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Sensory acceptability of reduced fat, low calorie and protein rich ice cream and its production cost estimation

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Abstract
Present study was conducted to evaluate the sensory acceptability of the reduced fat, low calorie and protein rich Ice Cream. The mean sensory score for attributes such as color and appearance, flavor, sweetness, body and texture, aftertaste and overall acceptability of optimized Ice Cream was observed as 8.28, 7.86, 8.28, 8, 7.71 and 7.86 respectively whereas for control Ice Cream it was 8.43, 8.57, 8.71, 8.43, 8.43 and 8.28 respectively. It is revealed from the above findings that the mean sensory score for flavor and aftertaste of optimized Ice Cream was significantly ($P < 0.05$) different to the control Ice Cream due to the fortification of soy protein Isolate, inulin and stevia; whereas the non-significant ($P > 0.05$) effect was observed for mean sensory score for other organoleptic properties of optimized Ice Cream as compare to the control Ice Cream.

Keywords: Ice Cream, Sensory, Soy protein isolates (SPI), Inulin, Stevia, Production cost

1. Introduction
Ice cream is a frozen dairy product which is made by freezing of ice cream mix with whipping. It is produced by blending the food ingredients such as milk products, sweetening materials, stabilizers, flavors, colors and egg products. Pre-mix of ice cream is mixture of ingredients in unfrozen condition. It contains all the ingredients which are required for Ice cream except air and flavoring agent (Deosarkar *et al*., 2016) [6]. Ice cream is consumed by different age group on very large scale because it contains high nutrition value and well assimilated body. In present time it can be seen that the consumption of the dairy products becoming very popular in the cities where younger generation is adopting westernized diet and many dairy products such as ice cream, yogurt which is used to be consumed during the warm season are now being consumed in large quantities whole year.
Most of the ice cream manufacturer has been focused on the kids and health conscious people because consumers are more educated and further aware about the relations between food and health than ever before as they are pleasing more concerned in foods which add to affirmative outcome on health further than nutritional needs. In the manufacturing of functional foods development of non-dairy based foodstuffs has been pointed out as a new fashion. Foodstuffs containing functional ingredients such as probiotic, prebiotic, dietary fiber, soy and derivatives have growing market of around 5% per year worldwide and selling is expected to be over US$19.6 billion from these products in 2013.
Inulin is a non-digestible and naturally existing storage fructo-oligosaccharide which is present in plants such as chicory and Jerusalem artichoke (Schaller-Povolny and Smith 1999) [25]. It is consider that Inulin have prebiotic properties which stimulate the growth of the probiotic bacteria in the colon as a result the health of host is improved. (Gibson and Roberfroid 1995; El-Nagar *et al*. 2002; Özer *et al*. 2005) [13, 10, 23]. Beside nutritional properties of inulin, it is also used in the formulation of new food products as an ingredient because it have some technological attributes such as sugar and fat replacer and texture alterant (Meyer *et al*. 2011) [21]. Fat mimetic property of inulin is responsible for its capability to binding water molecules and forming particle gel network into the solution (Franck 2002) [11].
In recent years a large portion of plant proteins are going to be used in human diet. Soybeans are considered as the most plentiful resource of plant proteins. In the global plant protein consumption the share of soybeans is around 68% (Mondor *et al*. 2010) [22] going to be just about 98% for animal feed (Henley *et al*. 1992) [16]. Soy proteins have several functional and nutritional properties,

Which assure an extensive series of applications in a range of food industry sectors (Hojilla-Evangelista *et al*. 2004) [17].

In the development of many healthy food products soy products such as protein isolates and concentrates can be used. Recently many studies conducted to observe the health effect of soybean and they revealed that there are many health benefits of consuming soy compound. It can be used in preventive and therapeutic applications, in the treatment of cardiovascular disease, osteoporosis, cancer and symptoms related to menopause (Hasler 1998; Donkor and Shah 2008) [15, 7]. Soy proteins have several functional attributes such as emulsifying, gelling, foaming and water absorption (Tsumura *et al*. 2005; Pednekar *et al*. 2010) [27, 24]. When soy proteins are replaced by dairy products and added to the other foodstuffs such as processed meat, infant formulas and nutritional beverages these attributes play an important role into high-quality food production (Tsumura *et al*. 2005) [27].

In recent utilization of alternative sweeteners in the development of food products becomes more popular due to the increasing demand of low calorie foods by consumers. Due to the too much use of sugar in diet the prevalence of metabolic disorders such as obesity, diabetes, cardiovascular disease is ever-increasing. Sucrose is the major sweetener which is utilized in ice cream production but it contains glucose. For the diabetic patients the quantity of sucrose in their diet should be decreased. Stevia can be used as an alternative to the sugar because it has negligible effect on the blood glucose level. It is good alternative for the people who are on carbohydrate controlled diet. Stevia is a natural sweetener which is obtained from the leaves of *Stevia rebaudiana* plant species which is native of Brazil and Paraguay. A number of natural, heat-stable ent-kaurene glycosides (steviol glycosides) are present in stevia, there intensities of sweetness and flavor is different from each other and differ according to concentration and environment. Collectively, the sweetness of stevia is 100 to 300 times more than sucrose (Cardello *et al*. 1999) [5]. Stevia would be accepted as a sugar substitute in ice -cream since stevia has a sugar –like taste and often a somewhat bitter taste (Alizadeh *et al*. 2014) [1].

Materials and Methods

Fresh cow milk was obtained from the Dairy Farm of Banaras Hindu University. Skimmed milk powder, cream and sugar were bought from the local market of the Varanasi. Soy protein isolate (SPI) was obtained from the DUPONT India Pvt. Ltd. Gurugram, Haryana; inulin powder was procured from NOW FOODS, USA; stevia extract powder was procured from Stevia Zone Agritech Pvt. Ltd. Ahmedabad, Gujarat. Reduced fat, low calorie and protein rich Ice Cream was manufactured in the departmental laboratory of Animal Husbandry and Dairying, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. Various preliminary trails with different treatment combination of SPI, inulin and stevia were performed and their sensory evaluation was carried out by a panel of judges; finally a suitable combination was obtained.

Table 1: Ingredients required for the manufacturing of control and reduced fat, low calorie and protein rich Ice cream (optimized Ice Cream)

Ingredients	Control Ice Cream	Optimized Ice Cream
Milk (ml)	607	769
Cream(ml)	243	81
Skimmed Milk Powder (g)	93.50	122.40
Sugar (g)	110	0
Soya protein isolates (g)	0	13.60
Inulin (g)	0	33.66
Stevia (g)	0	8.5

Manufacturing Process of Ice Cream

Milk was standardized to 10% and 6% fat for control and optimized ice cream respectively with the appropriate combination of milk and cream. Than milk was heated; when the temperature of milk rise to the 40 ºC skimmed milk powder, sugar and emulsifiers & stabilizers were added into the milk for control sample whereas for optimized ice cream SPI, inulin and stevia with required amount were added with continuous stirring. This mix was heated to 82 ºC for 20 sec. with continuous stirring. When the temperature of the mix was come down to the 60 ºC, it was transferred for the homogenization at 2000 psi; further the mix was aged at 5 ºC for overnight and transferred to the continuous freezer (temperature maintained at -4 to -5 ºC) through the pump. The prepared ice cream was filled in the plastic bowel and placed for hardening at -18 ºC for overnight.

Sensory evaluation

Ice Cream samples were evaluated for different sensory characteristics like colour and appearance, flavour, sweetness, body and texture, aftertaste and overall acceptability for sensory acceptability. Sensory evaluation was performed by a panel of 7 semi-trained judges from the Department of Animal Husbandry and Dairying, Banaras Hindu University, Varanasi (India) and all the analysis were performed in triplicate. The panellists were asked to evaluate the samples on a nine point hedonic scale, where a score of nine represents 'extreme liking' and one denotes 'extreme disliking' (Amerine *et al*. 1965) [2]. Sensory evaluation was done at 25°C and 60% relative humidity.

Production cost estimation

Production cost of the control and optimized Ice Cream was calculated on the basis of raw material cost and processing cost. Per litter of ice cream cost was estimated through the following formula.

$$Cost\ of\ production\ (per\ litter) = \frac{Cost\ A + Cost\ B}{Q}$$

Where, Cost A – Cost of Raw Materials, Cost B – Cost of Processing and Q- Quantity of Ice Cream Obtained (litters)

Statistical analysis

Data are expressed as Mean ± SE and all data were calculated on the basis of three independent experiments. The two sample independent t-test was used to know the acceptability. The t-statistics and its p-value were calculated using the IBM

SPSS version 16 to find the significance difference of the sensory attributes for both control and optimized Ice Cream samples.

Result and Discussion

Sensory evaluation of the ice cream samples

The visual manifestation of food is essential for the consumer because the color of food surface is the first superiority factor evaluated by consumers, and it is important to product acceptance. Food appearance determined usually by surface color; it is the first sensation that the consumer perceives and uses as a means to either accept or reject food (Leon *et al.*, 2006) [19]. Table 2 show the color and appearance score for control and optimized Ice Cream. It was 8.43 for control whereas 8.28 for optimized Ice Cream sample. The score for color and appearance of the control Ice Cream was observed non-significantly ($P > 0.05$) different than the optimized Ice Cream. Low score for color and appearance of optimized Ice Cream was due to the fortification of SPI. Similar findings were observed by Friedeck *et al.* (2003) [12], they observed that the incorporation of SPI in the Ice Cream mixes had significantly inferior color than control mixes. Similarly Drake *et al.* (2000) [8] found that the addition of five percent soy protein in yoghurt had darker color as compared to the control sample.

Flavor is comprised of taste (perceived on the tongue) and odor (perceived in the olfactory center in the nose) and is the response of the receptors in the oral cavity to chemical stimuli (Bourne, 2002) [4]. Table 2 shows the mean score for flavor. The value 8.57 and 7.86 represents for control and optimized Ice Cream respectively. Optimized Ice Cream was significantly ($P < 0.05$) different from the control Ice Cream. The low score for flavor of optimized Ice cream could be due to flavor binding capacity of soy protein. This is in agreement with the study of Friedeck *et al.* (2003) [12] who reported that higher intensities of green/grassy and doughy/fatty flavors were detected in the two per cent and four per cent SPI incorporated ice cream mixes when compared to control mixes. This is again in accordance with the study of Drake *et al.* (2000) [8] who reported that flavor, aroma and astringency increased with soy protein incorporation in dairy yoghurt.

Table 2: Sensory evaluation of control and optimized Ice cream.

Variables	Control	Optimized Ice cream	p value
	Mean ± SE	Mean ± SE	
Color & Appearance	8.43 ± 0.20	8.28 ± 0.18	0.305
Flavor	8.57 ± 0.20	7.86 ± 0.14	0.006
Sweetness	8.71 ± 0.18	8.28± 0.28	0.115
Body & texture	8.43 ± 0.20	8 ± 0.21	0.087
Aftertaste	8.43 ± 0.20	7.71 ± 0.18	0.011
Overall acceptability	8.28 ± 0.18	7.86 ± 0.26	0.102

Sweetness is basic taste most commonly perceived when eating food rich in sugar. Sweet tastes are regarded as pleasurable experience, except perhaps in excess. Table 2 shows the score for sweetness of control and optimized Ice Cream which is 8.71 and 8.28 respectively. The sweetness score of optimized Ice Cream was non-significantly ($P > 0.05$) different than control. It was due to the replacement of sugar with stevia and partial replacement of skimmed milk powder with SPI. Stevia sweeter the ice cream with bitter aftertaste whereas SPI and Inulin have no taste but when these ingredients added to the pre-mix they changed the composition so both of this also reduces the sweetness score of the optimized Ice Cream. Similar result was reported by Alizadeh *et al.* (2014) [1] they studied that the complete replacement of sugar with stevia reduces the score of sweetness. Several factors such as concentration, ingredients and temperature of the Ice Cream affect the sweetening power and persistence of sweet taste by Stevioside. Present study is also in agreement with Friedeck *et al.* (2003) [12] who reported that the sweet taste decreased with increasing SPI.

Body the whole mass of Ice Cream is referred to its firmness and resistance. Texture refers to finer particles of the Ice Cream. The body and texture score of control Ice Cream was 8.43 whereas it was 8 for the optimized Ice Cream. It is revealed from Table 2 that the score of body and texture for optimized Ice Cream was non-significantly ($P > 0.05$) low as compare to the control Ice Cream. It could be due to the low fat content and incorporation of Inulin and SPI into the Ice Cream mix. Present study is in agreement with the study of Shridharrao (2012) [26] reported that when Inulin was added @ 3% level in the Shrikhand, there non-significant difference were observed for the body and texture score as compare to the control sample. Drake *et al.* (2000) [8] attributed that the higher protein content of SPI compared to non fat dry milk as the reason for higher viscosity, which is not a desirable characteristic for ice cream.

Aftertaste is the taste of foodstuffs which is remains in your mouth after your food has been swallowed or spit out. In present study it is confirmed from the Table 2 that the score of aftertaste of optimized Ice Cream was significantly ($P < 0.05$) low as compare to the control Ice Cream. It could be due to the complete replacement of stevia with sugar. DuBois and Stephenson (1985) [9]; Cardello *et al.* (1999) [5] reported that that adding of very high concentrations of Stevia to many food products negatively influences mean liking of those products. Further the bitter aftertaste of Stevioside is more persistent than other natural and synthetic sweeteners and appears in a dose dependent manner.

Acceptability is the distinctiveness of a food being subject to acceptance for some point. A food is acceptable if it is adequate to serve the purpose for which it is provided, even if it is far-off not as much of usable for this purpose than the idle example. The score of overall acceptability was 7.86 of optimized Ice Cream, which was very near to the control Ice Cream sample which obtains a score of 8.28 for overall acceptability. Giri *et al.* (2012) reported that the kulfi prepared by substituting sugar with stevia had low overall acceptability score compare to the control kulfi. There were no significant difference observed between control and 0.05% stevia added kulfi for overall acceptability score but they found that as the levels of stevia addition increased, the overall acceptability score significantly decreased compared to control sample. A similar study for this attribute conducted by Awasthi and September (2004) [3] on development and

evaluation of soy fortified eggless cakes reported that defatted soy flour can be incorporated up to 15 per cent in the formulation of cakes where egg could be replaced completely without adversely affecting the sensory acceptability and functional quality of cake.

Estimation of production cost

Various costs incurred in the production of control and reduced fat, low calorie and protein rich Ice Cream are presented in Table 3. Total cost was divided into two parts first was raw material cost and second was processing cost. Raw material costs for control Ice Cream sample include cost of milk, cream, skimmed milk powder, sugar and emulsifier/stabilizer costs and for experimental Ice Cream sample it includes cost of milk, cream, skimmed milk powder, emulsifier/stabilizer, stevia, SPI, and inulin. Processing costs for both control and experimental Ice Cream include costs of electricity charges, labour charges and miscellaneous costs. For manufacturing of 100 liters of Ice Cream on an average the total cost of production for control Ice Cream was Rs 11657 whereas for reduced fat, low calorie and protein rich Ice Cream it was Rs 19653. Table 2 also show the per kg production cost, for control Ice Cream it was Rs 68.56 whereas for experimental Ice Cream it was Rs 119. The increased cost of reduced fat, low calorie and protein rich Ice Cream was due to the higher cost of its added ingredients such as inulin, stevia and SPI.

Table 3: Production cost estimation of control and optimized Ice Cream.

Ingredient required	Rate(Rs)	Reduced fat, low calorie and protein riched Ice cream		Control Ice Cream	
		Quantity	Cost (Rs.)	Quantity	Cost (Rs.)
Raw Material Cost (A)					
Milk (4% fat)	45/Lit.	76.9	3460	60.7	2731.5
Cream (25 % fat)	182/Lit.	8.1	1539	24.3	4422.6
Skimmed milk powder	230/Kg	11.513	2648	9.35	2150.5
Sugar	45/Kg	0	0	11	495
Stevia	2100/ Kg	0.85	1785	0	0
Inulin	2000/ Kg	3.4	6732	0	0
SPI	1200/Kg.	1.36	1632	0	0
Emulsifier and stabilizers	834/Kg	0.425	354	0.425	354
Total Raw Material Cost		165	18150	170	10154
Processing Cost (B)					
Electricity charges	7Rs/Unit	29	203	29	203
Labour	300/8 hrs.	8 (Hrs.)	300	8 (Hrs.)	300
Misc.	--	--	1000	--	1000
Total Processing Cost			1503		1553
Total cost (A+B)			19653		11707
Ice cream obtained		165		170	
Cost Rs./kg			119		68.86

Conclusion

It was concluded on the basis of above findings that there were no significant difference were observed in optimized Ice Cream for all sensory attributes except flavor and aftertaste. The low mean sensory score for flavor and aftertaste of optimized Ice Cream was due to the addition of SPI and Stevia; which can be overcome by adding some flavoring agents. The production cost of optimized Ice Cream was observed higher than the control Ice Cream sample. It was due to the utilization of the expensive ingredients.

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