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Research Article

STUDIES ON SENSORY EVALUATION OF *ALOE VERA* ICE CREAM WITH ARTIFICIAL SWEETENERS AND NATURAL CARAMEL COLOUR

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ABSTRACT
In India type -2 diabetic is increasing every year and make the people to go for alternative sugar. 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 and vanilla is the second largest flavour wished in the world. Natural vanilla flavour being most expensive hence using natural identical flavour much advantage to meet the demand. Natural identical flavours are substances that are chemically identical to natural substances, but which are obtained by chemical processes or by chemical modification of other natural substances like plants. The present investigation was undertaken to prepare herbal (*Aloe Vera*) ice cream with artificial sweeteners and natural identical vanilla flavour to assess its acceptable level of the resultant product. *Aloe vera* pulp, artificial sweeteners and natural identical vanilla flavour are added different level in ice cream and prepared ice cream was subjected to sensory analysis to found out the optimum level of inclusionin the ice cream preparation. Then sample were stored at -29°C and studied for their sensory scores.

Key Words: *Ice Cream – Aloe vera – Artificial Sweeteners – Aspartame – Levulose – Sucralose – Flavour – Chocolate flavour – Caramel Colour – Sensory Analysis*

INTRODUCTION
Ice cream is one of the oldest fat rich delicious dairy products relished by all age groups of people throughout the world. In India annual growth rate of ice cream pro 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.

Hence, producing an ice cream with reduced sugar and medicinal herbs and natural colour is deemed to fill a gap in the market and fulfill consumer demand. Hence this study on herbal ice cream with artificial sweeteners was carried out.

Aloe vera is one of the oldest known medicinal plants gifted by nature; *Aloe vera*, often called miracle plant is known by many names. There are over 200 types of *Aloe vera* and of these only 4 or 5 are commonly used in medicines. 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. It has been reported to cure eczema, diabetes, arthritis and is said to prevent infection. It also improves human immune system and digestive system.

Colour becomes the most sensitive part of any commodity not only for its appeal but also it enhances consumer acceptability. In addition, the color of a food substance is important to indicate its freshness and safety that are also indices of good aesthetic and sensorial values. For natural color and additives, adherence to the norms of bio-safety protocol, are limited. The demand for natural source of such

compounds is increasing day by day because of awareness of positive health benefit out of natural compounds. It therefore, necessitates looking into natural sources of food grade colorants and their use potentials. Caramel colour, from the palest yellows to the deepest browns, accounts for more than 80% (by weight) of all colourants added to the foods we eat and drink (Kamuf *et al.*, 2003).

Caramel colours have been used for so long and in such a wide variety of food products that consumers tend to think of them as a single substance, when in reality they are a family of similar materials with slightly different properties. There are, in fact, four distinct types of caramel colour to satisfy the requirements of different food and beverage systems (JECFA, 1992, National Academy of Science 1996.): Caramel Colour I (also known as plain or spirit caramel), Caramel Colour II (caustic sulfite caramel), Caramel Colour III (ammonia or beer caramel, bakers and confectioners caramel), and Caramel Colour IV (known as sulfite-ammonia, soft drink caramel, or acid proof caramel). Each type of caramel colour has specific functional properties that ensure compatibility with a product and eliminate undesirable effects, such as haze, flocculation, and separation. For Ice cream Caramel Colour III is used at the level of 1% (Kamuf *et al.*, 2003).

In India, Rule 26 of The Prevention of Food Adulteration Rules (PFAR) permits 11 colours for food use: Lactoflavin, Caramel, Annato, Saffron, Curcumin etc., also approved by EU and FDA (Pritam *et. al.2008,*).

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. Chocolate flavor was purchased from the Chemical Engineering Corporation Pvt. Ltd., Ponpadi, R.S and PO – 631 213, Tamil Nadu was used flavouring ice cream. Caramel purchased from the M/s The flavours India, C-5, Pipdic Industrial Estate, Mettupalayam, Pondicherry was used for colouring the chocolate flavour ice cream. Artificial sweeteners Levulose – Diabetics Dezire manufactured by the Sudar Diabetics Dezire, 6G, Century Plaza, 560 – 562, Anna Salai, Teynampet, Chennai – 18, Sucralose – Sugar Free Natura manufactured by the Acme Remedies, Village Katha, Post Baddi – 173 205, Himachal pradesh, Aspartame – Sugar Free Gold manufactured by the Acme Remedies, Village Katha, Post Baddi – 173 205, Himachalaparadesh are used in the ice cream preparation. 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, 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 (caramel), flavour (chocolate) 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.

ADSA IC Score card

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

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

Milk

↓

Preheating 55-60°C

↓

Skim Milk Powder, Butter, Emulsifier, Stabilizer and Sugar (50%Cane sugar + 50%Artificial sweeteners),

↓

Preheating at 55-60°C

↓

Homogenization (2500 and 500 psi 1st and 2nd stage)

↓

Pasteurization 80°C for 30 seconds

↓

Cooling (4-5 °C and aging overnight)

↓

Mixing *Aloe vera* pulp, color and flavor and freezing

↓

Packing in ice cream cups

↓

Storage of ice cream (-29°C)

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

Parameters	Control	*Aloe vera* 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±0175	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*

Table 2: Sensory analysis score (Mean± SE)* for chocolate ice cream with caramel as natural color

Parameters	Control	Caramel		
		1%	2%	3%
Flavour	40.80±0.290[b]	38.52±0.242[a]	40.63±0.233[b]	39.09±0.112[a]
Color	4.93±0.030[c]	4.20±0.043[a]	4.96±0.021[c]	4.56±0.065[b]
Body & texture	28.40±0.130[b]	26.96±0.205[a]	28.31±0.107[b]	27.27±0.208[a]
Melting quality	4.79±0.051[c]	4.31±0.051[a]	4.80±0.051[c]	4.61±0.063[b]
Microbial	15.000.000[a]	15.000.000[a]	15.000.000[a]	15.000.000[a]
Over all score	93.92±0.269[c]	88.99±0.221[a]	93.70±0.217[c]	90.54±0.248[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±0.206c	43.07±0.189c	38.52±0.242b	37.77±0.193a
Color	4.80±0.021b	4.92±0.027b	4.87±0.032b	4.47±0.068a
Body& texture	29.29±0.137b	29.31±0.101b	27.31±0.207a	26.87±0.194a
Melting quality	4.96±0.021c	4.91±0.029c	4.61±0.063b	4.38±0.064a
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±0127 [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*

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: Sensory score (Mean± SE)* of ice cream with *Aloe vera* pulp with natural caramel color and chocolate flavour and various concentrations 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
Flavour	43.12± 0.32^{d}	39.78± 0.44^{a}	43.12± 0.32^{d}	39.35± 0.42^{a}	39.60± 0.29^{a}	43.04± 0.35^{d}	41.84± 0.44^{bc}	42.19± 0.43^{cd}	43.03± 0.36^{d}	41.03±0 .50^{b}
Color	4.67±0 .09^{c}	4.16±0. 13^{ab}	4.71±0. 09^{c}	4.01±0. 13^{a}	4.13±0. 13^{ab}	4.66±0. 10^{c}	4.41±0. 12^{bc}	4.37±0. 12^{abc}	4.67±0. 10^{c}	4.36±0. 12^{abc}
Body& texture	28.00± 0.29^{c}	25.97± 0.24^{ab}	27.62± 0.33^{c}	25.33± 0.19^{a}	26.49± 0.31^{b}	27.44± 0.33^{c}	26.28± 0.30^{b}	25.84± 0.23^{ab}	27.88± 0.32^{c}	25.79±0 .26^{ab}
Melting quality	4.76±0 .07^{e}	4.21±0. 08^{bc}	4.41±0. 10^{cd}	3.77±0. 12^{a}	4.18±0. 09^{bc}	4.54±0. 10de	4.08±0. 12^{b}	4.40±0. 69^{cd}	4.64±0. 08de	4.38±0. 10^{cd}
Micro	15.00± 0.00 ^{a}	15.00± 0.00 ^{a}	15.00± 0.00 ^{a}	15.00± 0.00 ^{a}	15.00± 0.00 ^{a}	15.00± 0.00 ^{a}	15.00± 0.00 ^{a}	15.00± 0.00 ^{a}	15.00± 0.00 ^{a}	15.00±0 .00 ^{a}
Overall score	95.55± 0.460^{d}	89.12± 0.526^{b}	94.86± 0.468^{d}	87.46± 0.528^{a}	89.40± 0.512^{b}	94.68± 0.506^{d}	91.61± 0.577^{c}	91.79± 0.504^{c}	95.22± 0.476^{d}	90.55±0 .552^{bc}

Means bearing different superscripts in a row differ significantly (P<0.01)
** Average of 8 trails*

RESULTS 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.

Table 2 shows the average sensory analysis scores for the caramel liquid added at one, two and three percent levels as natural colour for the chocolate flavour ice cream. The sensory scores for one percent caramel liquid ranged from 84.60 to 95.50 with an average of 88.99 while the three percent level scored an average of 90.54 with a range of 86.60 to 93.40. The two percent inclusion level had an overall average of 93.70 and ranged from 91.40 to 97.00; while the control sample scored an overall average of 93.92. Preliminary screening tests conducted by visual perception revealed that 2 percent caramel was the optimum level of incorporation in chocolate flavoured ice creams. Hence, its immediate lower and higher level of incorporation ie. 1 percent and 3 percent along with 2 percent were taken up for sensory evaluation. The inclusion of caramel liquid as natural colour for the chocolate flavour ice cream at two percent level was found to be optimum as it was not significantly different from the control samples for all the sensory characters. But, in contrast to this finding, Kamuf *et al.* (2003) reported that the optimum level of inclusion of caramel colour III as colouring agent in the ice cream was one percent. This two percent level was included in the preparation of the chocolate flavoured ice cream and samples were stored in the deep freezer at – 29°C. The samples were subjected to sensory evaluation and reveals that sensory sores of natural coloured ice cream was not significantly differ from the artificial coloured ice cream at two percent level inclusion of caramel liquid for chocolate flavoured ice cream.

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 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-Lphenylalanyl-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 average sensory evaluation scores of ice cream samples prepared with different levels of *Aloe vera* pulp (15, 20 and 25 percent) using different artificial sweeteners viz., aspartame, levulose and sucralose having natural caramel colour and chocolate flavour are presented in table 6. The overall average score for the control samples was 95.55. The level of inclusion of *Aloe vera* pulp significantly ($P<0.01$) altered the sensory scores. The 20 percent inclusion level had the highest average when compared to the other two levels. The overall average for the samples prepared with aspartame as artificial sweetener were 89.12, 94.86 and 87.46, respectively for 15, 20 and 25 percent inclusion of *Aloe vera* pulp. The corresponding values for levulose were 89.40, 94.68 and 91.61 and for sucralose were 91.79, 95.22 and 90.55, respectively. Ice cream samples prepared with 20 percent *Aloe vera* pulp and synthetic vanilla flavour secured an overall average of 92.89, while 20 percent *Aloe vera* ice cream with caramel liquid and chocolate flavour due to their pleasantness in taste panel scored higher scores. From the table sucraloseas artificial sweetener at 20 per cent *Aloe vera* pulp scored 95.22 followed by the aspartameand levulose respectively.

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* juice. 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 addition of various levels of caramel colour in the ice cream significantly (P<0.01) altered the sensory qualities and the optimum inclusion levels was found to be 2.0 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. Three different concentration of *Aloe vera* pulp incorporated in the ice cream sucralose as artificial sweetener at 20 per cent *Aloe vera* pulp scored 95.22 followed by the aspartame and levulose respectively.

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