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Ajisha Robins
M.V. Sc scholar, Department of Dairy Science, College of Veterinary and Animal Sciences, Mannuthy, Thrissur, Kerala, India

K Radha
Department of Dairy Science, College of Veterinary and Animal Sciences, Mannuthy, Thrissur, Kerala, India

CT Sathian
Department of Dairy Science, College of Veterinary and Animal Sciences, Mannuthy, Thrissur, Kerala, India

R Geetha
Department of Dairy Science, College of Veterinary and Animal Sciences, Mannuthy, Thrissur, Kerala, India

AK Beena
Department of Dairy Microbiology, College of Dairy Science and Technology, Mannuthy, Thrissur, Kerala, India

Correspondence
Ajisha Robins
M.V. Sc scholar, Department of Dairy Science, College of Veterinary and Animal Sciences, Mannuthy, Thrissur, Kerala, India

Development of low calorie goat milk ice cream by using stevia leaf powder

Ajisha Robins, K Radha, CT Sathian, R Geetha and AK Beena

Abstract
Low calorie goat milk ice cream was developed using stevia leaf powder as a low calorie sweetener. Sugar was partially replaced by stevia powder after conducting trials. The treatment mix was formulated to contain more than 10% fat, 20.5% milk solid not fat, 0.1% stevia, 5% sugar and 0.4% stabilizer-emulsifier combination. Effect of incorporation of stevia leaf powder was evaluated and compared with the control containing 15% sugar. Physico-chemical, microbiological and sensory qualities of control ice cream and ice cream incorporated with stevia were compared. The protein content of low calorie ice cream was higher ($p<0.01$) than control. Meltdown time was also higher in low calorie ice cream ($p<0.01$) than control. Flavour scores revealed no significant difference between low calorie ice cream and control. There was no significant difference between control and low calorie ice creams in fat, weight per litre, coliform count, total viable count and sensory parameters.

Keywords: goat milk, low calorie ice cream, stevia leaf powder, quality evaluation

1. Introduction
Ice cream is the most popular dairy product widely consumed by all age groups of people. It has high energy value due to high sugar content. So development of a functional food which is having low calorific value is much more beneficial to consumers. Thus replacement of sugar with low calorie sweeteners can reduce the calorific value of product. Thereby diabetic patients can consume it without health related problems. Goat milk had many advantages such as better digestibility, lower allergenic properties and stronger antimicrobial characteristics when compared to cow milk. Hence production of low calorie ice cream using stevia leaf powder from goat milk is much more beneficial.

Only few research works had been conducted so far regarding the use of natural sweeteners in ice cream production. The leaves of stevia plants are 200 to 300 times sweeter than sugar with zero calories. It has advantage over artificial sweeteners due to its high heat stablility. According to Marcinek and Krejpcio (2015) [1] leaf of stevia was also used in liver disease, gastric hyperacidity, stomach ache and for stimulating the nervous system. It exhibits antibacterial, antifungal properties and may be used in the prevention of caries as well as in the treatment of wounds, burns and ulcerations. Mishra *et al*. (2010) [2] suggested that stevia leaf powder, a low calorie sweetener with high water holding capacity can be used for the preparation of various viscous foods such as frozen desserts and soups. Therefore, this study was aimed to develop low calorie ice cream using stevia leaf powder and to evaluate the product based on physico-chemical, microbiological and sensory qualities of the product.

2. Materials and Methods
Materials include dairy ingredients and non-dairy ingredients. Dairy ingredients include goat milk, cream and skimmed milk powder. Non dairy ingredients include stevia leaf powder, sugar, flavour, stabilizer and emulsifier. Fresh goat milk was procured from University Goat and Sheep farm, Mannuthy. Cream was separated from goat milk by using a centrifugal cream separator. Skimmed milk powder (sagar®), sugar and flavour (bush®) were purchased from local market. The stabilizer and emulsifier used was cremodan sampoorna® of Danisco purchased from Bharath marketing, Palakkad. Stevia leaf powder was purchased from Harikrishna Ayurvedics, Balaramapuram.

2.1 Analysis of dairy ingredients
The fat per cent in milk, skim milk, skimmed milk powder were found out by using the skim milk butyrometer (AOAC, 2016) [3]. The fat content of cream was estimated by the procedure

laid out in IS – SP: 18 Part IX, (1981) [4]. The total solids content of whole milk, cream, skim milk and skimmed milk powder were estimated by the procedure laid out in IS – SP: 18 Part IX, (1981) [4].

2.2 Preparation of ice cream

Ice cream was prepared as per the procedure suggested by Akin *et al.* (2007) [5]. First step was figuring of mix. The proportionate quantity of different ingredients to meet the minimum standard for fat (ten per cent) and total solids (36 percent) as per Food Safety and Standards Act was calculated for the preparation of ice cream. Next step is making the mix. Ingredients selected for the preparation of ice cream were weighed. Solid ingredients (skimmed milk powder, stevia leaf powder, sugar, stabilizer and emulsifier) were mixed together and kept separately. The liquid ingredients (milk and cream) were taken in milk cooker and heated with stirring. The thoroughly mixed solid ingredients were added into the milk cooker when the temperature of the liquid content reached around 42ºC. The mix was pasteurized at a temperature of 83ºC for 25 seconds. Homogenization of the mix was done at a temperature of 65ºC by using a pressure of 2500 PSI at first stage and 500 PSI at the second stage. The mix after pasteurization was immediately cooled to 4ºC and later transferred to a cold storage maintained at a temperature of 4±1ºC and kept for overnight. Vanilla (bush®) flavor at the rate of 2ml per kg of the mix was added to the mix and mixed well. The ice cream mixes in each treatment group were frozen individually using a softy ice cream freezer (Technogel HMT®). The ice cream was collected in 500 ml plastic containers. Then it was stored at -20±1 ºC.

2.3 Standardization of level of stevia leaf powder for the preparation of low calorie ice cream

Trials were conducted to standardize the level of stevia leaf powder required for the preparation of low calorie ice cream. Stevia leaf powder was incorporated at three different levels (0.05, 0.1 and 0.15 per cent). The sensory acceptability of these ice cream samples were evaluated by the sensory panel. Based on the sensory scores the level of stevia leaf powder was selected.

2.4 Low calorie ice cream mix

Low calorie ice cream was prepared by using selected level of stevia leaf powder as a low calorie sweetener. Stevia leaf powder was added along with other dry ingredients during the preparation of mix as shown in Table 1.

Table 1: Formulation of different ice cream mixes (2 litre)

Ingredients	Control	Low calorie ice cream
Milk(ml)	1267	1327
Cream (g)	349	312
SMP (g)	74	264
Sugar (g)	300	100
Stabilizer (g)	8	8
Stevia (g)	-	2

2.5 Physico-chemical properties of Ice cream

The titratable acidity of control and treatment groups of ice cream was determined by the procedure outlined by BIS (1981) [4]. The pH of the ice cream samples were analysed by digital pH meter (Hanna HI2020). The pH meter was calibrated using the standard pH solutions. After selecting the measurement mode, the electrode was dipped into the ice cream sample. The reading was noted directly from the Liquid Crystal Display. The percentages of total solids, protein and fat in control and treatment ice creams were determined using the procedure outlined by AOAC (2000) [6]. The whipping ability of the product was determined by the procedure outlined by Rajor (1980) [7]. While the mix was being frozen in a softy ice cream freezer, mix was drawn at five minutes intervals up to ten minutes and weighed. The loss of weight of the mix due to air incorporation was recorded. The meltdown time was estimated following the procedure outlined by Rajor (1980) [7]. 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 complete meltdown was recorded. Weight per litre of ice cream was estimated using the procedure outlined in BIS (1983) [8].

2.6 Microbial Analysis of ice cream

The coliform count and total viable count of ice cream were performed as per BIS (1981) [4].

2.7 Sensory Evaluation

Organoleptic evaluation was carried out by a panel of selected judges. The frozen ice cream was served in 50 ml cups for sensory evaluation. The evaluation was done by using the score card as per Homayouni *et al.* (2008) [9].

2.8 Statistical analysis

The data obtained were subjected to statistical analysis using the software SPSS version 24 as per the procedure suggested by (Snedecor and Cochran, 1994) [10]. Means were compared by one way ANOVA followed by Duncan multiple range test. The data obtained from storage studies were analysed by pairwise comparison. Sensory scores were subjected to non-parametric kruskal-wallis test followed by Mann whitney test.

3. Results

Low calorie ice cream was prepared by using 0.1 per cent stevia leaf powder and five per cent sugar. Whereas in control ice cream 15 per cent sugar was used. The mean pH, titratable acidity, total solids, fat, protein, weight per litre, whipping ability, meltdown time values are presented in Table. 2. The mean coliform count and total viable count are presented in Table. 3. The mean sensory scores are presented in Table. 4.

Table 2: Physico-chemical properties of low calorie ice cream

Type of ice cream	pH	Titratable acidity (%)	Total solids (%)	Fat (%)	Protein (%)	Weight per litre(g/l)	Whipping ability (%)	Meltdown time (minutes)
Control	6.36±0.03	0.12±0.01	42.28 ±1.64[a]	10.80 ±0.71	4.47 ±0.24[b]	769.88±12.01	32.82 ±2.40	52.67±1.25[b]
Low calorie ice cream	6.23±0.05	0.17±0.018	39.38 ±1.29[b]	11.10 ±0.31	5.89 ±0.62[a]	703.20±29.37	32.04 ±3.04	74.00±5.05[a]

Means bearing different superscripts within the same column differ significantly ($p<0.01$)
Means are averages of six replications

Table 3: Microbial quality of low calorie ice cream

Type of ice cream	Coliform count (log cfu/g)	Total viable count (log cfu/g)
Control	1.170±0.434	4.618±0.14
Low calorie ice cream	1.519±0.489	4.752±0.479

No significant difference between control and treatment ($p>0.05$)
Means are averages of six replications

Table 4: Sensory evaluation of low calorie ice cream

Type of ice cream	Flavour (1-10)	Body & texture (1-5)	Colour & appearance (1-5)	Total (1-20)
Control	8.8±0.2	4.27±0.18	4.33± 0.12[a]	17.4± 0.34[a]
Low calorie ice cream	8.33±0.18	4.07± 0.18	3.6± 0.16[b]	16±0.2[b]

Means bearing different superscripts within the same column differ significantly ($p<0.01$)
Means are averages of six replications

4. Discussion

There was no significant difference in pH and titratable acidity between control and low calorie ice cream. Total solids content of low calorie ice cream was significantly lower ($p<0.01$) than control. Giri *et al.* (2014) [11] have also reported similar findings in kulfi. Due to lower levels of sugar, there was a reduction in total weight of kulfi when stevia was incorporated. Thus the moisture percentage increased proportionally in these samples. In this study also reduction of sugar level in ice cream samples incorporated with stevia caused significant decrease in total solids content. However, the total solids content was with in the legal limit prescribed by FSSAI. There was no significant difference in fat content between control and stevia added ice cream. The protein content of low calorie ice cream was significantly higher ($p<0.01$) than that of control. Increase in protein content of stevia added kulfi was reported by Giri *et al.* (2014) [11]. In the present study also significant increase in protein content was observed in low calorie ice cream incorporated with stevia. This could be due to the addition of higher levels of skim milk powder to maintain the minimum total solids content in ice cream. The results are in accordance with the earlier findings. The weight per litre of ice cream incorporated with stevia was lesser than that of control but it was not statistically significant. Alizadeth *et al.* (2014) [12] noticed significantly higher percentage of overrun in ice creams incorporated with stevia (65.03 per cent) than control (53.37 per cent).The reduction in weight per litre might be due to the reduction in sugar content. Statistical analysis revealed that there was no significant difference in whipping ability between control and treatment. Pon *et al.* (2015) [13] obtained significant increase in overrun percentage in ice cream with the increment in the concentration of stevia leaf powder. In the present study no such increase in whipping ability could be observed. This could be due to the low level of stevia used in this study. Low calorie ice cream had significantly higher ($p<0.01$) meltdown time than control. Giri *et al.* (2014) [11] reported that sugar replacement with stevia cause increase in free moisture content and subsequent increased in large ice crystal formation that might have decreased the melting rate in the kulfi sample. According to Flores and Goff (1999) [14], the higher amount of air cells in stevia added ice cream could slow the meltdown because air cells reduce the rate of heat transfer across the ice cream. Pon *et al.* (2015) [13] have also reported similar findings. The results obtained in the present study are in accordance with the above findings.

No significant difference in coliform count and total viable count was observed between control and treatment group. There was no significant difference in flavour scores between control and Low calorie ice cream. Giri *et al.* (2014) [11] observed no significant difference in flavor score between control and 0.05 per cent stevia added kulfi. The sweetness score of control kulfi was 8, as against 7.9, 7.9, and 7.8 for 50, 60 and 70 per cent sugar reduction through 0.05, 0.06 and 0.07 per cent stevia addition respectively. There was no significant difference in body and texture scores between control and low calorie ice cream. Giri *et al.* (2014) [11] found no significant difference in body and texture score between control and 0.05 per cent stevia added kulfi. Low calorie ice cream had obtained significantly lower scores ($p<0.01$) for colour and appearance than the control. Similar results were reported by Giri *et al.* (2014) [11]. In their study kulfi incorporated with stevia at different levels had obtained lower sensory scores for colour and appearance than control. The decrease in scores could be attributed to the colour of stevia leaf powder. Low calorie ice cream had obtained significantly lower ($p<0.01$) total scores than control. In a study conducted by Giri *et al.* (2014) [11], no significant difference in overall acceptability score was observed between control and 0.05 per cent stevia added kulfi. But as the level of stevia addition was increased above 0.05 per cent the overall acceptability scores decreased significantly as compared to control sample. In the present study stevia added ice cream had obtained significantly lower total scores when compared to control. This could be due to the higher level (0.1 per cent) of incorporation of stevia.

5. Conclusion

Low calorie ice cream could be successfully developed by using stevia leaf powder as low calorie sweetener. Meltdown time and protein content were significantly higher in low calorie ice cream than that of control. Flavour scores shows no significant difference between control and low calorie ice cream.

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