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Quality evaluation of whey incorporated ice cream

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Abstract

Ice cream, a common frozen dessert around the world could be used as probiotic vehicles, with the added advantage of being appreciated by people belonging to all age groups and social levels. An attempt was made to standardize whey water incorporated ice cream. The standard ice cream was done by using milk, skim milk powder, sugar, carboxymethyl cellulose (CMC), glycerol mono stearate (GMS) and corn flour. Three variations of whey incorporated ice cream was formulated by substituting milk with whey water (milk: whey water) in the ratio 3:1 (V_1), 1:1 (V_2) and 1:3 (V_3). The physiochemical acceptability, nutrient contribution and sensory acceptability of the formulated ice creams were assessed. The physico-chemical and nutrient content of the formulated ice cream were analysed. The results indicated that variation 3 (V_3) having 1:3 (milk:whey water) ratiowas highly acceptable and its overrun was found to be 80 per cent. Ice cream had a pH of 6.6 and the titrable acidity was 0.03 with 38.7 per cent of total solids. The whey incorporated ice cream (V_3) provided 248 kcal and 6.1 per cent protein and 12.11 per cent fat which is relatively higher than the commercially available ice cream. Therefore, the results showed that incorporation of whey water into ice cream improves the nutritional quality of the ice cream which would enhance its potential marketable value.

Key words: Dairy, Ice cream, Probiotics, Whey, Protein.

Introduction

Today, the food industries are looking for ingredients which can provide excellent functional and nutritional properties for the formulation of value added products. The increasing awareness for nutrition, health and quality food consciousness of consumers and keen competition in the market,inducethe food industries to search for ingredients such as whey proteins, which can impart specific functionalities to food products (Moor and Hay, 1992).

When the pH of the milk is reduced from 6.6 to 5.3, casein starts losing colloidal dispersability and separates out to form a coagulum which is called as channa (De, 1976). This is the base material for cheese, paneer and exotic traditional sweet delicacies like rasagulla, sandesh and rasamalai.

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The preparation of coagulated products gives a nutritional fluid portion called whey. Whey contains 50–60 per cent of the nutrients of the milk but is paradoxically drained into gutters as an environmental hazard (Uma, 2008). On an estimate more than three million tonnes of whey is produced in the country which contains two lakh tonnes of valuable nutrients (Khamuri and Rajorhia, 1998).

Whey complies with "maximum biological value – minimum calories" (Seetharam,1999). Whey contains 50 per cent milk solids, 70 per cent milk sugar and 20 per cent milk proteins (Horton, 1995 and Gupta, 2000). Whey has Protein Efficiency Ratio (PER) of three which is higher than egg with 2.5 (Goyal, 1999). Its amino acid profile is complete and has high proportion of Branched Chain Amino Acids (BCAA) and a good biological value (European Dairy Association, 1998).

According to Goel (1997), whey proteins are the wonder proteins for nutritional, clinical, dietetic, sports and infant foods. Whey proteins, as food ingredients can modify organoleptic, visual, hydration, textural, structural and rheological properties of food resorting in improved consumer acceptance of the finished product.

Whey protein can be used as a novel ingredient in several food and pharmaceutical applications. The unique properties of whey protein such as solubility, gelling, foaming may pave way for them to be used directly in human foods (DeWit, 1989).The wide applications in foods include a main stay in the food industry. The protein additive can also be used in processed meat, cheese, beverages, yoghurt and ice cream in low fat food formulations. The application can also be extended to soup, sauces and salad dressings (Savitri, 2001).

Ice cream is a common frozen dessert around the world. Ice cream shows potential for use as probiotic vehicles, with added advantage of being appreciated by people belonging to all age groups and social level (Tamime, 2009).

Ice cream is considered a food for enjoyment, rather than a basic food. Therefore fortification of ice cream with nutrients or other bio active substances should be supported (Bandri, 2001).Hence, an effort was taken to develop whey incorporated ice cream and to assess its quality characteristics.

Methods

The ingredients selected for the study was milk (standardized - Fat- 4.5 %; SNF – 9%), sugar, milk powder, cream, Glycerol Mono Stearate (GMS), Carboxy Methyl Cellulose (CMC), vanilla essence which were procured from local market of Coimbatore city.The basic standard ice cream (control) was prepared using milk, skim milk powder, sugar, CarboxyMethyl Cellulose (CMC), Glycerol Mono Stearate (GMS) and corn flour. Three variations of whey incorporated ice cream was formulated by substituting milk with whey in the ratio of 3:1 (V_1), 1:1 (V_2) and 1:3 (V_3) respectively. The proportion of ingredients in whey water incorporated ice cream is presented in Table I.

Table I

Formulation ofwhey incorporated ice cream

Ingredients	Control (100 % milk)	Variation 1 (milk: whey – 3:1)	Variation 2 (milk: whey – 1:1)	Variation 3 (milk: whey – 1:3)
Milk(ml) (standardized - Fat- 4.5 %; SNF – 9%),	500	350	250	150

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Milk powder(g)	150	150	150	150
Whey (ml)	-	150	250	350
Cream (g)	50	150	150	150
Sugar (g)	65	65	65	65
Carboxy methyl cellulose (g)	1	1	1	1
Glycerol monostearate(g)	1.5	1.5	1.5	1.5
Corn starch (g)	1	1	1	1

Milk was boiled and cooled to room temperature. Other ingredients (sugar, milk powder, cream, Glycerol Mono Stearate (GMS), Carboxy Methyl Cellulose (CMC), vanilla essence) were added to the milk and the mixture was heated to 120°C for 15 minutes and quickly homogenized using electrical blender (Phillips-150 HP) and cooled immediately. Whey was prepared by coagulating milk using citric acid and the channa was separated by filtering through a muslin cloth. The filtered whey was added to the cooled ice cream mixture as per the formulation given in Table I and the initial volume was noted. The whipped mixture was refrigerated for four hours and whipped again for 15 minutes and frozen for six hours. After six hours, the mixture was again whipped for six minutes and left for hardening in the freezer (Figure 1). A control ice cream was also prepared using 100 per cent milk without addition of whey.

Preparation of whey incorporated ice cream

Boiling milk (100° C)
↓
Cooling (room temperature - 37° C)
↓
Addition of other ingredients
(Sugar, milk powder, cream, GMS, CMC, vanilla essence)
↓
Boiling (120°C – 15 minutes)
↓
Homogenization
↓
Cooling
↓
Addition of whey
↓
Aging (4 hours)
↓
Whipping (15 minutes)
↓
Freezing (-6°C to -10°C, 6 hours)
↓
Whipping (6 minutes)
↓
Hardening (-6° C)

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Figure 1

The formulated ice creams along with control and commercially available ice cream were evaluated by twenty semi trained panel members for its organoleptic acceptability using five point rating scale (BIS, 1983). Appearance, taste, colour, flavour and texture were the parameters assessed.

Physical characteristics of a food product is an important aspect which determines the consumer acceptability. Therefore, the prepared whey incorporated ice cream was assessed for its physico – chemical characteristics like over run, pH, titrable acidity and total solids.

Over run: Over run is the increase in volume of the mix due to the incorporation of air. It is expressed as the percentage of the volume of mix. The over run of the standardized ice cream was evaluated using the following formula provided by Arbukle (1977).

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

pH:pH is the measure of the active acidity which influences the flavour and palatability of food product. The pH was measured using a digital pH meter.

Titrable acidity: Titrable acidity was estimated to find out the percentage of lactic acid by method provided by Hatmann (1920) (BIS, 1983).20 g of the sample was weighedin a conical flask and 50 ml of recently boiled cooled water was added and titrated against 0.1N sodium hydroxide using phenolphthalein indicator.

Total solids: Total solids include fat, milk solids not fat (MSNF) and all other solids added to the ice cream mix from other sources. Melting characteristics is influenced by total solids. Total solids helps to provide moderate degree of viscosity on melting which was analysed using gravimetric method was given by Padmasini (2000).

Nutrient content such as fat (Mojonnier method) and protein (micro kjeldahl method) were analysed using standard procedures whereas energy content was calculated using food composition tables provided by Nutritive value of Indian Foods (ICMR NIN, 2014) for the formulated ice cream. To ensure that the microbial hazard is under control, total bacterial count was enumerated in the ice cream using standard plate count method (Kannan, 1986).

Results and Discussion

Sensory evaluation of whey incorporated ice cream

The only way to evaluate sensory quality or some of its attributes is to get the opinion, since sensory quality is not an intrinsic food characteristic, but the result of interactions between humankind and food. The analysis of the chemical composition and the physical properties of a certain food product affords information about the nature of stimuli perceived by the consumer, but not about the sensation experienced in its consumption (Brandt et al, 2003). The mean scores of the sensory evaluation of the products are tabulated in Table II.

Table II

Mean scores of sensory evaluation of whey water incorporated ice cream

Criteria	Commercial ice	Control (100 %	Variation 1 (milk: whey –	Variation 2 (milk: whey –	Variation 3 (milk: whey –

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	cream	milk)	3:1)	1:1)	1:3)
Colour & Appearance	4.21	3.70	3.31	2.70	**3.70**
Texture	4.58	4.42	3.84	3.68	**4.16**
Mouth feel	4.78	4.68	4.31	3.94	**4.57**
Flavour	4.74	4.37	4.26	3.79	**4.10**
Taste	4.63	4.05	3.95	3.57	**4.00**
Overall acceptability	4.58	4.24	3.93	3.53	**4.10**

The commercial, control and variation 3 (1:3) had a smooth fine texture with no detectable feel of ice crystals whereas variation 1 (3:1) and variation 2 (1:1) had a sandy textureandwas fairly acceptable. Variation 3 obtained high score (4.16) next to commercial and control.A sandy texture may be due to large lactose crystals which are slow to dissolve. This defect may be controlled by reducing the milk solids non-fat content of the mix, acid standardization, replacing part of the cane sugar content with the dextrose and maintaining uniformly low storage temperature (Arbuckle, 1966).The commercial, control and variation 3 had a good mouth feel whereas variation 1 and variation 2 had a grainy texture.

The commercial, control and variation 3 had a very good flavour and secured higher score. The variation 2 and variation 3 had a mild vanilla flavour which was fairly acceptable. Substitution of skimmed milk powder to 25 per cent with whey protein concentrate in the preparation of ice cream resulted in fullness of flavour, low melt down, good body and texture (Hemaprabha, 2003).

The commercial, control and variation 3 had pleasant taste but variation 2 and variation 3 had a mild taste.Among the whey incorporated ice creams, variation 3 recorded higher scores in all organoleptic criteria and found to be highly acceptable with one part of milk and three parts of whey.

Physico chemical characteristics of the formulated ice cream

Table IV shows the physico chemical characteristics of ice cream

Table IV

Physico chemical characteristics of whey water incorporated ice cream

S. No.	Physico chemical characteristics	Variation 3 (milk: whey – 1:3)	Standards
1.	Over run	80%	80-100% (BIS)
2.	Titrable acidity	0.03	0.25 (BIS)
3.	Total Solids	38.7	36 (FSSAI, 2011)
4.	pH	6.6	6.6-6.8 (BIS)

The over run of the selected variation 3 was found to be 80 per cent.Homemade ice creams usually have no more than 30-40% overrun, whereas commercial ice cream has at least 80 per cent overrun and sometimes 90-100 per cent. The higher percentage of overrun in commercial ice cream in comparison to home made products results from a better control of freezing conditions,

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such as the rate of freezing and the stage of hardness at which the freezing is discontinued (Bennion, 1975).

The acidity of the selected variation 3 was found to be 0.03 per cent. The percentage of lactic acid present in the ice cream was much lower than the maximum limit specified by BIS. This implies that the condition were not favourable for fermentation of lactose by microbes.

The texture of the ice cream is dependent on the total solids of the mix. An inadequate total solids reduces the viscosity and affects the texture of the ice cream (Uma, 2008). Total solids in the formulated ice cream – variation 3 were found to be 38.7 per cent. According to Food Safety and Standards (Food Products Standards and Food Additives) Regulations (2011), the total solids in ice cream should not be less than 36 per cent.

pH is the measure of active acidity modulates, the flavour in ice cream hence an important index of quality. The pH of the formulated ice cream was found to be 6.6 which correlates with the study ofKhillari et al (2007) who prepared low fat ice cream using whey protein concentrate (WPC) which had a pH between 6.5- 6.6.

Nutrient content of the formulated ice cream

The nutrient content of the commercial and formulated ice cream is presented in the Table V.

Table V
Nutrient Content of the Standardized Ice Cream

Nutrients	Commercial Ice cream	Variation 3 (milk: whey – 1:3)
Total Energy (kcal)	144	**248**
Protein (g)	2.8	**6.12**
Fat (g)	10.6	**12.11**

The selected variation 3containsapproximately 6 g of protein, 12 g of fat. It provides 248 kcal whereas commercial ice cream provides only 144 kcal and approximately 3 g of protein. Therefore, the whey incorporated ice cream had relatively high nutrient content.

Whey has high quality protein as its Biological Value is 104 and Protein Efficiency Ratio (PER) is 3. With the addition of whey protein concentrate improvement in the quality of frozen desserts and ice cream by eliminating the shrinkage problem was observed (Raffio, 1982).

The microbial load of the ice cream determines the safety and quality of the products for human consumption. Hindering the growth of micro-organisms is a yardstick for quality control.The microbial load of an ice cream should be less than 2, 50,000 CFU/g (ISI, 1964). The total bacterial count in the formulated ice cream was found to be 1×10^3 CFU/g.It is evident that the total bacterial count of the 5^{th}day sample of variation 3 is in limits of the standards prescribed by ISI and it is safe for human consumption.

The cost of the product was calculated using the standard price list and the cost of the formulated whey incorporated ice cream was found to beRs. 10/- for 45g/100ml which is equal to the commercial ice creams sold.

Conclusion

Whey water is a nutritional and functional ingredient rich in proteins has been used to replace milk at different levels inthe ice cream preparation to enhance the proteincontent. The

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whey water incorporated ice cream sampleshad sensory characteristics similar to that of controlice cream sample and was highly acceptable. Hence, it is concluded that whey water incorporated up to 75 per cent in the ice cream replacing milk could enhance the protein content of the ice cream without affecting sensory qualities.

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