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PHYSICO-CHEMICAL, MICROBIAL AND SENSORY ANALYSIS OF ALOE VERA (PULP) ICE CREAM WITH NATURAL COLOUR IN DIFFERENT ARTIFICIAL SWEETENERS

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ABSTRACT

The demand for natural source of such compounds is increasing day by day because of awareness of positive health benefit out of natural compounds. Ice cream is fat rich product enjoyed by all age groups. The demand for ice cream production is increasing 12 to 15 per cent every year in India. The growing concern with health and the higher incidence of overweight, metabolic syndrome and diabetes have resulted in an increase in interest for foods with lipid and sugar reduction. However, the development of new food products turns out to be increasingly challenging, as it has to fulfill the consumer's expectancy for products that are simultaneously relish and healthy. The present investigation was undertaken to study the physico-chemical and microbial properties of herbal (*Aloe Vera*) ice cream with natural colour beetroot for strawberry flavour.

Key Words: Ice Cream – Aloe Vera – Artificial Sweeteners – Aspartame – Levulose – Sucralose – Flavour – Strawberry Flavour – Natural Colour – Beetroot Juice – Physico-Chemical – Microbial Analysis.

INTRODUCTION

In recent years, there has been a growing interest in using herbal products as dietary adjuncts in the dairy industry. Products have been developed and are on the market worldwide. Among dairy products with live cultures, sugar substitute and herbal dairy products are also gaining popularity. In India annual growth rate of ice cream is 12 – 15% with market value of 2500 cores per year. India, as elsewhere in the world, incidence of diabetes and coronary diseases are on the rise, and hence people have become conscious about their diet. *Aloe vera* is one of the oldest known medicinal plants gifted by nature; *Aloe vera*, often called miracle plant is known by many names. The most widely used variety of *Aloe vera* is *Barbadensis millar*. It is perennial, succulent plant with stiff fleshy leaves. *Aloe vera* is a clear thin gelatinous material that comes from inside the *Aloe vera* leaves. *Aloe Vera* juice also improves blood circulation due to its ability to detoxify. It is also a natural healer, and hence any internal ulcers or lesions will be soothed and healing will be enhanced. *Aloe vera* leaves have vital ingredients such as vitamins, minerals, amino acids, polysaccharides, enzymes, plant steroids, saponins, lignin, anthraquinones, salicylic acid, which are necessary for the human body. *Aloe vera* works as anti-septic, antibacterial, antiviral, anti-carcinogenic and anti-inflammatory. Red beet (*Beta vulgaris*) extract shows variety of colours, depending on their content of yellow compound and may have a good flavour. Also a bluish-red colour produced by a compound known as betanin and is stable at higher pH range than red cabbage extract. There is no limit on its upper usage level. It has wide application in different food commodities from beverages to candy and dairy products (Counsell *et al.*, 1979). Osborne and Vogot (1978) reported that 100 gm of raw red beet contains 88% water, 7% carbohydrate, 1.5% crude protein, 0.1% fat, 33 Kilo calories of energy, 0.8% fiber, 1mg ash, 25mg calcium, 35mg phosphorus, 0.7mg Iron, 7mg vitamin C and 25 I.U vitamin A, 0.03mg thiamin, 0.04mg Riboflavin, 0.2mg Niacin, 80mg sodium, 350mg potassium, Copper, Iodine Sulphur and Chloride in traces.

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Sharma *et al.* (2001) reported that beetroot red was used as a colouring agent in hard candies, yoghurt, ice-creams, salad dressing, readymade frostings, cake mixes, meat substitute, powdered drink mixes and gravy mixes soft drinks and gelatin desserts.

Independent WHO observers have estimated the total number of diabetics in the world as 177 million. India tops the list of 10 countries, followed by China. In south India, Prof. Lefebvre said, the incidence of diabetes and impaired glucose tolerance had been increasing since 1984. The risk factors for the increase in prevalence of diabetes among Asian Indians included high racial susceptibility, general obesity and insulin resistance even with a low Body Mass Index. The objective of this study was to produce herbal icecream containing natural colour with reduced sugar (artificial sweeteners) and to determine their physico-chemical, microbial and sensory charactersl immediately after freezing and during storage. In an attempt to improve the nutritive value of the ice cream and deemed to fill a gap in the market and fulfill consumer demand. Furthermore, the effects of artificial sweeteners and sugar levels on the physical and sensory characteristics of the herbal ice-cream were also examined.

MATERIALS AND METHODS

The present study was conducted at the modern dairy plant, Institute of Food and Dairy Technology, Koduvalli, Alamathi (post), Chennai. The raw materials used for the preparation of ice cream are as follows: Buffalo milk (5.0 per cent fat and 9.5 per cent MSNF) purchased from the nearby village; Butter (80 per cent fat) purchased from the Tamil Nadu Co-operative Milk Producers Federation Ltd., Aavin and was used to standardize the fat content of the ice cream. Skimmed milk powder (95 per cent MSNF) obtained from Tamil Nadu Co-operative Milk Producers Federation Ltd. Aavin was used to standardize the milk solids not fat (MSNF) content of ice cream. High quality stabilizers (gelatin) and emulsifiers (Glycein-mono-strate) were used for this research. Strawberry flavour ice creamwas prepared using beet root juice used as a natural colour. Strawberry natural identical flavorwas purchased from the Chemical Engineering Corporation Pvt. Ltd., Ponpadi, R.S and PO – 631 213, Tamil Nadu was used flavouring ice cream. High quality cane sugar (sucrose) was used. Ice cream mix was prepared with 10 percent fat, 36 percent total solids, 0.5 percent stabilizer and emulsifier in the ice cream, as per ISI (IS: 2802, 1964) specification (Sukumar De, 2008). The Artificial sweeteners like Levulose, Sucralose and Aspartame (along with dry mix) were added at the rate of 50 percent. In each treatment, mix ingredients were homogenized as described by Arbuckle, (1986) and then heated to 80°C for 30 sec as suggested by Rothwell, (1976). Mixes were cooled to 5°C and aged overnight at the same temperature. The natural colour (beet root juice), natural identical vanilla flavour (0.05 percent)and *Aloe vera* pulp were added at the rate of 15 percent, 20 percent and 25 percent respectively before freezing. The different treatments carried out are shown in the following table. The freezing was done in a batch freezer. The ice cream was filled in 50 ml paper cups, covered with lid and stored at –29°C.

The sensory characteristics of the ice cream samples were assessed using the ADSA IC score card. The sensory panel belongs to staffs and students of Institute of Food and Dairy Technology, Koduvalli, Chennai.

Items	Perfect score	Score obtained
Flavor	45	
Body and Texture	30	
Color	5	
Melting quality	5	
Bacterial count	15	
Total score	100	

ADSA IC Score card

The titrable acidity and pH of the ice cream were determined as per the procedure described in IS: 2802-1964.

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The standard plate count and coliform counts of the ice cream samples were determined as per the procedure described in IS: 2802-1964.

The data collected were analyzed by analysis of variance (one way ANOVA) as described by Snedecor and Cochran (1989). And Duncan's multiple range tests were used as post hoc technique to study the significant difference among the means.

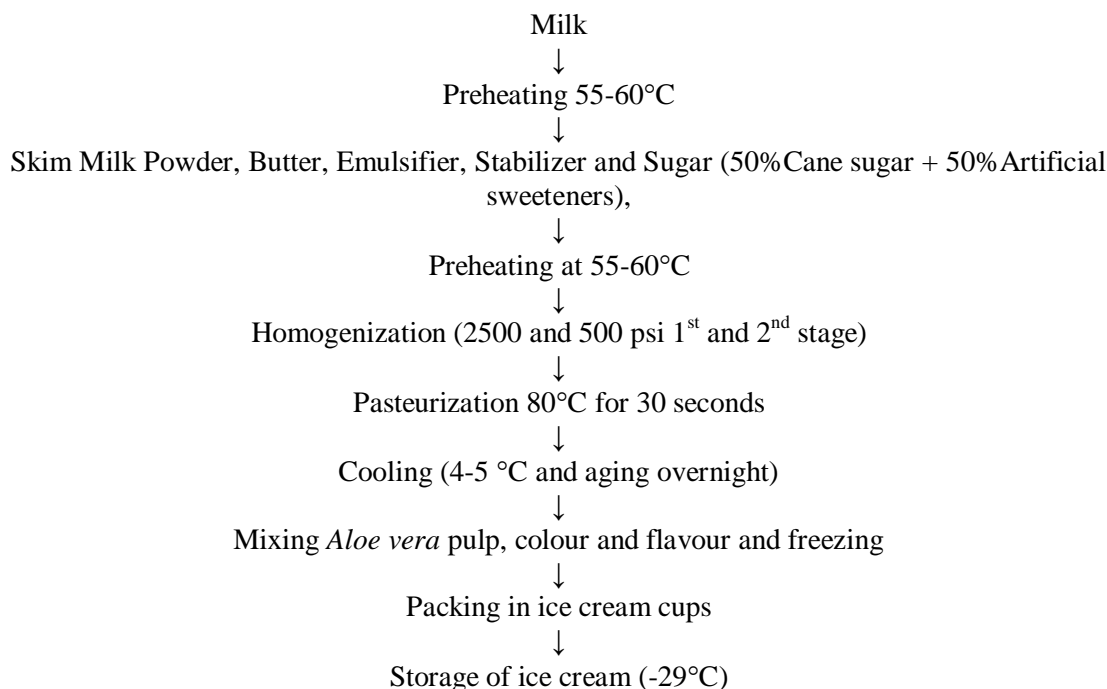


Figure 1: Process flow chart for the preparation of ice cream samples

RESULT AND DISCUSSION

The average sensory scores presented in table 1 reveals that the incorporation of *Aloe vera* pulp in the ice cream significantly diminished the overall sensory scores compared to the control ice cream. The average scores for flavour, colour, body and texture and melting quality were significantly lower than the control samples. The aim of the study was to include maximum amount of *Aloe vera* pulp in the ice cream since it contains very low amount of total solids with all micronutrients essential for mankind, but is bitter in taste. Hence inclusion of *Aloe vera* pulp in ice cream reduces the sensory characters viz., colour, flavour, which can be overcome by using proper flavour and colour. The sensory evaluation scores revealed that acceptability was highest for the ice cream mix incorporated with 20 percent *Aloe vera* pulp. Hence, its next lower and higher level of incorporation viz., 15 percent and 25 percent along with 20 percent *Aloe vera* pulp were taken up for further studies. Beetroot juice contains betanin (300-600 mg/kg) and lower concentrations of isobetanin, betanidin, and betaxanthins (Kanner et al. 2001). Betanins, as natural antioxidants and provide protection against oxidative stress-related disorders (Tesoriere et al. 2005, Kanner et al. 2001). Beetroot can be used as a colouring agent in foods such as dairy, bakery and meat products (Sharma et al., 2001). Preliminary screening tests conducted by visual perception revealed that 4 percent beet juice was the optimum level of incorporation in strawberry flavoured ice creams. Hence, its immediate lower and higher level of incorporating ie. 3 percent and 5 percent along with 4 percent were taken up for sensory evaluation.

Table 1: Sensory evaluation scores (Mean± SE)*for the ice cream prepared with different levels of *Aloe vera* pulp

Parameters	Control	<i>Aloe vera</i> pulp								
		5%	10%	15%	20%	25%	30%	35%	40%	45%
Flavour	41.32±0.314	42.12±0.431	41.85±0.409	41.26±0.428	39.50±0.212	38.02±0.302	38.61±0.144	38.76±0.150	38.56±0.176	38.21±0.209 ^a
Color	4.92±0.027	4.80±0.056	4.79±0.056	4.80±0.054	4.81±0.058	4.91±0.042	4.91±0.043	4.78±0.059	4.80±0.049	4.72±0.056
Body & texture	28.41±0.154	27.35±0.216	27.52±0.184	27.64±0.176	28.80±0.117	27.71±0.175	27.71±0.180	26.97±0.188	26.50±0.203	26.73±0.227
Melting quality	4.82±0.043	4.38±0.062	4.40±0.059	4.42±0.059	4.82±0.043	4.40±0.063	4.40±0.062	4.39±0.045	4.39±0.042	4.27±0.054
Microbial	15.00±0.000 ^a	15.00±0.000 ^a	15.00±0.000 ^a	15.00±0.000 ^a	15.00±0.000 ^a	15.00±0.000 ^a	15.00±0.000 ^a	15.00±0.000 ^a	15.00±0.000 ^a	15.00±0.000 ^a
Over all score	94.47±0.387	93.65±0.484	93.56±0.452	93.13±0.454	92.93±0.225	90.05±0.378	90.63±0.270	89.89±0.252	89.24±0.286	88.94±0.338

Means bearing different superscript in a row differ significantly ($P < 0.01$)

* Average of 8 trails

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Table 2: Sensory analysis score (Mean± SE)* card for ice cream with beetroot juice as natural color for strawberry flavour

Parameters	Control	Beetroot juice		
		3%	4%	5%
Flavour	40.18±0.208 ^c	38.35±0.258 ^a	40.27±0.216 ^c	39.14±0.193 ^b
Color	4.86±0.034 ^b	3.80±0.060 ^a	4.91±0.029 ^b	4.78±0.052 ^b
Body & texture	28.39±0.131 ^b	27.31±0.207 ^a	28.56±0.125 ^b	27.39±0.203 ^a
Melting quality	4.80±0.037 ^b	4.41±0.058 ^a	4.81±0.037 ^b	4.54±0.059 ^a
Microbial	15.00±0.000 ^a	15.00±0.000 ^a	15.00±0.000 ^a	15.00±0.000 ^a
Overall score	93.22±0.269 ^c	88.88±0.351 ^a	93.55±0.281 ^c	90.85±0.361 ^b

Means bearing different superscript in a row differ significantly ($P < 0.01$)

* Average of 8 trails

Table 3: Sensory analysis score (Mean± SE)*for ice cream with sucralose as artificial sweetener

Parameters	Control	Sucralose		
		50%	75%	100%
Flavour	43.24±0.206 ^c	43.07±0.189 ^c	38.52±0.242 ^b	37.77±0.193 ^a
Color	4.80±0.021 ^b	4.92±0.027 ^b	4.87±0.032 ^b	4.47±0.068 ^a
Body & texture	29.29±0.137 ^b	29.31±0.101 ^b	27.31±0.207 ^a	26.87±0.194 ^a
Melting quality	4.96±0.021 ^c	4.91±0.029 ^c	4.61±0.063 ^b	4.38±0.064 ^a
Microbial	15.00±0.00 ^a	15.00±0.00 ^a	15.00±0.00 ^a	15.00±0.00 ^a
Overall score	97.44±0.256 ^c	97.21±0.225 ^c	90.37±0.328 ^b	88.48±0.272 ^a

Means bearing different superscript in a row differ significantly ($P < 0.01$)

* Average of 8 trails

Table 4: Sensory analysis score (Mean± SE)*for ice cream with levulose as artificial sweetener

Parameters	Control	Levulose		
		50%	75%	100%
Flavour	42.96±0.250 ^c	42.65±0.258 ^c	38.97±0.101 ^b	37.63±0.212 ^a
Color	4.91±0.029 ^b	4.88±0.032 ^b	4.44±0.068 ^a	4.37±0.066 ^a
Body & texture	29.44±0.154 ^b	29.35±0.132 ^b	26.53±0.104 ^a	26.56±0.127 ^a
Melting quality	4.94±0.024 ^c	4.87±0.037 ^c	4.12±0.032 ^b	4.02±0.039 ^a
Microbial	15.00±0.00 ^a	15.00±0.00 ^a	15.00±0.00 ^a	15.00±0.00 ^a
Overall score	97.26±0.275 ^c	96.75±0.299 ^c	89.07±0.144 ^b	87.57±0.283 ^a

Means bearing different superscript in a row differ significantly ($P < 0.01$)

* Average of 8 trails

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Table 5: Sensory analysis score (Mean± SE)*for ice cream with aspartame as artificial sweetener

Parameters	Control	Aspartame		
		50%	75%	100%
Flavour	43.61±0.223 ^c	43.37±0.261 ^c	39.79±0.615 ^b	38.14±0.242 ^a
Color	4.78±0.067 ^c	4.66±0.071 ^{bc}	4.51±0.065 ^b	4.21±0.065 ^a
Body & texture	28.98±0.184 ^b	28.89±0.136 ^b	28.92±0.119 ^b	25.28±0.123 ^a
Melting quality	4.79±0.063 ^c	4.64±0.070 ^c	4.27±0.070 ^b	3.59±0.069 ^a
Microbial	15.00±0.00 ^a	15.00±0.00 ^a	15.00±0.00 ^a	15.00±0.00 ^a
Overall score	97.16±0.300 ^c	96.56±0.316 ^c	92.49±0.638 ^b	86.22±0.298 ^a

Means bearing different superscript in a row differ significantly ($P < 0.01$)

* Average of 8 trails

Table 6: Physico-chemical, microbial and sensory analysis of *Aloe vera* (pulp) ice cream (Mean ± SE)*at various concentrations with natural color (beetroot juice) and natural identical strawberry flavour in different artificial sweeteners

Parameters	Control	Aspartame			Levulose			Sucralose		
		15% Aloe	20% Aloe	25% Aloe	15% Aloe	20% Aloe	25% Aloe	15% Aloe	20% Aloe	25% Aloe
pH	6.45±0.060 ^c	6.47±0.078 ^c	6.42±0.078 ^c	6.08±0.134 ^{ab}	6.45±0.090 ^c	6.39±0.065 ^c	6.10±0.116 ^{ab}	6.42±0.107 ^c	6.36±0.086 ^{bc}	5.95±0.134 ^a
Titration acidity	0.24±0.014 ^a	0.22±0.013 ^a	0.24±0.002 ^a	0.29±0.020 ^b	0.21±0.007 ^a	0.23±0.004 ^a	0.29±0.016 ^b	0.21±0.014 ^a	0.24±0.001 ^a	0.31±0.023 ^b
SPC (log 10 cfu/ml)	3.41±0.549 ^b	3.12±0.528 ^b	2.24±0.497 ^{ab}	2.12±0.419 ^{ab}	3.06±0.496 ^b	2.12±0.514 ^{ab}	1.94±0.489 ^{ab}	3.06±0.511 ^b	1.47±0.478 ^a	1.41±0.446 ^a
Overall organoleptic quality	95.51±0.46 ^{7d}	89.84±0.565 ^b	94.57±0.571 ^{cd}	88.13±0.502 ^a	89.51±0.569 ^{ab}	93.66±0.512 ^c	88.66±0.577 ^{ab}	88.94±0.397 ^{ab}	95.15±0.522 ^{cd}	87.93±0.443 ^a

Means bearing different superscript in a row differ significantly ($P < 0.01$)

* Average of 8 trails

The average overall sensory scores for ice cream samples prepared with different levels of beetroot juice as natural colour is presented in table 2. The sensory scores for different characters of the ice cream samples prepared with four percent beetroot juice were not significantly different from the control sample and consistently higher when compared to the other two inclusion levels indicating that the optimum level of inclusion of beetroot juice in the ice cream mix was 4 percent. In this study, sucralose was substituted for cane sugar in the ice cream samples at three different levels viz., 100, 75 and 50 percent and the average sensory scores for different characters and the overall average scores are presented in table 3. It may be noticed that the inclusion level of 50 percent had the maximum overall score and was statistically similar to that of control samples for all the sensory characters. It was also found that sucralose when substituted for cane sugar at 75 and 100 percent level adversely affected the body and texture and melting quality apart from flavour which might be due to the reduction in the bulk volume of the ice cream. Sucralose has no calorific value, is not metabolized by the body, can be used in cooking and baking, and an average daily intake (ADI) of 15 mg per kg of bodyweight is permissible in human beings. (Marie

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Spano, 2002). Hence the optimum level of substitution (50 percent) as found in the present study is well within the ADI.

Table 4 shows the average sensory analysis scores of ice creams incorporated with levulose in place of cane sugar at different levels in the ice cream. The overall average sensory scores for 100, 75 and 50 percent inclusion levels were 87.57, 89.07 and 96.75, respectively; while the corresponding value for control samples were 97.26. All the sensory characters were significantly altered by the level of inclusion of levulose in the ice cream samples. The inclusion of levulose at the level of 50 percent was statistically different from the remaining two levels of inclusion and was not significantly different from the control samples. The results of the study showed that levulose can be added with the ice cream mix at the rate of 50 percent.

Aspartame was substituted for cane sugar in ice cream in three levels viz., 100, 75 and 50 percent. The overall average values scored by three levels of inclusion namely 100, 75 and 50 percent were 86.22, 92.49 and 96.56, respectively. The control samples had the maximum overall average score of 97.16 and all the sensory characters were not statistically different from the samples prepared with 50 percent aspartame as artificial sweetener (Table 5). However the other two levels of inclusion viz., 100 and 75 percent significantly altered the sensory scores of the all the characters and hence the 50 percent level of inclusion of aspartame in the ice cream was considered as optimum. Aspartame is a dipeptide (L-aspartyl-L-phenylalanyl-methyl ester) with a sweetening power of 180 to 200 times that of sucrose (Mazur RH, 1969). The Joint Expert Committee on Food Additives (JECFA) estimated the level causing no effect in the rat to be 4 g/kg body wt/day and proposed an ADI (safety factor 100) of 40 mg/kg body wt/day for humans (JECFA, 1980). Hence, it was found that aspartame can be substituted for cane sugar at 50 percent level without affecting the sensory characters of ice cream which was also well within the ADI.

The results of physico-chemical, microbial and sensory quality of ice cream samples prepared with beetroot juice as natural colour for strawberry flavour and *Aloe vera* at three different levels in three different artificial sweeteners are presented in table 6. The average pH, titrable acidity and standard plate count of the control sample was 6.45, 0.24 and 3.41, respectively. The average pH values of the samples with 15, 20 and 25 percent *Aloe vera* and aspartame, levulose and sucralose as artificial sweeteners were 6.47, 6.42, 6.08; 6.45, 6.39, 6.10; 6.42, 6.36 and 5.95 respectively. The corresponding values for titrable acidity were 0.22, 0.24, 0.29; 0.21, 0.23, 0.29; 0.21, 0.24 and 0.31, respectively. In general, the standard plate counts decreased as the level of inclusion of *Aloe vera* increased. The average standard plate count values of 15, 20 and 25 percent samples with aspartame, levulose and sucralose were 3.12, 2.12, 2.24; 3.06, 2.12, 1.94; 3.06, 1.47 and 1.41 (\log_{10} cfu/gm) respectively.

The results of the present study revealed that the increased level of inclusion of *Aloe vera* in the ice cream reduced the pH value and standard plate count and simultaneously increased the titrable acidity. *Aloe vera* contains uronic acid, salicylic acid and phenolic compounds which is responsible for the increase in the acidity there by decrease the pH of the ice cream. In addition to the above *Aloe vera* also contains many anti-bacterial, anti-viral and anti-fungal agents namely saponins, fatty acids etc. which might have caused in the reduction of standard plate count (Marshall, 1990; Ahmad *et al.*, 1993). The ice cream was prepared in the department dairy plant under strict hygienic precautions and hence, coliforms were not found in the sample. This may be also due to the presence of *Aloe vera* which was having anti-microbial properties.

Conclusion

The results of the present study of one way analysis of variance revealed that the incorporation of *Aloe vera* pulp in the ice cream significantly diminished the sensory scores. The average scores of flavour, colour, body and texture and melting quality were significantly ($P < 0.01$) lower than the control samples. The sensory evaluation scores revealed that acceptability was highest for the ice cream mix incorporated with 20 percent *Aloe vera* pulp. Hence, its next lower and higher level of incorporation viz., 15 percent and 25 percent along with 20 percent *Aloe vera* pulp were taken up for further studies. The one way analysis of variance showed that the inclusion various levels of natural colour significantly ($P < 0.01$)

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altered the sensory scores of the ice cream. The optimum inclusion level of natural colour beetroot juice was found as 4.0 percent. Three artificial sweeteners namely aspartame, levulose and sucralose were also added to substitute cane sugar at 100, 75 and 50 percent. Significant difference ($P < 0.01$) was noticed between the various levels of substitution of artificial sweeteners and it was found that the artificial sweeteners can be substituted for cane sugar at the rate of 50 percent without much altering sensory properties of the ice cream. It was found that the increased level of inclusion of *Aloe vera* in the ice cream significantly ($P < 0.01$) reduced the pH value and standard plate count and simultaneously increased the titrable acidity. The ice cream was prepared in the department dairy plant under strict hygienic precautions and hence coliforms were not found in the sample. This may be also due to the presence of *Aloe vera* which was having anti-microbial properties. However, the amount of *Aloe vera* in the ice cream above 20 percent reduced the sensory scores significantly ($P < 0.01$) and hence it was concluded that the optimum level of inclusion of *Aloe vera* in the ice cream was 20 percent. Three different concentration of *Aloe vera* pulp incorporated in the ice cream sucralose as artificial sweetener at 20 per cent *Aloe vera* pulp scored 95.15 followed by the aspartame and levulose respectively.

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