

Formulation, Quality Evaluation and Consumer Acceptance of Young Coconut (*Cocos nucifera*) Ice Cream

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ABSTRACT

Coconut is the fourth most important crop in Malaysia after palm oil, rubber, and paddy; however, its processed products remain underutilized. This study aimed to develop a viable coconut ice cream formulation using fresh young coconut puree and systematically evaluate its quality, stability and consumer acceptance. Nine prototype formulations were screened using a Balanced Incomplete Block (BIB) experimental design, followed by sensory evaluation using a seven-point hedonic scale with 36 panellists. Formulation (F4) was selected as optimal and subjected to proximate, physicochemical, and microbiological analyses over eight weeks of storage at -18°C. Proximate composition of F4 comprised of moisture (62.89%), crude fat (14.26%), total carbohydrate (10.65%), crude protein (6.66%), crude fiber (5.08%), and ash (0.53%). Weekly physicochemical analysis demonstrates storage stability with pH shifting from 6.69 to 6.32 and total soluble solids adjusting from 36.8 to 35.3 °Brix. Microbiological evaluation confirmed safety profile throughout storage, maintaining Total Plate Count (4.93×10^4 cfu/ml) and yeast/mold counts (3.12×10^4 cfu/ml) within permissible limits. The product achieved an overrun of 54%. Consumer acceptance testing (n=100) revealed strong commercial potential, with 98% positive overall liking and 93% of respondents agreeing on its market viability. Out findings confirm that young coconut ice cream can be developed as a nutritious, stable, and commercially viable food product.

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1. Introduction

Ice cream is a widely consumed frozen dessert defined by a minimum required fat content derived from dairy or non-dairy sources combined with sweetener, emulsifiers, and stabilisers. The global market for frozen desserts continues to expand, driven by increasing consumer demand for novel flavours, health-conscious alternatives, and locally sourced plant-based ingredients. In response to shifting consumer preferences, product innovation in the ice cream industry has increasingly focused on incorporating functional agricultural commodities (Marshall et al., 2003).

In Malaysia, coconut (*Cocos nucifera*) represents the fourth most critical agricultural crop following oil palm, rubber and paddy. Although coconuts are widely enjoyed in fresh form, its application in processed food products, particularly value-added frozen desserts, remains significantly underutilised relative to its total agricultural output (Encyclopaedia of Foods, 1998). Coconut flesh and coconut water offer rich nutritional profiles, natural aromatic qualities, and dietary fibre. Furthermore, with Malaysia's commercial ice cream market projected to grow steadily, there is a clear opportunity for niche product development centred on agricultural commodities. Despite the economic and nutritional potential of coconut, an information gap exists regarding the optimization, frozen storage stability, and sensory profile of dairy-based ice cream formulated with fresh coconut purée (Zakaria & Ahmad, 2024). Thus, addressing this gap is necessary to establish standard processing parameters and evaluate the commerciality viability of local coconut-based frozen treats. Therefore, the objective of this study was to formulate a consumer acceptable coconut ice cream, evaluate its proximate composition, monitor its physicochemical and microbiological stability in frozen storage and assess its market feasibility.

2. Materials and Methods

The main ingredients included whipping cream, low-fat milk, sugar, whole eggs, salt, fresh young coconut flesh, and coconut water. Fresh young coconuts were procured locally from vendors in Kota Kinabalu, Sabah. Processing equipment comprised of a batch ice cream maker, electric heater, mixing machine, analytical balance, and standard laboratory utensils.

2.1 Formulation and Processing Procedures

Experimental procedures for preparing raw materials and prototype ice cream samples were conducted under standard laboratory conditions.

2.1.1 Preparation of coconut purée

Fresh young coconut flesh and coconut water were blended at a fixed weight ratio of 60:40 to yield a standardised purée. To ensure batch consistency and maintain flavour balance, purée mixtures were prepared fresh daily immediately prior to processing.

2.1.2 Basic formulation

The base mix was prepared using whipping cream (38.83%), low-fat milk (19.42%), sugar (18.45%), whole egg (9.71%), and the coconut purée blend (13.59%). To optimize the recipe, a factorial experiment design was applied by systematically adjusting the sugar (40-50g) and coconut purée (95-105g) levels, yielding nine distinct prototype formulations (Marshall et al., 2003).

2.1.3 Preparation procedure

Ingredients were combined and pasteurised under controlled heating at 50–60°C until fully homogenised. The mixture was cooled to 1–5°C, aged, blended with whipping cream, and processed in an ice cream maker. Final samples were packaged and stored at –18°C prior to quality testing (Nwaogazie et al., 2024).

2.1.4 Sensory evaluation

Screening of the nine prototype formulations was structured using a Balanced Incomplete Block (BIB) experimental design to minimise panellist fatigue. Sensory testing was conducted with 36 panellists using a 7-point hedonic scale (1 = dislike extremely to 7 = like extremely) evaluating taste, aroma, texture, colour, and overall acceptability. Friedman's test and one-way ANOVA ($\alpha = 0.05$) were performed to select the optimal formulation.

2.1.5 Physicochemical and proximate analysis

Proximate compositions including moisture, crude fat, crude protein, crude fibre, total ash, and total carbohydrates were determined for the optimal formulation (F4) using standard AOAC methods (1992, 2000). To monitor stability over time, changes in pH and total soluble solids (°Brix) and pH were recorded weekly across an eight-week storage period at -18 °C.

2.1.6 Microbiological analysis

Microbiological safety was monitored weekly for eight weeks by determining Total Plate Count (TPC) and Yeast/Mold count using Place Count Agar (PCA) and Potato Dextrose Agar (PDA). Results were evaluated against safety limit defined by Malaysian food safety standards (MARDI, 1986; Halsa et al., 2024).

2.1.7 Overrun measurement

Overrun was calculated by comparing weight of a fixed volume of liquid mix against the weight of the same volume of finished ice cream.

3. Results

Screening by BIB design has identified Formulations F2, F4 and F6 as the top-ranking samples. Statistical evaluation confirmed that F4 provided the most balanced profile, combining high coconut flavour intensity with an appealing creamy texture ($p < 0.05$). F4 was consequently selected for downstream proximate, physiochemical, microbiological, and consumer acceptance analyses.

3.1 Physiochemical and Proximate Properties

The proximate composition of the selected coconut ice cream (F4) is presented in Table 1.

Table 1. Proximate composition of optimal coconut ice cream (F4)

Component*	Content (%)
Moisture	62.89 ± 0.42
Crude Fat	14.26 ± 0.18
Carbohydrate	10.65 ± 0.25
Crude Protein	6.66 ± 0.11
Crude Fiber	5.08 ± 0.09
Total Ash	0.53 ± 0.02

* Value expressed as mean ± standard deviation.

The fat (14.26%) and protein (6.66%) contents align with the standard dairy based frozen dessert requirements, contributing to body and smooth mouthfeel. A key finding in this formulation is the crude fibre content of 5.08%, which directly stems from the incorporation of young coconut purée. Conventional ice creams contain negligible dietary fibre; thus, F4 provides a functional nutritional distinction compared to standard dairy products (Beegum et al., 2021)

Physicochemical monitoring over eight weeks revealed high stability during frozen storage at -18 °C. The pH decreased slightly from 6.69 to 6.32, while the total soluble solids exhibited a small adjustment from 36.8 to 35.3 °Brix. These gradual variations are consistent with minor physical restructuring in plant-incorporated ice cream matrices over extended frozen storage (Marshall et al., 2003).

3.2 Microbiological Safety and Physical Quality

Microbiological counts during eight weeks of storage remained within permissible safety levels. TPC ranged from 4.79×10^4 to 4.93×10^4 cfu/mL, while yeast/mold counts ranged from 3.00×10^4 to 3.12×10^4

cfu/mL. Both remained below the permissible limit of 10^5 cfu/ml, confirming product safety (MARDI,1986). Figure 1 illustrate the peak microbiological levels relative to regulatory limits.

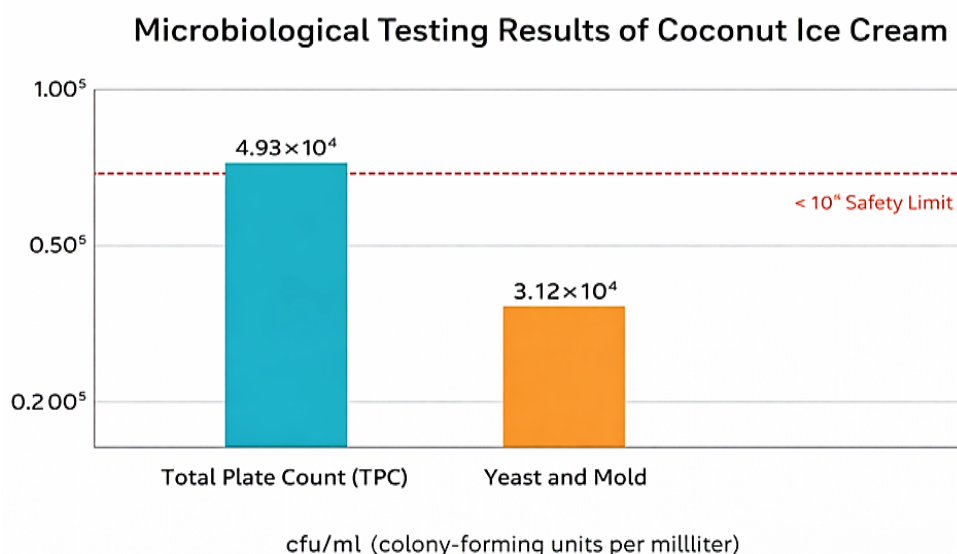


Figure 1. Microbiological testing result of coconut ice cream.

3.3 Consumer Acceptability

Consumer acceptance testing ($n = 100$) revealed strong market reception. Overall acceptability showed that 57% of respondents rating the ice cream as “very like” and 41% as “slightly like”. Regarding attribute liking, taste was rated highest (38% strongly liked). Colour feedback suggested incorporating natural plant-based colorants to enhance visual appeal beyond the natural off-white matrix. Overall, 93% of consumers surveyed indicated that the young coconut ice cream possesses viable commercial marketability.

3.4 Physical Properties

F4 achieved an overrun value of 54%. While slightly lower than commercial soft-serve standards (60-90%), this overrun range yields a denser, richer mouthfeel characteristic of premium, artisanal frozen desserts (Goff & Hartel, 2013).

4. Discussion

Sensory scores confirmed that formulation significantly dictates product quality, with F4 delivering the most balanced profile. The addition of fresh coconut purée introduced meaningful dietary fibre levels, offering a clear nutritional advantage over conventional ice cream. Throughout eight weeks at -18°C , the ice cream maintained high physicochemical stability and stayed well within safe microbiological limits. Although panellists expressed strong overall enthusiasm for the product, minor adjustments to its visual presentation could improve market positioning. Paired with a moderate 54% overrun that yields a premium, dense texture, these findings highlight young coconut ice cream as a viable, value-added addition to Malaysia’s frozen dessert sector.

5. Conclusion

This study successfully developed a consumer- acceptable young coconut ice cream formulation utilizing fresh local coconut purée. Formulation 4 achieved an optimal balance of sensory attributes, enriched dietary fibre content (5.08%), and an appealing density with 54% overrun. The product maintained physicochemical quality and microbiological safety under frozen storage for over eight weeks, adhering to regulatory safety limits. These results demonstrate that young coconut purée can be effectively commercialized into functional frozen desserts, providing added value to local Malaysian coconut agriculture.

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