

# Development of Low Sugar Vanilla Ice Cream Using Fructo-Oligosaccharide and Liquorice

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## Abstract

The demand for healthier food alternatives has driven the exploration of novel ingredients and formulations in the food industry. This research endeavours to develop a low-sugar ice cream utilizing Fructo-oligosaccharide (FOS) and liquorice. The primary objectives of this study were to formulate a low-sugar ice cream by integrating varying concentrations of FOS and liquorice and to conduct a comprehensive assessment of the sensory, physico-chemical, and nutritional qualities of the developed product. A nine-point scale sensory analysis was employed to evaluate the organoleptic properties of the ice cream samples, with variations in liquorice formulation ranging from 0.08% to 0.32%. Notably, the formulation containing 0.16% liquorice was identified as optimal based on sensory analysis grades, indicating superior taste. Proximate analysis was conducted on the optimal sample (T2), revealing a protein content of 6.17%, fat content of 8.82%, carbohydrate content of 32%, solid-not-fat (SNF) content of 39.4%, total ash content of 1.23%, and sugar content of 4.79%. The findings of this research offer insights into the development of healthier ice cream alternatives with promising sensory attributes and nutritional profiles, thus contributing to advancements in the field of food science and catering to consumer preferences for nutritious indulgences.

## Introduction

It is commonly stated that ice cream dates back to the second century B.C., yet no one is unquestionably credited with its discovery or knows whence it originated. The first mention of ice cream dates back to 1553 in France (Adil, et al.,2022). There are two to three times as much fat in ice cream and significantly higher protein content than milk. Additionally, ice cream is a great source of minerals, phosphorus, and calcium. Ice cream is high in lactose. encourages increased absorption of the dietary calcium content. Indian dairy is emerging very fast and has the world's largest and fastest growing market for milk product (Verma et al., 2018). Ice-cream is a frozen mixture of a combination of milk solids, sweeteners, stabiliser, emulsifiers and flavours. Other ingredients include egg solids, colours and starch products may be used (De, 1980). This mixture called a "mix" which is pasteurised and homogenised before freezing. Freezing involves rapid removal of heat while agitating vigorously to incorporate air thus imparting the desirable smoothness and softness to the frozen product. Obesity and cardiovascular diseases are the leading causes of increasing calories of intake in dairy food products like ice-cream. A survey conducted by Indian council of Medical Research (ICMR) reported that 49 percent of women and 36 percent of men in urban India are obese (Anjana et al., 2011). Reduced fat formulations need to be developed for persons suffering from CVD which accounts for around 15% deaths in India and this figure is likely to rise to as high as 40% by 2015 (Anjana et al.,2023). The major contributors of calorie in these products are fat and sugar. To satisfy the consumer demands for new, nutritionally acceptable products, many types of new dietetic frozen desserts have appeared in the market world over. Therefore, sincere efforts were made to develop and evaluate the quality of the low sugar ice-cream by incorporation of fructo-oligosaccharide and liquorice.

## Materials and methods

The experiment was conducted in the laboratories of the MIT School of Food Technology, Pune. The experimental materials milk, fresh cream, skimmed milk powder, fructo-oligosaccharide, vanilla essence, xanthan and guar gum were collected from the local market of Loni-kalbhor. Ice cream mixes

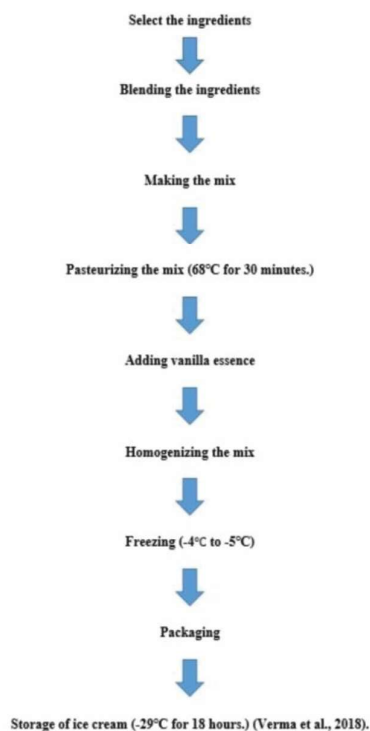
were prepared by variation of the level of liquorice (0.08, 0.16, 0.24, and 0.32%).

## Preparation of ice cream samples

The ice-cream sample preparation was followed as per the flow chart shown fig. 1 with slight modifications to the process laid down by the process of producing low sugar vanilla ice cream involves several distinct stages

meticulously executed to ensure the quality, safety, and palatability of the final product. It begins with the careful selection of ingredients, including milk, cream, cream, skimmed milk powder, stabilizers, emulsifiers, flavouring, which are then blended together to create a uniform mixture. This blend serves as the foundation for the ice cream base, which undergoes pasteurization at 68°C for 30 minutes to eradicate harmful bacteria. Following pasteurization, vanilla essence is added to enhance flavour, and the mixture is homogenized to achieve a smooth texture by breaking down fat globules. The mix is then subjected to controlled freezing at temperatures ranging from -4°C to -5°C, crucial for the formation of small ice crystals, contributing to the desired creamy consistency. Once frozen, the ice cream is carefully packaged to maintain its quality and safeguard against contamination. Finally, the packaged ice cream is stored at a chilly -29°C, ensuring long-term freshness and inhibiting bacterial growth.

**Fig 1. Flow chart**



**Fig. 1: Processing flow chart for low sugar ice-cream**

### Proximate analysis

**Protein content-** The protein content of the samples was determined by Kjeldahl method A.O.A.C., (2005).

**Fat content-** Fat content of the Ice Cream was calculated By Gerber method (FSSAI Laboratory Manual 1).

**Moisture, ash and carbohydrate content-** The percentage moisture, ash and carbohydrate were determined by the standard methods of A.O.A.C. (1990).

**Sugar content-** sugar content in ice-cream was found by the method of IS 28021964.

### Sensory Evaluation

Sensory evaluation of the five ice cream samples produced from buffalo milk was conducted using 30 semi-trained panellists. Ice cream quality was judged in terms of appearance/colour, taste, flavour, mouth feel (texture) and overall acceptability. The 9-point hedonic scale (9 -like extremely, 5 – neither like nor dislike, 1 – dislike extremely) was used as described by (Lum et al. 2008).

### Statistical analysis

In the statistical analysis, critical difference (CD) and standard error (SE) were calculated using Excel. The critical difference indicates the minimum difference required between two values to be considered statistically significant. This helps identify meaningful variations between samples. On the other hand, standard error measures the precision of sample estimates, providing a range within which the true value is likely to lie. These analyses enable robust interpretation of the data, highlighting significant differences and ensuring the reliability of the findings.

### Results and Discussion

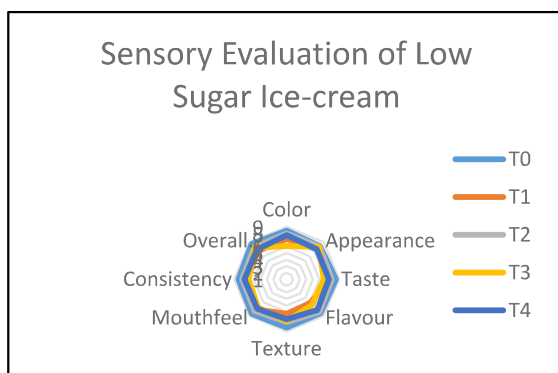
#### Sensory evaluation

The sensory evaluation of the low-sugar ice cream samples aimed to assess taste, colour, flavour, mouthfeel, and overall acceptability using a nine-point hedonic scale. The results revealed notable differences between the control and treated samples. In terms of taste, the treated sample achieved a significantly higher mean score (8.5) to sample T<sub>2</sub> compared to the control sample (7.58) as shown in fig. 2. This indicates that the

incorporation of fructo-oligosaccharide and liquorice in the formulation positively influenced the taste perception of the ice cream. The increased sweetness level likely contributed to this improvement in taste

Parameters	T <sub>0</sub> (Control)	T <sub>2</sub>	SE	CD
Protein content (%)	3.7	6.17	1.235	2.7417
Carbohydrate content (%)	26.8	14.7	6.05	13.431
Fat content (%)	13	8.82	2.09	4.6398
Milk Solid not fat (%)	18	39.4	10.7	23.754
Ash content (%)	0.6	1.23	0.315	0.6993
Moisture content (%)	53.37	63.59	5.11	11.3442
Sugar content (%)	16	4.79	5.605	12.4431

(Hayoglu et al., 2017). The colour of both samples received favourable ratings, with the treated sample showing a slightly higher mean score (8.25) to sample T<sub>2</sub> compared to the control (7.67). This minor difference suggests that the addition of FOS and liquorice contributed to a subtle enhancement in colour, possibly due to improved emulsion stability or enhanced browning reactions (Sarvestani et al., 2021). The non-significant difference in flavour scores between the control and treated samples (6.92), the treated sample exhibited superior mouthfeel, receiving a higher mean score (8.08) compared to the control (7.33). This suggests that the treated sample displayed improved textural properties, such as creaminess and smoothness, which are critical factors in overall consumer satisfaction. Overall acceptability scores further reinforced the superiority of the treated sample, with a higher mean score (8.08) compared to the control (7.33). This indicates that the addition of FOS and liquorice resulted in a more favourable sensory experience, leading to increased consumer preference and acceptance (Kherade et al., 2021).



**Fig. 2: Sensory graph for low sugar ice-cream**

Note: The sample T<sub>0</sub> made without liquorice and fructo-oligosaccharide, T<sub>1</sub>- Ice-cream with 0.08% liquorice and fructo-oligosaccharide, T<sub>2</sub>- Ice-cream with 0.16% liquorice and fructo-oligosaccharide,

T<sub>3</sub>- Ice-cream with 0.24% liquorice and fructo-oligosaccharide and T<sub>4</sub>- Ice-cream with 0.32% liquorice and fructo-oligosaccharide.

**Proximate composition**

Proximate Composition of low sugar ice cream samples are depicted in Table no. 1.

**Table 1: Effect of liquorice incorporation on proximate composition**

Note: The sample T<sub>0</sub> made without liquorice and fructo-oligosaccharide, T<sub>1</sub>- Ice-cream with 0.08% liquorice and fructo-oligosaccharide, T<sub>2</sub>- Ice-cream with 0.16% liquorice and fructo-oligosaccharide, T<sub>3</sub>- Ice-cream with 0.24% liquorice and fructo-oligosaccharide and T<sub>4</sub>- Ice-cream with 0.32% liquorice and fructo-oligosaccharide.

In the present study, the protein content of the treated sample significantly increased to 6.17% compared to the control sample 3.7%. This notable rise in protein levels was observed following the addition of skimmed milk powder to the formulation. Furthermore, the carbohydrate content in T<sub>2</sub> sample decreased significantly to 14.7% from the control sample (26.8%), indicating a successful reduction in carbohydrates (Elsamani,2016) with reduced content of sugar in formulation. The fat content was observed to be decreased in T<sub>2</sub> from 13% (control) to 8.82%, which can be attributed to the increased protein and FoS addition that might have offered better mouthfeel by acting as fat replacer in T<sub>2</sub> sample (Kherade et al., 2021). Moreover, there was a substantial increase in the milk solid-not-fat (MSNF) content in the treated sample, rising to 39.4% from the control 18% which is attributed to increased amount of skim milk powder in T<sub>2</sub>

sample formulation. The ash content showed a significant increase in the T<sub>2</sub> sample (1.23%) compared to the control (0.6%). However, the most notable change was observed in the sugar content, which significantly decreased to 4.79% in the treated sample, contrasting sharply with the control sample 16% due to addition of FoS and liquorice. Similar results were obtained by Sabet et al., 2021. These results collectively demonstrate the efficacy of incorporating fructooligosaccharide and liquorice powder into the ice cream formulation to develop a low-sugar variant while simultaneously enhancing protein levels and modifying other nutritional attributes.

**Conclusion:** The present investigation findings conclude the application of FoS and liquorice in combination provide opportunity to reduce the sugar content by 28%. The nutritional content with respect to fat and carbohydrate could be reduced due to the better mouthfeel characteristics obtained by FoS. The sensory evaluation showed acceptability for combined incorporation of both ingredients. The combination approach (FoS and liquorice) can be used for sugar reduction in ice-cream.

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