**Development and Consumer Assessment of Muskmelon-Enriched Soft Serve Ice Cream: A Sensory-Driven Investigation**

**ABSTRACT**

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| The present study was conducted to assess the impact of Muskmelon (*Cucumis melo*) pulp incorporation at varying levels on the sensory characteristics and consumer acceptance of softy ice cream. The primary aim was to develop a nutritionally appealing product and identify the formulation with optimal acceptability.  The experiment followed a Completely Randomized Design (CRD) comprising five treatments—T₀ (0%, control), T₁ (10%), T₂ (15%), T₃ (20%) and T₄ (25%) muskmelon pulp—each replicated five times. The research was carried out during the academic year 2024–2025 at the Division of Animal Husbandry and Dairy Science, Dr. Sharadchandra Pawar College of Agriculture, Baramati.  Sensory evaluation was performed by a semi-trained panel using a 9-point hedonic scale to score appearance, flavor, texture, mouthfeel and overall acceptability. Additionally, consumer acceptance was studied by collecting responses from 30 untrained individuals across diverse age, education and occupational backgrounds. Data on purchase intent, sweetness level and product preference were statistically analyzed using ANOVA.  Among all treatments, T₃ (20% muskmelon pulp) received significantly higher sensory scores for flavor (8.82 ± 0.14), texture (8.70 ± 0.13) and overall acceptability (8.77 ± 0.16), indicating strong preference (*P* < 0.05). Consumer feedback echoed the sensory panel results, showing a marked inclination toward T₃ for its pleasant taste and natural sweetness. Favorable responses were observed across most demographic segments, supporting its market potential.  **Conclusion:**  The incorporation of muskmelon pulp up to 20% significantly enhances the sensory quality and consumer appeal of softy ice cream. T₃ emerged as the most accepted formulation, highlighting its potential for development into a commercially viable and health-oriented frozen dessert. |

***Key words:*** *Softy ice cream; Muskmelon (Cucumis melo); Sensory evaluation; Consumer acceptance; Functional dairy product; Hedonic scale*

1. **INTRODUCTION**

Milk is widely recognized as one of the most complete and nutritious natural foods, offering an ideal balance of essential nutrients that support growth, development and overall well-being. It is a rich source of high-quality proteins, calcium, phosphorus and vitamins like B2 and B12, which play vital roles in maintaining strong bones, healthy muscles, immune defense and metabolic function. Regular milk consumption has also been associated with a lower risk of conditions such as osteoporosis, cardiovascular disease and metabolic disorders (Kubicová *et al*., 2019). Beyond its nutritional value, milk holds cultural importance and continues to be a daily dietary staple around the world—especially in India.

India ranks as the world’s largest producer of milk, with an output exceeding 230 million metric tons (BAHS, 2023). India leads the world in milk production, and its dairy sector plays a central role in the rural economy, providing income and employment to millions of smallholder farmers. Dairy products form an essential part of the Indian diet, contributing significantly to daily intake of calcium, protein and vitamin D. With milk production projected to exceed 180 million metric tons and consumer demand expected to cross 200 million metric tons in the near future, there is increasing pressure to modernize the sector, adopt efficient processing techniques and strengthen supply chains.

The dairy industry is also evolving in response to changing consumer preferences and growing health awareness. There is rising interest in natural, clean-label products with lower sugar content and no artificial additives (Park, 2018). This shift has encouraged innovation in functional dairy foods that offer added health benefits. Frozen desserts like ice cream and softy continue to attract consumers of all age groups due to their taste, texture and convenience (Weaver, 2003).

Softy ice cream, introduced in the 20th century, is a softer and lighter alternative to traditional ice cream. It is typically lower in fat and served at slightly warmer temperatures. The product's light texture is achieved through the incorporation of air (overrun), which also enhances flavor perception (Jana *et al*., 2016). In India, softy has grown in popularity thanks to its affordability, appealing sensory qualities and increased availability in both urban and rural settings (Sonwane & Hembade, 2014).

From a nutritional standpoint, softy ice cream provides energy along with proteins, carbohydrates and fats. When enriched with fruits, it can also supply vitamins, minerals and antioxidants (Renner, 1989; Arbuckle, 1966). However, the industry must continue addressing challenges related to hygiene, quality and the growing demand for naturally flavored, health-oriented options.

Consumer preferences for dairy products are influenced by a complex interplay of personal, socio-demographic, and market-driven factors. Key drivers include freshness, nutritional content, taste, packaging, and brand reputation, with urban consumers showing increased sensitivity to health and quality aspects. Additionally, education level, income, and family structure significantly affect purchasing behavior. Marketing strategies—especially pricing and promotional efforts—also impact product choice, highlighting the importance of aligning product offerings with both consumer expectations and lifestyle trends (Parasuraman *et al.,* 2021).

Muskmelon (*Cucumis melo L.*), a member of the Cucurbitaceae family, is known for its sweet flavor, high water content and refreshing nature. It is particularly rich in vitamins A and C and contains valuable antioxidants that help reduce oxidative stress and may lower the risk of chronic illnesses such as heart disease, diabetes and certain types of cancer (Ismail, 2009). Despite its nutritional value and wide availability, muskmelon remains underutilized in dairy-based frozen dessert formulations.

Integrating muskmelon pulp into softy ice cream offers a novel opportunity to enhance both nutritional and sensory appeal. The fruit’s natural sweetness, vibrant color and bioactive components can improve the flavor, aroma and appearance of the final product while also offering functional health benefits. In the current landscape of consumer demand for seasonal, clean-label and functional foods, such innovation aligns well with market trends and health-conscious eating habits.

**2. MATERIAL AND METHODS**

**2.1 Procurement of Raw Materials**

Fresh buffalo milk, cream, skim milk powder and sugar were procured from the local dairy market of Baramati, Maharashtra. Fully ripened muskmelon (*Cucumis melo* L.) fruits were sourced from nearby fruit vendors during the peak summer season. All ingredients were food-grade and complied with FSSAI standards.

**2.2 Preparation of Muskmelon Pulp**

Fresh muskmelon fruit were purchased from the local market of Baramati for preparation of muskmelon pulp, the fruits were cleaned under running water and sorted according to quality after that stalk were removed and carefully peeled. The peeled muskmelon fruits were cut into halves and deseeded. The fruit was then transferred to a blender and grinded to a mixture. Therefore, the pulp was obtained for further use. (Washimbe *et al.,* 2020)

**2.3 Preparation of Softy Ice Cream**

A standardized formulation of softy ice cream mix was developed using precise amounts of milk, cream, skim milk powder and sugar

Collection of Buffalo Milk (Fat- 6%, SNF-9%)

v

Pre- heating (@35-400C)

v

Blending of ingredients [Cream & SMP @800C, For standardization of mix ]

v

Addition of Sugar (22%) and Stabilizer( 0.4%)

v

Heat treatment (800C for 20 mins)

v

Homogenization ( 2 stage @700C)

v

Cooling (@40C)

v

Keeping the ice cream mix for overnight in refridgerator for aging (4-50C)

v

Addition of muskmelon pulp as per treatment

v

Continuous freezing in softy ice cream making machine ( 40-45mins)

v

Storage of the product / distribution ( as desired depending on the product )

Softy ice cream was preapared as per protocol given by Sangma *et.al.,*(2017) with slight modification.

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| --- | --- |
| **Figure 1. Different treatment combinations** | |
| **T0** | |
| **T1** | **T2** |
| **T3** | **T4** |

**2.4 Physico-Chemical Analysis**

Milk used in the formulation was analyzed for total solids, fat, protein, lactose, titratable acidity and pH using standard methods specified in IS 12333:2017, IS 1224:1977, FSSAI 01.026/027:2022, IS 1479 (Part I & II) and IS 11918:2017. Muskmelon pulp was analyzed for pH (Ranganna, 1986), total soluble solids (FSSAI, 2021) and titratable acidity (IS 2802:1964) using standard procedures. The fresh softy ice cream samples were analyzed immediately after production for total solids, fat, protein, titratable acidity and pH using established ISI and AOAC methods.

**2.5 Sensory Evaluation**

Samples from all five treatments were coded and served in randomized order under hygienic conditions. The panelists evaluated appearance, flavor, texture, mouthfeel and overall acceptability using a 9-point Hedonic scale, with 1 indicating "dislike extremely" and 9 indicating "like extremely."

**2.6 Consumer Acceptance Study**

A structured consumer survey was conducted to assess preferences and acceptance of the muskmelon softy ice cream. Thirty untrained participants from varied age groups, occupations and educational backgrounds were selected. The respondents were asked to rate the product on key attributes such as appearance, taste, sweetness, purchase intent and preferred ice cream type. Demographic data such as age, gender, qualification, occupation and ice cream consumption frequency were also recorded. Data were compiled and analyzed to understand market potential and consumer response toward muskmelon-incorporated softy ice cream.

1. **RESULT AND DISCUSSION**

**3.1 Physico-Chemical Analysis of Muskmelon Incorporated Softy Ice Cream**

The physico-chemical analysis of softy ice cream with increasing levels of muskmelon pulp (T₀ to T₄) showed a steady decline in fat, protein, and total solids, while titratable acidity rose and pH decreased. These changes reflect the high moisture and low solids content of muskmelon pulp, which increases acidity.

Treatment T₃ (20% pulp) demonstrated the most balanced profile, combining moderate nutrient levels with acceptable acidity and pH, making it suitable both nutritionally and sensorially.

**Table 1. Physico-chemical Evaluation of Muskmelon Incorporated Softy Ice Cream (Mean values with statistical significance)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Treatment** | **Fat (%)** | **Protein (%)** | **Total Solids (%)** | **pH** | **Titratable Acidity (%)** |
| T₀ | 11.69ᵃ | 3.75ᵃ | 37.33ᵃ | 6.86ᵃ | 0.11ᵉ |
| T₁ | 10.83ᵇ | 3.39ᵇ | 36.60ᵇ | 6.70ᵇ | 0.13ᵈ |
| T₂ | 10.65ᶜ | 3.18ᶜ | 35.45ᶜ | 6.50ᶜ | 0.14ᶜ |
| T₃ | 10.36ᵈ | 2.91ᵈ | 34.83ᵈ | 6.30ᵈ | 0.17ᵇ |
| T₄ | 10.04ᵉ | 2.71ᵉ | 33.76ᵉ | 6.14ᵉ | 0.20ᵃ |
| **SEd (±)** | 0.1283 | 0.0421 | 0.0918 | 0.0315 | 0.0023 |
| **CD (P = 0.05)** | 0.37 | 0.12 | 0.27 | 0.09 | 0.006 |

These results are consistent with earlier findings by Rajeesha et al. (2023), Shelke et al. (2023), and Bagul et al. (2024), confirming that incorporating moisture-rich fruit pulp like muskmelon alters the nutritional composition and acidity of dairy products, with 20% pulp offering the best overall balance.

**3.2 Sensory and Consumer Acceptance of Muskmelon Incorporated Softy Ice Cream**

**3.2.1 Sensory Evaluation**

Softy ice cream samples with muskmelon (*Cucumis melo*) pulp were prepared in five treatments: T₀ (0%, control), T₁ (10%), T₂ (15%), T₃ (20%) and T₄ (25%). Sensory analysis was conducted using a 9-point hedonic scale by a panel of five semi-trained judges. The evaluated attributes included appearance, flavor, texture, mouthfeel and overall acceptability (Table 1).

Among all samples, Treatment T₃ (20% pulp) stood out with the highest average scores for flavour (8.82), texture (8.70), and overall acceptability (8.77). T₄ (25%) also performed well, especially in appearance (8.94) and mouthfeel (8.50), but its overall acceptability (8.53) was statistically similar to T₃ and T₂. These results suggest that while both T₃ and T₄ were well-received, T₃ offered the most consistent and harmonious sensory profile. On the other hand, T₀, which contained no muskmelon pulp, scored the lowest across all attributes, likely due to its lack of fruit flavour and visual appeal.

**Table 2. Sensory evaluation scores of softy ice cream samples (Mean ± SEM)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Treatment** | **Appearance** | **Flavour** | **Texture** | **Mouthfeel** | **Overall Acceptability** |
| **T₀** | 8.08ᵉ | 7.56ᵉ | 7.68ᵉ | 7.82ᵉ | 7.78ᵈ |
| **T₁** | 8.28ᵈ | 7.88ᵈ | 7.98ᵈ | 8.04ᵈ | 8.04ᶜ |
| **T₂** | 8.58ᶜ | 8.20ᶜ | 8.18ᶜ | 8.30ᶜ | 8.31ᵇ |
| **T₃** | 8.86ᵃ | 8.82ᵃ | 8.70ᵃ | 8.72ᵃ | 8.77ᵃ |
| **T₄** | 8.94ᵇ | 8.40ᵇ | 8.48ᵇ | 8.50ᵇ | 8.53ᵃᵇ |
| **SEd (±)** | 0.0456 | 0.0537 | 0.0590 | 0.0329 | 0.0837 |
| **CD (P = 0.05)** | 0.13 | 0.15 | 0.17 | 0.09 | 0.25 |

**Figure 2.** Overall acceptability scores of soft serve ice cream as influenced by different levels of muskmelon pulp incorporation (T₀–T₄)

**3.2.2 Consumer Acceptance Study**

A consumer preference study was conducted to evaluate the acceptability of muskmelon softy ice cream based on sensory characteristics. Around 30 individuals from various demographic categories participated in the tasting. Their responses have been summarized in Table 3.

Half of the participants described the ice cream as *excellent*, with the T₃ (20%) formulation receiving the highest approval due to its pleasant flavor, smooth consistency and attractive appearance. Another 30% rated it as *very good*, highlighting their appreciation for the flavor and texture.

Meanwhile, 13% of respondents gave it a *good* rating and 7% marked it as *fair*. Overall, T₃ stood out as the most well-received variation, followed by T₄ in terms of consumer appeal.

**Table 3: Classification of respondents Based on Acceptance of Muskmelon Softy Ice Cream**

|  |  |  |
| --- | --- | --- |
| **Preference Score** | **Number of Respondents** | **Percentage** |
| Excellent | 15 | 50.0 |
| Very Good | 9 | 30.0 |
| Good | 4 | 13.0 |
| Fair | 2 | 7.0 |

Table 3 indicates that T₃ (20%) received the highest level of preference, with 50% of respondents selecting it as their top choice. This suggests that incorporating 20% muskmelon pulp resulted in a softy ice cream that stood out in terms of flavor, appearance and creamy consistency, making it the most appealing option overall.

Approximately 30% of participants rated the product as *very good*, showing that treatments like T₄ (25%) were also well-liked, though not as widely favored as T₃.

**Figure 3.** Consumer preference distribution for muskmelon soft serve ice cream based on sensory evaluation

About 10 percent of respondents rated the ice cream as good, indicating generally positive feedback with minor scope for improvement in flavor or texture, which could be considered in future product development. The lowest ratings were observed for T₀ (control) and T₁ (10%), as these samples were found to be less appealing in terms of flavor and texture compared to the treatments containing muskmelon pulp. Similar findings were reported by Bhoite V.A. (2017) in a study on betel leaf–infused ice cream, where approximately 45 percent of consumers rated the product as excellent, reflecting a clear preference for formulations with added functional ingredients.

**3.3 Discussion**

The strong consumer preference for T₃ can be linked to its well-balanced formulation, where a 20% muskmelon pulp addition achieved the ideal combination of flavor and texture. At this level, the fruit flavor was pronounced without affecting the product’s structure or stability. These observations align with the results reported by Bagul S. M. (2024) who observed similar trends with mint softy ice cream, where optimal levels of mint gave pleasant flavour, appearance, body and texture while providing a desirable mouthfeel.

Bajwa *et al.,* (2003) stated, T3 (20%) had the highest sensory scores (8.60) of all concentrations of strawberry adding any more resulted in undesirable textures and adding less resulted in in adequate flavour.

Rajeesha *et al.,* (2023), found that jackfruit pulp added ice cream showed some trends in the overall acceptability. They found T2, T1, T0 showed an increasing trend in the sensory scores, while, T3, T4, T5 and T6 showed a decreasing trend in the sensory scores.

**4. CONCLUSIONS**

The findings of this study demonstrate that adding muskmelon pulp has a notable impact on both the sensory qualities and consumer acceptance of softy ice cream. Among the various formulations, T₃ (20% pulp) emerged as the most favored, offering a well-rounded flavor, smooth texture and attractive appearance. Evaluations by a semi-trained sensory panel, along with consumer feedback, consistently identified T₃ as the most successful treatment. Based on these results, incorporating 20% muskmelon pulp is recommended for creating a nutritious, consumer-friendly softy ice cream with strong market potential.

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**DISCLAIMER**

Author(s) hereby declares that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during writing or editing of manuscripts. COMPETING INTERESTS: Authors have declared that no competing interests exist.

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