

Sensory Evaluation of a Tuna-Enhanced Ice Cream

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Abstract: The study was conducted to evaluate the tuna enhanced ice cream for both sensory attributes (color, aroma, taste, texture), physicochemical properties (sweetness, melting rate, and pH) and its comparative costing and ROI. It utilized an experimental research design in a Completely Randomized Design (CRD) with two treatments: (1) control ice cream without tuna, and (2) ice cream with tuna incorporation. Each treatment was prepared with five replications.

Result shows that both trained panelists and customer evaluators liked the product when they tested it with their senses. Customers evaluated the tuna ice cream as "Like Extremely," which shows that it could sell well as a new frozen treat. In terms of physicochemical attributes, the control had a higher pH, less sweetness (°Bx), and melted more quickly than the tuna ice cream. Tuna proteins lower liquid sugar, change pH, and change how things freeze.

Lastly, the t-test showed that the only sensory characteristic that was statistically different between trained and consumer raters was taste. In terms of physicochemical indicators, the pH changed significantly because of the tuna enhancement, but the sweetness and melting rate did not. Likewise, the tuna enhanced ice cream shows a more favourable cost of goods per serving (COGS) percentage as compared to the control treatment.

Keywords: Tuna, Acceptability, and Enhancement.

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I. INTRODUCTION

Ice cream is a highly popular frozen dairy product globally, recognized for its desirable flavor, creamy consistency, and adaptability. Ice cream has historically been regarded as a sweet dessert; however, recent trends in the food industry indicate an increasing demand for innovative and functional foods that extend beyond traditional flavor profiles (Guinard, 2018). A substantial portion of milk produced in various countries is utilized for the manufacture of frozen desserts (Me-elahi et al. 2002). Likewise Choo, Leong, and Henna (2010) described ice cream as a frozen and aerated dairy-based food typically linked to happiness, pleasure, and fun. Psychologically, its consumption induces a pleasurable state in individuals.

Various functional ingredients may be incorporated into foods to enhance quality and rheological properties, provide health benefits, or achieve desired product structure appearances (Zuidam and Velikov 2018). As consumer interest in foods that offer enjoyment alongside nutritional

benefits increases, researchers and food innovators are investigating unconventional ingredients that enhance ice cream's value (Muse & Hartel, 2004; Ares et al., 2010). Several research studies clearly shows the capacity of natural extracts like ginger, basil, fruit pulps and functional additives (dietary fibers, prebiotics) to augment antioxidant activity, nutritional value, and sensory attractiveness in ice cream formulations (Gabbi et al., 2018; Soukoulis et al., 2014). To date, there are innovative ice cream in the market like the Tilapia ice cream developed by Central Luzon State University and the onion-based ice cream by Occidental Mindoro State College.

The Philippines ranks among the largest tuna producers globally; however, challenges such as post-harvest losses and underutilization hinder the maximization of its value (Philippine Statistics Authority, 2023). Tuna represents a significant but underexploited resource in the Philippines. Occidental Mindoro, recognized as a segment of the nation's "Tuna Highway," serves as a significant fishing area characterized by the abundance of various tuna species,

including *Auxis thazard* (tulingan), *Auxis rochei* (bullet tuna), and *Katsuwonus pelamis* (skipjack). The province's abundant marine resources play a crucial role in local consumption and export markets. This abundance results in surplus catch, especially for smaller tuna species such as tulingan, which are often underutilized or command lower market value relative to premium tuna varieties. This scenario underscores the necessity for initiatives that enhance the value of tuna resources and reduce post-harvest losses.

Thus, it could be a potential ingredient for innovation in frozen desserts is Tulingan or Tuna (*Katsuwonus pelamis*), a widely available fish species in the Philippines. Tuna provides a significant source of protein, omega-3 fatty acids, vitamins, and minerals, which are vital for human health (Gopakumar, 2017). The integration of tuna into value-added products, including ice cream, may yield nutritional and economic advantages. Limited research on fish-based ingredients in frozen desserts creates a knowledge gap concerning consumer acceptability and physicochemical effects.

Likewise, the identified knowledge gap necessitates for a product innovation and facilitates the development of flavored ice creams with improved health benefits and consumer appeal (Gabbi et al., 2018; Moriano & Alamprese, 2017).

The inclusion of tuna in ice cream, while nutritionally beneficial, prompts inquiries regarding consumer acceptance and the overall quality of the product. The unique flavor and aroma of fish can influence sensory perception, while its protein content may modify the physicochemical properties of ice cream, including texture, overrun, and melting characteristics. Thus, this study was conducted to:

- Determine the sensory evaluation of tuna enhanced ice cream, in terms of: aroma, taste, texture, and color.
- Evaluate the physicochemical properties of tuna enhanced ice cream, in terms of: sweetness, melting rate, and pH.
- Test the significant difference between the treatments in terms of sensory evaluation and physicochemical properties.
- Determine the comparative costing and ROI of the tuna enhance ice cream,

II. MATERIALS AND METHOD

➤ Research Design

The study utilized an experimental research design in a Data with two treatments: (1) control ice cream without tuna, and (2) ice cream with tuna enhancement (250 grams of tuna in 1000 grams of ice cream based) from August 1-September 2025.

Each treatment was prepared with five replications. The ice cream samples were evaluated for both sensory attributes (color, aroma, taste, texture) and physicochemical properties (sweetness, melting rate, and pH).

➤ Materials

➤ Ingredients

- Fresh tuna (*Aluy or tulingan*), pre-cooked
- Full cream milk
- Heavy cream (35% fat)
- White sugar
- Skim milk powder
- Salt
- Optional seasonings: white pepper or herbs (minimal use for flavor balance)

➤ Equipment

- Weighing scale (digital, ±0.1 g accuracy)
- Measuring cups and spoons
- Saucepan and mixing bowls
- Thermometer (0–100 °C range)
- Blender or food processor
- Fine mesh strainer
- Ice cream maker (or manual freeze–stir method)
- Freezer (-18 °C)
- pH meter or pH test strips
- Refractometer
- Stopwatch or timer
- Containers for storage (plastic tubs, 250 mL each)
- Measuring cylinders/beakers (100–500 mL)

➤ Experimental Lay out

Table 1 The experimental layout for a Completely Randomized Design (CRD) with two treatments: T1: Control and T2: Tuna-enhanced.

	Col1	Col2	Col3	Col4	Col5
Row A	Control	Tuna	Control	Tuna	Control
Row B	Tuna	Control	Tuna	Control	Tuna

➤ *Preparation of Tuna*

- **Cooking:** Fresh tuna fillets were boiled in 1% salt solution for 5–7 minutes until fully cooked.
- **Deodorizing (optional):** Cooked tuna was soaked in water with a small amount of lemon juice for 10 minutes to reduce fishy odor.
- **Blending:** The tuna was finely minced.

➤ *Procedure:*

- Mix milk, cream, sugar, skim milk powder, stabilizer, and salt in a saucepan.
- **Pasteurization:** Heat mixture to 80 °C for 25 seconds (or 69 °C for 30 minutes in batch pasteurization), with constant stirring.
- Rapidly cool mixture to 4 °C.
- Age the mixture for 4–6 hours at 4 °C.
- Churn mixture in an ice cream maker until it reaches semi-solid consistency (~-5 °C).
- Harden in freezer at -18 °C for at least 12 hours before evaluation.

❖ *Data Gathering*

➤ *Sensory Evaluation*

A total of 10 faculty with National Certificate on Food Processing and 30 Grade 7 & 8 students from Magsaysay National High School were selected to test the acceptability level. Panelists were asked for allergies to fish or dairy before participation. Informed consent was sought before the conduct of the study.

- **Method:** 5-point Hedonic Scale (1 = Dislike Very Much; 5 = Like Very Much)
- **Attributes Rated:** Color, Aroma, Taste Texture
- **Sample Presentation:** Each treatment was coded with random letters, served in 30 mL portions in white cups at -12 to -14 °C. Water was provided for palate cleansing between samples.

➤ *Physicochemical Tests*

- **Sweetness-**It is measure using refractometer on the liquid mix—not on the frozen product. Read at ~20 °C (room temp). If the ice cream is already frozen, melt it fully, mix gently, and measure.
- **Melting Rate-** Place the ice cream on a wire mesh above a beaker at 25 °C. Record time to first drip and weight of melted portion every 10 minute for 60 minutes.
- **pH Measurement-**It measure pH of thawed ice cream using pH meter at 10 °C.

➤ *Statistical Analysis*

Sensory data and physicochemical properties were tabulated and summarized as means ± standard deviation. T-test was used to determine significant differences among treatments. A 5% significance level (p < 0.05) was used.

III. RESULTS AND DISCUSSIONS

➤ *Sensory Evaluation of Tuna Enhanced Ice Cream*

A sensory evaluation of control ice cream was performed utilizing a 5-point hedonic scale, where trained panelists and consumer evaluators assessed aroma, taste, color, and texture. Results are presented in Table 1.

The control ice cream formulation, prepared without tuna, was evaluated by both trained panelists and consumer evaluators across four sensory attributes: aroma, taste, color, and texture. Results indicate high acceptability overall, with consumer ratings consistently higher than those of trained evaluators.

The sensory evaluation of the control treatment indicates that the standard ice cream formulation achieves high acceptability across all attributes, especially in taste and texture according to consumer feedback. The findings reveal a consistent trend: trained evaluators generally assess the product more critically, whereas consumers display greater enthusiasm. This distinction highlights the necessity of evaluating both groups to achieve comprehensive feedback for product development.

Table 2. Sensory Evaluation for the Control Ice Cream.

Sensory Evaluation	TRAINED EVALUATOR						CONSUMER EVALUATOR					
	R1	R2	R3	R4	R5	Mean	R1	R2	R3	R4	R5	Mean
Aroma	4.52	4.65	4.50	4.45	4.60	4.54	4.60	4.80	4.52	4.40	4.60	4.58
Taste	4.30	4.20	4.30	4.30	4.50	4.32	4.56	4.80	4.82	4.80	4.72	4.74
Color	4.50	4.20	4.40	4.40	4.70	4.44	4.52	4.70	4.65	4.70	4.78	4.67
Texture	4.20	4.20	4.50	4.50	4.62	4.40	4.80	4.60	4.80	4.60	4.62	4.68
Grand Mean	4.43, Like						4.67, Like Extremely					

Legend: 0.50-1.50- Dislike Extremely; 1.51-2.50- Dislike; 2.51-3.50- Neutral;3.51-4.50-Like;4.51-5.00- Like Extremely

A sensory evaluation of tuna-enhanced ice cream was performed involving trained evaluators and consumer panelists, concentrating on aroma, taste, color, and texture. The results indicated a generally favorable acceptability, with consumers providing higher ratings than trained evaluators for all attributes. Aroma is a distinct, pleasant odor linked with food and beverages. Aroma averaged 4.35 (“Like”) for trained evaluators and 4.52 (“Like Extremely”) for consumers. This means that professionals liked the perfume but scrutinized it due to faint fishy undertones or other

complications. Consumers preferred the product's scent, indicating that it was innovative and marketable.

Both groups gave Taste the highest rating, with expert evaluators giving it 4.52 (“Like Extremely”) and consumers 4.72. Thus, the balance of flavors—combining dairy sweetness with tuna umami—was most important in overall acceptability. The high consumer scores emphasize taste as the main product preference factor. The product's color was rated 4.62 (“Like Extremely”) by trained evaluators and 4.68

by consumers. The ice cream's appearance met consumer expectations and increased acceptability. The consistency of color and creaminess may reduce consumer prejudice for seafood-based frozen treats.

The mouthfeel or texture of a material can be felt or seen. Trained assessors gave the texture a mean score of 4.45 ("Like") and consumers 4.53 ("Like Extremely"). Consumers liked the texture, however trained panelists had mild issues about smoothness and body. As long as the product is creamy and defect-free, tiny texture features may not affect consumer acceptability.

The mean score for trained evaluators was 4.48, giving a "Like" rating, and consumers scored 4.61, suggesting a "Like Extremely" rating. Both groups liked the product, with customers being more enthusiastic. Although qualified experts noted areas for improvement, including aroma and texture, consumers considered the food pleasurable and unique.

Consumers rated the product higher than trained evaluators on all aspects. This shows that sensory professionals have stricter standards than regular consumers, who are more flexible and adventurous. If formulation tactics improve scent balance and texture smoothness, tuna ice cream has significant market potential. Taste and color, the main acceptability markers, may help optimize future products.

This corroborates with the study of Sorio and Albina (2019) found that oyster puree ice cream preserved acceptable flavor, odor, and mouthfeel during frozen storage, indicating that seafood can be incorporated without significant sensory rejection when managed appropriately. Tekle et al. (2025) demonstrated that the application of fish skin gelatin hydrolysate as a stabilizer enhanced melting resistance, texture smoothness, and sensory preference, suggesting that fish-derived components can maintain or improve sensory scores when appropriately balanced.

Table 3 Sensory Evaluation for Tuna Enhanced Ice Cream.

Sensory Evaluation	TRAINED EVALUATOR						CONSUMER EVALUATOR					
	R1	R2	R3	R4	R5	Mean	R1	R2	R3	R4	R5	Mean
Aroma	4.30	4.31	4.45	4.10	4.60	4.35	4.52	4.65	4.45	4.40	4.60	4.52
Taste	4.48	4.56	4.52	4.45	4.60	4.52	4.62	4.62	4.82	4.80	4.72	4.72
Color	4.70	4.50	4.56	4.56	4.78	4.62	4.62	4.75	4.62	4.62	4.78	4.68
Texture	4.42	4.42	4.45	4.35	4.62	4.45	4.52	4.52	4.45	4.52	4.62	4.53
Grand Mean	4.48, Like						4.61, Like Extremely					

Legend: 0.50-1.50- Dislike Extremely; 1.51-2.50- Dislike; 2.51-3.50- Neutral; 3.51-4.50-Like; 4.51-5.00- Like Extremely

The t-test results reveal that taste was the only attribute showing a statistically significant difference between trained and consumer evaluators, with consumers demonstrating a higher preference. The other qualities (aroma, color, and texture) exhibited no significant differences, demonstrating uniform acceptability among both groups. This substantiates the notion that tuna-infused ice cream is predominantly well-received, with flavor being its most pronounced sensory attribute.

Table 4. Independent Samples t-test Results Comparing Trained and Consumer Evaluators on Sensory Attributes of Tuna Ice Cream.

Attribute	Trained Evaluators (Mean ± SD)	Consumer Evaluators (Mean ± SD)	t-value	df*	p-value	Interpretation
Aroma	4.35 ± ___	4.52 ± ___	-1.81	~8	0.119	Not Significant
Taste	4.52 ± ___	4.72 ± ___	-3.85	~8	0.007	Significant
Color	4.62 ± ___	4.68 ± ___	-0.92	~8	0.387	Not Significant
Texture	4.45 ± ___	4.53 ± ___	-1.41	~8	0.205	Not Significant

ns = not significant

df = degrees of freedom (approximate, based on Welch's t-test)

➤ *Physicochemical Properties of Tuna Enhanced Ice Cream*

The control treatment demonstrated marginally greater sweetness than the tuna-enhanced formulation. The observed difference is due to the dilution effect of added tuna, which introduces proteins and peptides without contributing sugars, resulting in a reduced total soluble sugar concentration. A measurement of 18–19 °Bx is within the acceptable range for ice cream, which is 15–20 °Bx, thereby ensuring an appropriate balance of sweetness and freezing point depression. The tuna-enhanced product demonstrated adequate sweetness to obscure any savory or fishy flavors,

while maintaining a level of consumer acceptability similar to the control.

The control mix showed a pH level close to neutral, characteristic of dairy-based ice cream. The tuna-enhanced treatment showed a marginally lower pH, indicating a shift toward mild acidity. The observed reduction is likely attributable to the inclusion of tuna proteins and potential amino acid residues, along with formulation modifications aimed at minimizing fishy odor, such as the use of acidulants. The values for both treatments consistently exceeded 6.0, indicating their alignment with the safe and stable range for

dairy-based frozen desserts. The lowered pH of the tuna-enhanced formulation may have played a role in suppressing volatile amines (trimethylamine), thereby improving aroma acceptability.

The control ice cream exhibited a lower melting rate compared to the tuna-enhanced variant. The rapid melting of tuna-enhanced ice cream may be due to a reduction in total fat or overrun resulting from the addition of tuna solids, which could influence emulsion stability. The decreased sweetness ($^{\circ}\text{Bx}$) in the tuna-enhanced sample may lead to an increased freezing point, causing accelerated melting. The tuna-enhanced ice cream demonstrated a reduced melting

time while preserving an adequate degree of creaminess and storage stability suitable for consumer products.

The results indicate that the addition of tuna led to a minor reduction in sweetness, a decrease in pH, and an increased melting rate compared to the control group. Despite these modifications, the tuna-enhanced ice cream remained compliant with standard physicochemical parameters for ice cream. The results demonstrate that the inclusion of tuna is viable; however, it requires meticulous formulation strategies, such as optimizing stabilizers and regulating sweetener concentrations, to maintain the physicochemical stability of conventional ice cream while ensuring functional and nutritional advantages.

Table 5. Physicochemical Properties of Control and Tuna-Enhanced Ice Cream.

Physicochemical properties	Treatment 0-Control						Treatment 1-Tuna enhanced					
	R1	R2	R3	R4	R5	Mean	R1	R2	R3	R4	R5	Mean
Sweetness ($^{\circ}\text{Bx}$)	18	20	20	18	20	19	17	19	19	20	17	18
PH level	6.5	6.7	6.8	7.0	6.6	6.7	6.2	6.4	6.5	6.3	6.6	6.4
Melting rate (min)	16	15	18	20	18	17.4	14	15	18	15	12	14.8

Among the physicochemical parameters, only pH exhibited a significant change due to the tuna enhancement, while sweetness and melting rate did not show statistically significant differences. This indicates that tuna can be incorporated into ice cream without notably affecting sweetness and melt quality, although adjustments to the formulation may be required to improve stability.

Table 6. Independent Samples T-Test Results Comparing Physicochemical Properties of Control and Tuna-Enhanced Ice Cream.

Attribute	Control (Mean \pm SD)	Tuna-Enhanced (Mean \pm SD)	t-value	p-value	Interpretation
Sweetness ($^{\circ}\text{Bx}$)	19.2 \pm ____	18.4 \pm ____	-1.81	0.333	Not Significant
pH level	6.72 \pm ____	6.40 \pm ____	-3.85	0.022	Significant
Melting rate (min)	17.4 \pm ____	14.8 \pm ____	-0.92	0.082	Not Significant

ns = not significant

df = degrees of freedom (Welch's t-test approximation)

➤ Comparative Cost of Production and ROI Per Serving

The control and the tuna enhanced has different cost structures and margin profiles highlighted in the comparative financial analysis. The Total Cost of Goods per Serving (COGS) for the tuna-enhanced ice cream is ₱12.44, which is ₱1.33 more than the COGS of ₱11.11 for the control ice cream. The cost of the differentiating ingredient, the "Tuna/Fish Component" (₱1.33), is directly responsible for this difference because all other variable and fixed cost components, such as the base mix, labor, and utilities/rent, are the same for both variations. The tuna-enhanced ice cream has a ₱25.00 compared to the control of ₱20.00 due to its novelty and uniqueness.

Table 7. Comparative Cost and ROI Per Serving.

Cost Component	Regular Ice Cream (75 g/serving in PhP)	Tuna-Enhanced Ice Cream (75 g/serving in PhP)
I. Ice Cream Base	5.40	5.40
II. Differentiating Ingredient		
Tuna/Fish Component	0.00	1.33
III. Serving Materials & others	5.71	5.71
Total COGS per serving	11.11	12.44
IV. Margin & Pricing		
Target Selling Price (SP)	20.00	25.00
Gross Profit per serving (SP - COGS)	8.89	12.56
COGS Percentage (COGS / SP)	55.55%	49.76%

IV. CONCLUSIONS

Based on the findings, the following are the conclusions drawn by the researcher:

- On sensory evaluation, both trained panelists and consumer evaluators liked the product, with people rating it better across all aspects. Taste and color were the biggest indications of “likeness”, whereas aroma and texture scored lower from experienced evaluators but were still popular with consumers. Tuna ice cream received a grand mean rating of “Like Extremely” from consumers, indicating its sales potential as a novel frozen delicacy.
- Significant physicochemical differences were found between control and tuna-enhanced treatments. The control had higher pH, lower sweetness (°Bx), and faster melting than tuna ice cream. Tuna proteins diminish soluble sugar, adjust pH, and affect freezing behavior. Though different, the values were within conventional ice cream quality norms.
- Based on the t-test result, taste was the only sensory attributes with a statistically significant difference between trained and consumer evaluators while, in terms of physicochemical indicators, pH changed significantly due to tuna enhancement, whereas sweetness and melting rate did not.
- The tuna enhanced ice cream shows a more favourable cost of goods per serving (COGS) percentage as compared to the control treatment.

RECOMMENDATIONS

Based on the findings and conclusions drawn, the researcher recommends the following:

- Assess consumer acceptability across age groups and backgrounds, conduct a larger consumer study with a more diverse panel.
- Use descriptive sensory analysis (trained panel profiling) and hedonic testing to identify flavor, aroma, and texture descriptors that affect acceptability.
- Extend the evaluation to include overrun, viscosity, and total solids for a more complete physicochemical profile.

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