

Ice cream is a complex combination of partially frozen foam of emulsion held together by emulsified fat. Ice cream is made by freezing and aerating pasteurised mix with agitation to incorporate air for a smooth and good consistency.

Dairy fats are commonly used in the production of ice cream. They are primarily derived from milk, cream, butter and anhydrous milk fat. Milk fat is the major fat component in ice cream. The fat component contributes to the richness of flavour in ice cream. However, vegetable fats such as palm oil, palm kernel oil and coconut oil are being used to replace milk fat in ice cream. Besides being comparatively cheaper than milk fat, palm oil and its fractions are widely available. These oils could be tailor-made to meet the specific requirements for ice cream fat such as the melting point, solid fat content and fatty acid composition.

Palm-based prebiotic ice cream is an ice cream containing inulin as functional ingredient. Inulin is a carbohydrate and is well-known as prebiotic. Ice creams formulated with incorporation of inulin could be considered as value-added products due to their high fibre content. Inulin is increasingly being used to formulate new fibre-enriched products, or products with prebiotic benefits in low-fat products to improve creaminess and consistency, mimicking those of full-fat products.

Inulin stimulates the growth of helpful bacteria naturally residing in the intestines. These helpful bacteria are referred to as probiotics. Probiotic bacteria, specifically bifidobacteria and lactobacilli, promote health by inhibiting the growth of harmful pathogens thus reducing the potential for infections. These microorganisms also improve lactose digestibility.

Inulin is being used commercially in dairy products such as yoghurt and fermented milk. These products contain live culture, for example, *Lactobacillus acidophilus* and *Bifidobacterium bifidum*. These cultures are consumed because of their resistance

to intestinal bile salts. Therefore, products containing these microorganisms could have applications as therapeutic foods. Some studies on soft serve frozen yoghurt found that both bacteria were able to survive and grow before and after freezing.

However, inulin containing ice cream is not commercially available. Therefore, the Malaysian Palm Oil Board (MPOB) has carried out a study on utilisation of dietary fibre such as inulin in ice cream formulation to diversify the research on ice cream. The addition of inulin as functional food is to meet consumer demand for taste and texture in modern processed foods.

INGREDIENT AND PROCESSING

A balanced ice cream mix formulation and processing condition similar to conventional ice cream was used to produce prebiotic ice cream (*Figure 1*). The ice cream mixture was frozen in a batch ice cream processor. The ice cream was packed in a 85 ml container and stored at -18°C . The ingredients used were palm-based oil, skimmed milk powder, sugar, inulin and water.

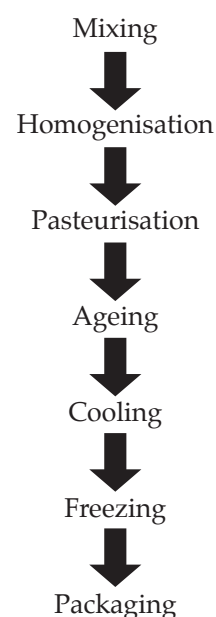


Figure 1. Flow process of palm-based prebiotic ice cream.

PRODUCT CHARACTERISTICS

Overrun is the incorporation of air into ice cream mix during freezing. Overrun provides a light texture and smoothness to ice cream. Figure 2 shows the overrun of palm-based prebiotic ice cream. The percentage of overrun for prebiotic ice cream is between 68.6% to 79.2% depending on the amount of inulin and fat used in the formulation. The percentage of overrun was higher with 1% inulin (79.2%) compared to 2% inulin (68.6%) and 8% fat. A formulation containing 10% fat has an overrun of 78%, while the one with 2% inulin has an overrun of 73.1%. However, the overrun of the formulations with 10% fat and the one with 8% fat and 1% inulin were not significantly different, *i.e.* 78.0% and 79.2%, respectively. Therefore, 1% inulin is preferred for higher overruns prebiotic ice cream. In the industry, if the percentage of overrun is higher, a softer ice cream with fine ice crystals will be produced.

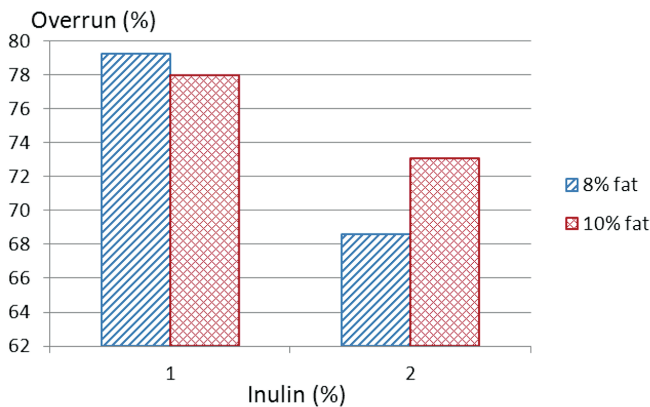


Figure 2. Overrun of palm-based prebiotic ice cream.

Figure 3 shows the melting properties of prebiotic ice cream. The percentage of melting was higher with 1% inulin (92.5%) compared to 2% inulin (88.9%) and 8% fat. A formulation containing 10% fat has melting of 82.9%, while the one with 2% inulin has melting of 88.1%. However, the melting of the formulations with 10% fat and the one with 8% fat and 2% inulin were not significantly different, *i.e.* 88.1% and 88.9%, respectively. The melting resistance increased with higher amount of inulin used in ice cream formulation.

The hardness of prebiotic ice cream is shown in Figure 4. The hardness of ice cream is related to its structure. The hardness of the samples is inversely correlated with penetration depth, and is reduced over time. The hardness was higher with 2% inulin (333 mm) compared to 1% inulin (360 mm) and 8% fat. A formulation containing 10% fat has hardness of 305.5 mm while, the one with 1% inulin has

hardness of 337 mm. Results showed that 2% inulin contributes hardness to prebiotic ice cream.

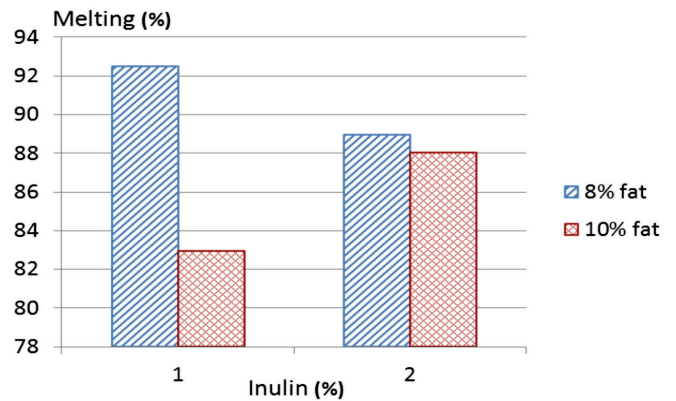


Figure 3. Melting of palm-based prebiotic ice cream.

The sensory scores among 20 MPOB panellists are shown in Figure 5. Results showed that prebiotic ice cream using palm oil received the highest score for appearance compared to other attributes. In terms of odour, the panellists preferred prebiotic ice cream using palm kernel oil. However, there is no significant difference in terms of taste and creamy attributes of ice cream. Therefore, the palm-based prebiotic ice cream was acceptable to the panellists.

PRODUCT NOVELTY

- Incorporation of inulin, a prebiotic with good functionality.
- The palm-based oil used is cholesterol-free.
- Reduces the dairy ingredient in prebiotic ice cream formulation.

MARKET POTENTIAL

Palm-based prebiotic ice cream has potential market in fast food restaurants, retailers and catering services. Children and adults are the target consumers of the product. The product has potential for both domestic and global markets.

ECONOMIC EVALUATION

The estimated expenditure and economic evaluation is shown in Table 1. The estimated total investment cost for the production of prebiotic ice cream is RM 419 300. At production levels of 240 000 kg per annum and at long-term price of RM 6.50 kg⁻¹, prebiotic ice cream production will generate an income of RM 127 571. The cost of production is estimated at RM 5.71 kg⁻¹. The investment prospective in prebiotic ice cream production is attractive with a payback period of three years. The commercial

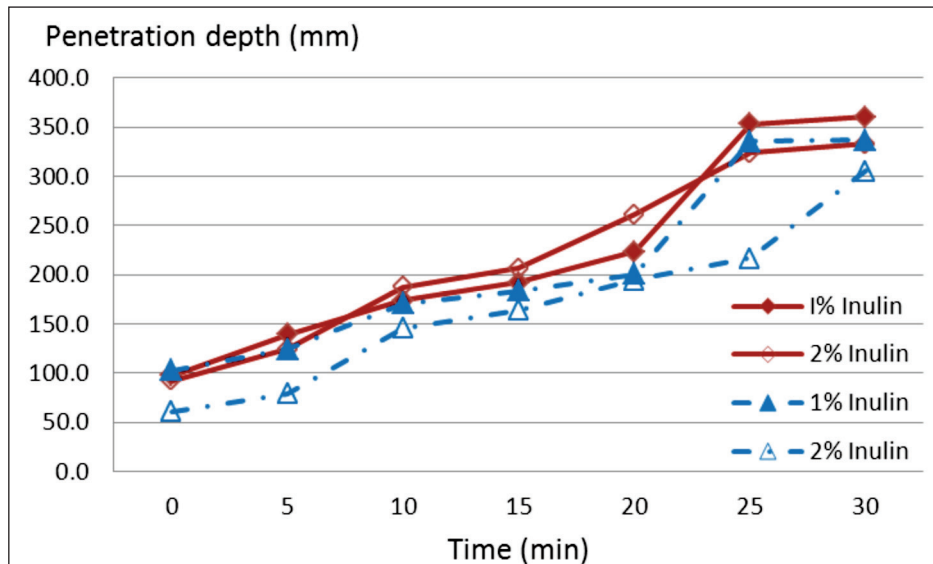


Figure 4. Hardness of palm-based prebiotic ice cream (Legend: $\text{--}\diamond\text{--}$ 8% fat; $\text{--}\triangle\text{--}$ 10% fat).

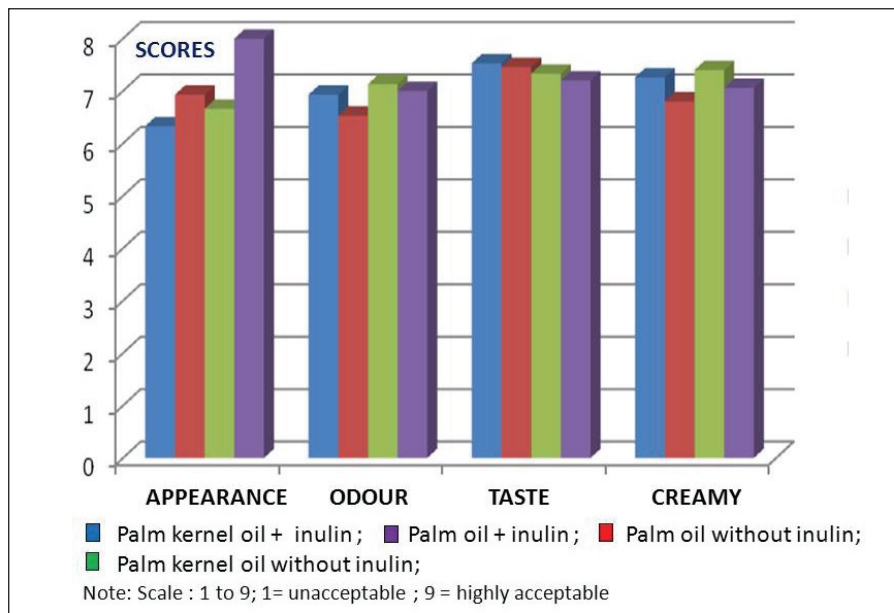


Figure 5. Sensory scores of palm-based prebiotic ice cream.



Figure 6. Prebiotic ice cream.

venture is expected to yield a benefit to cost ratio (B:C) of 1:1.05, net present value (NPV) of RM 140 917.15 and internal rate returned (IRR) of 23%. As the B:C is greater than unity, NPV is positive and IRR is greater than the opportunity cost of capi-

tal, thus the investment proposition is financially feasible.

TABLE 1. ESTIMATED EXPENDITURE AND ECONOMIC VALUES

Items	Value
Capital expenditure	RM 419 300
Benefit to cost ratio	1:1.05
Payback period	3 yr
Internal rate of return (IRR)	23%
Net present value (NPV)	RM 140 917.15
Return on investment (ROI)	34.36%

CONCLUSION

Prebiotic ice cream is healthier than conventional product and has a great market potential.

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