



# Physico-chemical and Texture Analysis of Ice Cream Prepared by Incorporating Various Spices

Dhanavath Srinu, D. Baskaran, R. Palani Dorai

10.18805/ajdfr.DR-1715

## ABSTRACT

**Background:** Spices are widely cultivated in India across various states, which promote the opportunity for the development of spices incorporated products, delivering health benefits along with flavour and taste in the functional food market. Hence, the present study was undertaken to develop exotic foods such as spices incorporated ice cream by inclusion of selected spices viz., fenugreek, coriander, black cumin and cinnamon.

**Methods:** The ice cream was formulated with spice powders at different equal incorporation levels of 1%, 1.5% and 2% and compared with control. The developed ice cream was investigated for their sensory characteristics, physico-chemical properties, textural parameters and microbial analysis.

**Result:** The spice powders with 1.5% incorporation level in ice cream showed higher overall acceptability than others. Among the physico-chemical properties, the melting rate of spices incorporated ice cream was found to be in the range of 1.20 to 1.41 g/min. The overrun of the developed ice cream was found to be in the range of 48.57 to 53.09%. The hardness of the developed ice cream was found to be in the range of 2280.77 to 2485.04 g. The results of the present study suggested that the incorporation of different spices in the form of powders improved the flavor and the textural parameters recorded higher values as the inclusion levels are high.

**Key words:** Black cumin, Fenugreek, Ice cream, Texture, Overrun.

## INTRODUCTION

Ice cream is a frozen dessert made by mixing different ingredients including milk, cream, milk solids non-fat, sugar, stabilizers and emulsifiers, in addition to flavors and colorants. Composition of ice cream varies depending on markets and locations [fat 8-20%; milk solids non-fat 8-15%; sugar 13-20%; stabilizers and emulsifiers 0-0.7% and total solids 36-43%] (Arbuckle, 2013). Usually, cow milk is used to produce ice cream, but other types of milk also used includes goat (Pandya and Ghodke, 2007; McGhee *et al.* 2015) buffalo (Minhas *et al.* 2002) and camel (Ahmed and El Zubeir, 2015). Several studies have been carried out in developing new functional ice cream with ingredients such as probiotics (Aboufazli *et al.* 2016; Ranadheera *et al.* 2013; Cruz *et al.* 2009; Akin *et al.* 2007), prebiotics (Akalin *et al.* 2008) and dietary fiber (Akbari *et al.* 2016; Hashemi *et al.* 2015), curcuminoids and carotenoids (Kumar *et al.* 2016; Rizk *et al.* 2014; Sun-Waterhouse *et al.* 2013). The use of these natural compounds in ice cream would be advantageous due to their antioxidant characteristics (Ratnam *et al.* 2006; Fraser and Bramley, 2004). Spices viz., fenugreek, cinnamon, black cumin and coriander have therapeutic properties such as antioxidative, antidiabetic, antihypertensive and antimicrobial activities. Hence, the present study was designed to develop ice cream fortified with the above spices to provide functional dairy products and also to improve the appearance and attractiveness.

## MATERIALS AND METHODS

Fresh cow milk is procured from the Community Cattle Care Center, College Food and Dairy Technology, Alamathi. Butter

Department of Livestock Products Technology (Dairy Science), Madras Veterinary College, Tamil Nadu Veterinary and Animal Sciences University, Chennai-600 007, Tamil Nadu, India.

**Corresponding Author:** Dhanavath Srinu, Department of Food Processing Technology, College of Food and Dairy Technology, Tamil Nadu Veterinary and Animal Sciences University, Chennai-600 052, Tamil Nadu, India. Email: dhansrinu@gmail.com

**How to cite this article:** Srinu, D., Baskaran, D. and Dorai, R.P. (2022). Physico-chemical and Texture Analysis of Ice Cream Prepared by Incorporating Various Spices. Asian Journal of Dairy and Food Research. 41(1): 28-32. DOI: 10.18805/ajdfr.DR-1715.

**Submitted:** 11-05-2021 **Accepted:** 07-06-2021 **Online:** 17-07-2021

and skim milk powder were purchased from Aavin milk parlour, Madhavaram milk colony. Carboxymethylcellulose and glycerol monostearate were purchased from Venus Essence Pvt. Ltd., Chennai. Spices viz., coriander, fenugreek, black cumin, cinnamon and sugar were purchased from Sri MRV supermarket, Redhills. The present study was carried out during the period of February 2019 to December 2019, in the Department of Food Processing Technology, College of Food and Dairy Technology, Alamathi, a constituent College of Tamil Nadu Veterinary and Animal Sciences University, Chennai.

### Optimization of ice cream incorporated with spices

In the present study, ice cream is prepared from cow milk incorporated with selected spices viz., coriander, fenugreek, black cumin and cinnamon. The cow milk (700 ml) was taken and to it 60 g of skim milk powder and 75 g of butter was

added, then grounded spice powders in different equal proportions *i.e.*, 1%, 1.5% and 2% were added and mixed well. Different unit operations such as pasteurization, homogenization, ageing, freezing, packing and hardening were carried out for the ice cream mix.

### Sensory evaluation

Sensory evaluation of spice powders incorporated ice cream (SPII) was carried out using the 9-point hedonic scale (Arbuckle, 1986) by a panel of 20 judges comprising of Post Graduate Students and Faculty Members of College of Food and Dairy Technology, Alamathi, Chennai.

### Physicochemical analysis

#### Determination of pH

The pH of the samples was estimated using a digital laboratory pH meter (SUSIMA Technologies Private Limited, Chennai) with a glass electrode calibrated with standard buffer solutions of pH = 4.00 and pH = 7.00.

#### Determination of titrable acidity

The titrable acidity of the ice cream samples was estimated as per the procedure described in ISI: 1989, SP: 18 (Part XI). The sample 10 g was weighed in a 250 ml beaker. To this, 10 ml of distilled water was added and the contents were mixed thoroughly. It was then titrated against 0.1N NaOH using few drops of phenolphthalein indicator till pink color persists for about 30 seconds in the solution. The readings obtained were expressed as per cent lactic acid values.

$$\text{Titrable acidity (\%)} = \frac{9 \times N \times V}{W} \times 100$$

Where,

V = Volume of 0.1N NaOH required for titration.

N = Normality of solution.

W = Weight of sample taken for the titration (g).

#### Determination of melting rate

The melting time of ice cream was estimated by the procedure outlined by Rajor and Gupta, (1982). A hundred grams of ice cream was carefully placed on a four-square inch glass plate rested on the brim of glass funnel, fitted on a metal stand with its tail end leading into a 100ml graduated cylinder. The time taken for a complete meltdown was recorded in minutes. The melting rate is calculated as follows:

$$\text{Melting rate (g/min)} = \frac{\text{Weight of the melted ice cream (g)}}{\text{Time (min)}}$$

#### Determination of overrun

The overrun per cent of the ice cream samples was calculated as mentioned by Muse and Hartel, (2004) using the following equation:

$$\text{Overrun (\%)} = \frac{\text{Weight of mix} - \text{Weight of ice cream}}{\text{Weight of ice cream}} \times 100$$

#### Texture profile analysis

The textural characteristics of ice cream were analyzed using

TA.XT Plus texture analyzer (Stable Micro System Ltd, Surrey, UK) fitted with a 6 mm diameter stainless steel probe, set up to record the force used to penetrate the sample to a depth of 25 mm at a speed of 1mm/s (Anonymous, 1998).

### Microbial analysis

The microbial analysis *viz.*, standard plate count, coliform count, yeast and mold count were carried out as per the standard procedure described in BIS: 1981, SP: 18 (Part XI).

### Statistical analysis

Results are presented as Mean $\pm$ SE. Analysis of variance was performed using SPSS®20.0 software for windows to determine the significant differences (Snedecor and Cochran, 2004).

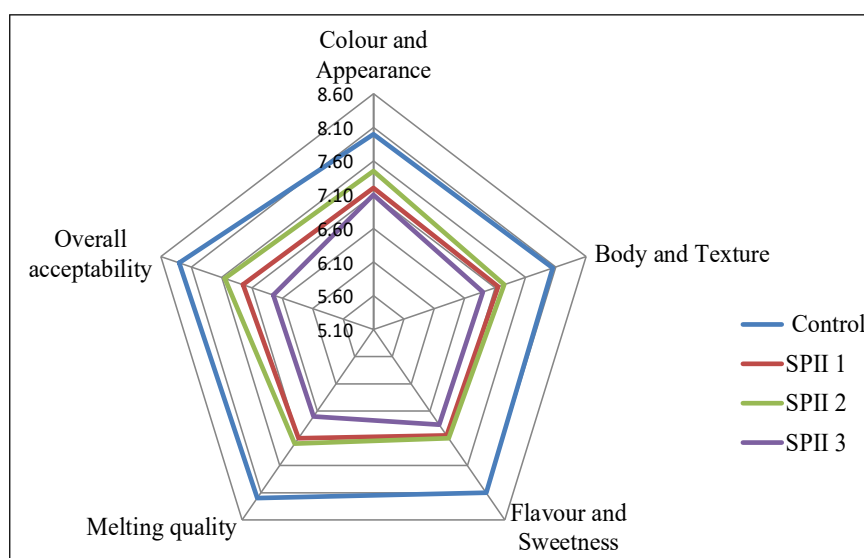
## RESULTS AND DISCUSSION

### Sensory analysis of spices incorporated ice cream

The spice powders incorporated ice cream (SPII) was served to panellists for sensory evaluation. The sensory scores for colour and appearance, body and texture, flavour and sweetness, melting quality and overall acceptability of the control and spices incorporated ice cream were shown in Fig 1. The sensory scores of colour and appearance for control, SPII1, SPII2 and SPII3 were found to be 8.00 $\pm$ 0.162, 7.20 $\pm$ 0.225, 7.45 $\pm$ 0.235 and 7.10 $\pm$ 0.191 respectively. The body and texture scores for control, SPII1, SPII2 and SPII3 were found to be 8.05 $\pm$ 0.185, 7.15 $\pm$ 0.264, 7.25 $\pm$ 0.280 and 6.90 $\pm$ 0.228 respectively. The flavour and sweetness scores for control, SPII1, SPII2 and SPII3 were found to be 8.10 $\pm$ 0.143, 7.05 $\pm$ 0.336, 7.10 $\pm$ 0.261 and 6.85 $\pm$ 0.196 respectively. The sensory scores of melting quality for control, SPII1, SPII2 and SPII3 were found to be 8.20 $\pm$ 0.156, 7.10 $\pm$ 0.228, 7.20 $\pm$ 0.200 and 6.70 $\pm$ 0.206 respectively. The overall acceptability for control, SPII1, SPII2 and SPII3 were found to be 8.15 $\pm$ 0.182, 7.25 $\pm$ 0.260, 7.80 $\pm$ 0.138 and 6.75 $\pm$ 0.239 respectively. Statistical analysis revealed that there was a highly significant ( $P < 0.01$ ) difference between the control and spice powders incorporated ice cream concerning colour and appearance, body and texture, flavour and sweetness, melting quality and overall acceptability. The highest mean score for overall acceptability was recorded in control ice cream compared to the spices incorporated ice cream.

### Physicochemical properties of spices incorporated ice cream

The physicochemical properties *viz.*, pH, titrable acidity, melting rate and overrun of the control and spices incorporated ice cream were presented in (Table 1). The pH of spice powders incorporated ice cream as found to be in the range of 6.58 to 6.68 and for control it was 6.71. The higher titrable acidity (0.28 $\pm$ 0.011) was found SPII3 and in control it was 0.20 $\pm$ 0.008. The melting rate in spice powders incorporated ice cream was found to be in the range of 1.20 $\pm$ 0.031 to 1.41 $\pm$ 0.029. The titrable acidity of developed ice cream samples increased significantly ( $p < 0.01$ ) during



**Fig 1:** Sensory evaluation of spice powders incorporated ice cream.

**Table 1:** Physico-chemical properties of spice powders incorporated ice cream (SPII).

Samples	Physico-chemical properties			
	pH	Titration acidity (% LA)	Melting rate (g/min)	Overrun (%)
Control	6.71±0.020 <sup>b</sup>	0.20±0.008 <sup>a</sup>	1.09±0.020 <sup>a</sup>	62.39±0.352 <sup>d</sup>
SPII1	6.68±0.016 <sup>ab</sup>	0.22±0.015 <sup>ab</sup>	1.20±0.031 <sup>b</sup>	53.09±0.248 <sup>c</sup>
SPII2	6.66±0.046 <sup>ab</sup>	0.24±0.019 <sup>ab</sup>	1.32±0.023 <sup>c</sup>	50.92±0.291 <sup>b</sup>
SPII3	6.58±0.017 <sup>a</sup>	0.28±0.011 <sup>b</sup>	1.41±0.029 <sup>c</sup>	48.57±0.305 <sup>a</sup>
F-value	3.845*	4.856*	30.851**	403.929**

Data are expressed as Mean±SE; n=6.

\* - Significant difference (0.01<P≤0.05);

\*\* - Highly significant difference (P≤0.01); Different superscripts in the same column indicate that treatments significantly differ.

the storage period and pH values decreased progressively. The control ice cream showed higher overrun as compared to the spices incorporated ice cream. Sakurai, (1996) found that ice cream with higher overrun melt speedily, whereas those with lower overrun began to melt slowly and had a good melting resistance. Statistical analysis revealed that there was a highly significant ( $P<0.01$ ) difference between the control and spice powders incorporated ice cream concerning melting resistance and overrun properties.

#### Texture analysis of spices incorporated ice cream

The textural parameters viz., hardness, adhesiveness, springiness, cohesiveness, gumminess, chewiness and resilience of the control and spices incorporated ice cream were presented in (Table 2). The hardness values of control and spice powders incorporated ice cream at 1, 1.5 and 2 per cent were found to be 2221.41±3.667, 2280.77±2.185, 2383.26±3.341 and 2485.04±6.040g respectively. The springiness values of control and spice powders incorporated ice cream at 1, 1.5 and 2 per cent were found to be 0.546±0.010, 0.340±0.014, 0.275±0.008 and 0.217±0.017 mm respectively. The cohesiveness values of control and spice powders incorporated ice cream at 1, 1.5

and 2 per cent were found to be 0.374±0.006, 0.288±0.027, 0.243±0.009 and 0.185±0.018 respectively. The gumminess values of control and spice powders incorporated ice cream at 1, 1.5 and 2 per cent were found to be 705.04±1.262, 516.05±3.584, 480.22±3.301 and 418.56±2.455 g respectively. The textural parameters were significantly ( $P<0.01$ ) differed between the control and spice powders incorporated ice cream concerning hardness, adhesiveness, springiness, gumminess and resilience properties.

#### Microbial analysis of spices incorporated ice cream

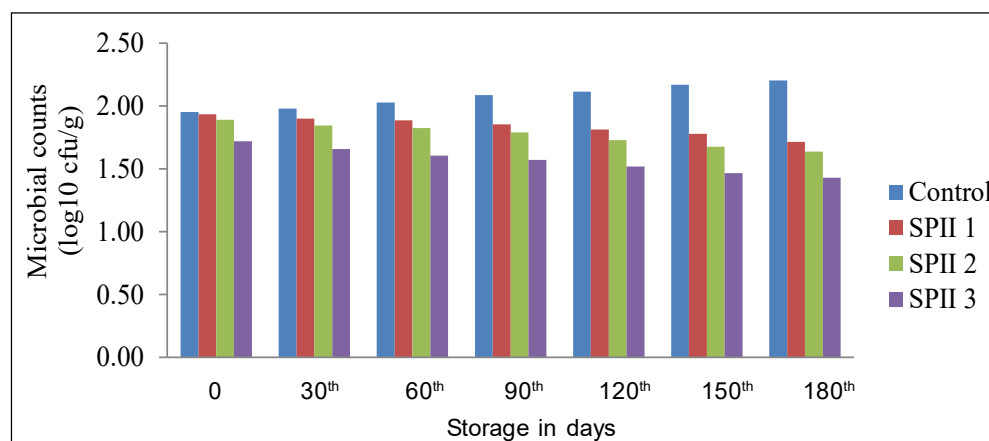
The microbial evaluation by standard plate, coliform, yeast and mold count during storage intervals of 0, 30, 60, 90, 120, 150 and 180 days for the control and spice powders incorporated ice cream were shown in Fig 2. It was observed that the standard plate count during storage gradually decreased from initial microbial load from 1.93±0.021 to 1.72±0.019. Increased incorporation level of spices in the ice cream considerably reduced the initial count from 1.89±0.094 to 1.64±0.031 during 180 days of storage. The result of the present study revealed that the low microbial load of the developed ice cream might be due to the presence of antibacterial and antifungal activities of spices.

**Table 2:** Texture analysis of spice powders incorporated ice cream (SPII).

Samples	Texture profile analysis					
	Hardness (g)	Adhesiveness (g s)	Springiness (mm)	Cohesiveness	Gumminess (g)	Resilience
Control	2221.41±3.667 <sup>a</sup>	-559.44±4.405 <sup>a</sup>	0.546±0.010 <sup>d</sup>	0.374±0.006 <sup>c</sup>	705.04±1.262 <sup>d</sup>	0.241±0.004 <sup>c</sup>
SPII1	2280.77±2.185 <sup>b</sup>	-188.72±3.948 <sup>d</sup>	0.340±0.014 <sup>c</sup>	0.288±0.027 <sup>b</sup>	516.05±3.584 <sup>c</sup>	0.217±0.003 <sup>c</sup>
SPII2	2383.26±3.341 <sup>c</sup>	-220.87±3.600 <sup>c</sup>	0.275±0.008 <sup>b</sup>	0.243±0.009 <sup>ab</sup>	480.22±3.301 <sup>b</sup>	0.155±0.016 <sup>b</sup>
SPII3	2485.04±6.040 <sup>d</sup>	-244.30±7.702 <sup>b</sup>	0.217±0.017 <sup>a</sup>	0.185±0.018 <sup>a</sup>	418.56±2.455 <sup>a</sup>	0.119±0.007 <sup>a</sup>
F-value	818.872 <sup>**</sup>	1106.250 <sup>**</sup>	123.085 <sup>**</sup>	21.794 <sup>**</sup>	1944.438 <sup>**</sup>	39.914 <sup>**</sup>

Data are expressed as Mean±SE; n=6; \*\* - Highly significant difference ( $P \leq 0.01$ ).

Different superscripts in the same column indicate that treatments significantly differ.

**Fig 2:** Microbial analysis of spice powders incorporated ice cream.

The coliform and mold count were not found in both the control and spices incorporated ice cream during different storage period at  $-18^{\circ}\text{C}$ , which indicates that the hygienic practices followed during production and storage.

## CONCLUSION

The ice cream was prepared by incorporating spice powders at varying levels of substitution (1%, 1.5% and 2%) and studied for their sensory attributes, physico-chemical properties, textural parameters and microbial analysis. The spice powders incorporated ice cream had higher influence in sensory characteristics as the incorporation levels increased the acceptance of the developed ice cream decreased. The increased incorporation level of spice powders was the major factor affecting the flavor and taste of the ice cream. The study revealed that the incorporation of spice powders significantly enhanced the antimicrobial properties due to the presence of antimicrobial compounds present in the spices. Further, evaluation is carried out to understand the nutritional composition and health benefits of spices incorporated ice cream.

## ACKNOWLEDGEMENT

Authors are thankful to the Dean, Faculty of Food Sciences, College of Food and Dairy Technology - TANUVAS, Alamathi, Chennai - 600 052 for his interest and providing facilities to carry out this work.

## Conflict of interest

The authors declare no conflict of interest pertaining to this manuscript.

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