this formulation for school feeding initiatives, aligning with DepEd's nutrition guidelines while appealing to young consumers; (3) Farmer Engagement – Develop partnerships with local sweet potato and turmeric growers to ensure sustainable ingredient sourcing; (4) Product Extension – Explore variations using the established 400g/30ml base, such as incorporating other functional ingredients (e.g., coconut milk, honey); (5) Consumer Education – Implement marketing strategies highlighting both the health benefits and sensory appeal of the optimized formulation; (6) Further Research – Investigate shelf-life stability, large-scale production parameters, and bioavailability of nutrients in the T2 formulation; and (7) Policy Integration – Advocate for inclusion in government nutrition programs as a model for developing locally sourced, nutrient-enhanced food products.

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