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Quality Characteristics of Ice Cream Prepared Using Stabilizers/Emulsifiers Blends Created with Semi-Refined Carrageenans (E407a) of Commercial Production at Different Fat Levels

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ABSTRACT

The present study was aimed to investigate the physical and sensory properties of ice cream samples prepared with stabilizer/emulsifiers blend involving commercially manufactured semi-refined Kappa and iota-carrageenans (E407a), locust bean gum, guar gum, sodium carboxymethyl cellulose, polysorbate-80, glycerol monostearate, calcium lactate and calcium sulphate to determine the suitability of stabilizer-emulsifier combination with different fat levels that could produce the best quality ice cream. Along with commercially manufactured kappa and iot semi-refined carrageenan (E407a), blend-1 was created without calcium salt with other gums and blend-2 was blend made up calcium salts and other gums. Ice-cream samples were prepared using blend-1 and blend-2 at dosages of 0.4%, 0.5%, 0.6% and 0.7% for fat content of 8% 10% and 12% in butter. Sensory analyses were conducted using 130 non-trained panelists and recorded result of overall consumer acceptability. Though ice cream samples prepared with low dosage of stabilizer-emulsifier blends (0.4% and 0.5%) scored more (95%) overall acceptability in fresh and shorter storage periods (15d and 30d) and at par with control product, samples prepared with high dosage (06% and 0.7%) had good storage life (90d and 120d) regardless of the blends used and whose acceptability was again comparable with commercial ice cream product manufactured using refined carrageenan (E407) as one the stabilizers in stabilizer-emulsifier blend ($p>0.05$).

INTRODUCTION

Ice cream is one of the delicious, nutritious frozen products, typically eaten as a snack, usually made from dairy products, such as skimmed milk powder, butter and often combined with sucrose, stabilizers, emulsifiers, colourings and flavourings. Ice cream has high nutritive and calorific value (180 Cal/100 gm). Typical compositional range for the ingredients/constituents used in ice cream mix is milk fat 10 to 16%, sucrose 12 to 14%, milk solids not fat 9 to 12%, stabilizer-emulsifier blend to 0.5% and total solids 36 to 45% [1]. It has been documented in the literature that hydrocolloids substances enhance the emulsion stability, binding free water, increase viscosity and improved overrun [2-4].

Stabilizer-emulsifier blend is one of the important ingredients in ice-cream preparation, which, in spite of the low level in the formulation, impart specific and important functions to the finished product. It is always difficult to get all desired properties in ice cream using a single stabilizer, hence mixture of different emulsifiers/stabilizers are used. The primary purpose of stabilizer is to absorb and hold large amounts of bound water, which produces good body, smooth texture, increase melting resistance and permits withstanding heat shock in the resultant product [5].

Emulsifier performs many important functions in ice cream such as reduced whipping time, control of fat destabilization, enhances smooth texture, increases melting resistance, helps in preventing shrinkage and improves dryness of resultant ice cream products [6,7]. Blending of stabilizer and emulsifier are generally designed to function best in high and low fat ice creams [8].

Earlier SRC was not a food grade it mostly applied in the pet food and dairy industries where clarity is not an important issue.

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However, recently there has been improved method to produce SRC of food grade for human consumption. Further the product is also processed by applying food safety procedures; therefore SRC is permitted in human consumption.

Recently, food technologists and researchers have found a new technique of blending these stabilizers/emulsifiers in different proportions to get exciting properties in ice cream. Amul, Vadilal, Hindustan Unilever and Mother Dairy are the major ice cream makers in India and they largely depend on the imported stabilizer-emulsifier blend for their operations. Guar gum is widely used as ice cream stabilizer. It is preferred for its relatively low cost and the body it contributes to the ice cream product. It hydrates well in cold water, and often used in combination with carrageenan and locust bean gum to impart excellent properties to ice cream and it is used up to 0.20% in ice cream mix depend on the usage level of other added gums.

Locust bean gum (LBG) enhances aeration, and imparts good body to ice cream, it can cause whey-off during processing if used alon, therefore, it is usually used in combination with carrageenan and guar gum. LBG can act synergistically with kappa-arrageenan and xanthan gum. Usage levels are similar to guar but again depending on which other gums are used in conjunction with it.

Carrageenan is available in several types, the most common of which are kappa, iota and lambda. For low fat and soft serve ice cream compositions, kappa often is used for its gel forming functionality and its reactivity with casein, which prevents whey separation. Similarly iota carrageenan forms gels better in the presence of calcium ions which result in preventing whey separation. It's mandatory to add carrageenan if an aging step exists in the manufacturing process. A kappa-iota blend is sometimes preferred, to keep kappa from forming a brittle gel. Kappa and iota solutions require heating for proper hydration and it can be used up to 0.05% of the blend [9].

Present study was undertaken to find out the effect of chemically derived stabilizer sodium-Carboxy Methyl Cellulose (Na-CMC) with calcium salts against natural stabilizers (LBG, guar gum) with other stabilizers and emulsifiers in different combination used at four dosage on the overrun and sensory quality of ice cream made using three fat level.

MATERIALS AND METHODS

Sample Collection

The ingredients like milk solids-not-fat from skimmed milk powder (SMP), butter for fat and vanilla flavour were procured from Mane India Pvt. Ltd., Dindigul, India and sucrose was purchased from Nice Chemicals Pvt. Ltd, Madurai, India. Food grade locust bean gum (E410) (RK Enterprises, (Madurai) India), guar gum (E412) (Sarda Gums and Chemicals, Jodhpur, India, calcium sulphate (E516) (Merck Specialities Pvt. Ltd, Mumbai, India), polysorbate-80 (E433), calcium lactate (E327) (Nice chemicals Pvt. Ltd, Madurai, India), sodium carboxymethyl cellulose (E466) (Wealthy chemicals industry, Suzhou, China) and glycerol monostearate (E471) (Myverol 18-04 K, Kerry, Novotech, Bangaluru, India) were sourced locally in India. Kappa and iota carrageenans (E407a) were bought from stock of Aquagri Processing Private Limited (Kappa carrageenan: Batch No-108/2014 and Iota carrageenan: Batch No-Ica-15/2014, Manamadurai, India).

Apparatus and Instrument

Remi motor-RQ 127/A, Remi elektrotechnik ltd, Mumbai, India, Water bath-250 W, Sigma Scientific Instrument (P) Ltd, Chennai, India, Blue Star Chest freezer, Model CHF 200 B, Coimbature, India, Sony Cyber shot, GPS- DSC- HX 200 were used in the present investigation.

Ice Cream Preparation

The different ratio of combined stabilizers and emulsifiers were created as shown in **Table 1**. The water required was preheated at 45°C, sucrose and SMP were added into warm water and then mixed properly. The thoroughly premixed dry ingredients of stabilizer/emulsifier blends was then added to the mix at 60°C and then butter was added to the mix at 65°C and homogenized with high speed blender for 2 min. The mixes were batch pasteurized at 80°C for 10 min. using water bath. The mixes were kept in refrigerator at 4°C for 1 h and homogenized for 15 min., added vanilla flavour into it at the ratio of 0.15% and stored at a chest freezer at -20°C to -18°C for 24 h. The ice cream mix was then whipped and aerated to produce ice cream samples and stored at -20°C to -18°C and used for physicochemical and sensory analysis studies.

Table 1. Ice cream formulations utilizing two stabilizer-emulsifier blends.

Ingredients	Ratio of stabilizers/emulsifiers	
	Blend-1	Blend-2
Kappa carrageenan	4	2
Iota carrageenan	4	2
Locust bean gum	5	0
Sodium Carboxymethyl cellulose	0	30

Guar gum	25	0
Sucrose	22	16
Glycerol monostearate	35	35
Polysorbate-80	5	5
Calcium lactate	0	5
Calcium sulphate	0	5

Physico-Chemical Analysis

Overrun was estimated as described by Varnam and Sutherland [10]. The mass of a fixed volume of aged ice cream mix was compared to the mass of the same volume of churned ice cream at intervals during the churning and aeration process.

A total solid was calculated using AOAC method (1990). Gerber method was applied for fat determination and acidity was determined by the method described by Kirk et al. [11,12]. The pH of the mixes was measured using a digital pH meter (Eutech Instruments, Malaysia) at 30°C and viscosity was measured at 80oC, 30 rpm and spindle no.62 using Brookfield LVDV-II+pro.

Melting Resistance of Ice Cream Samples

According to the methodology proposed by Lee and White, the ice cream samples stored at -20°C to -18°C was removed, weighed (50.0 ± 2.0 g) and was placed on 2 mm (mesh no. 10) wire screen at 25 ± 2°C. The dripped volume of melted ice cream was recorded at 10 min intervals for 120 min and result obtained in ml/10 min. was expressed as percentage loss of total sample [13].

Sensory Analysis

The ice cream samples portioned 50ml cups were coded with A, B, C and D served to the 25 panelists in individually partitioned booths to assess the sensory attributes of samples. Sensory quality of ice cream was evaluated using standard evaluation score card of BIS (Indian Standard 2003) and statistical analysis was done according to method of Steel et al. [14].

Storage Studies

Ice cream samples prepared were stored at -20 ± 2°C along with commercial product and evaluated their appearance and color, body and texture, mouth feel and flavor and overall acceptability was recorded for storage period of 15d, 30d, 60d, 90 and 120d.

Statistical Analysis

Pearson correlation analysis was used to find out the significant increasing in overrun, texture and overall acceptability of ice-creams prepared. All the statistical analysis was made using the SYSTAT version 7.

RESULTS AND DISCUSSION

Physicochemical Properties of Mix and Ice Cream

Physicochemical properties of ice creams with varying fat content i.e., 8, 10 and 12% milk fat prepared with stabilizers-emulsifier blend-1 and 2 at dosage of 0.4, 0.5, 0.6 and 0.7% by weight of ice cream mix is presented in **Table 2**.

Table 2. Ice cream mix formulations using stabilizers-1 and 2 with different fat levels.

Ingredients	Ice cream with varying rate of stabilizer-emulsifier blend				Ice cream with varying rate of stabilizer-emulsifier blend				Ice cream with varying rate of stabilizer-emulsifier blend			
	0.4	0.5	0.6	0.7	0.4	0.5	0.6	0.7	0.4	0.5	0.6	0.7
Cream* (Fat)	10 (8)	10 (8)	10 (8)	10 (8)	12.5 (10)	12.5 (10)	12.5 (10)	12.5 (10)	15 (12)	15 (12)	15 (12)	15 (12)
SMP** (MSNF)	13.7 (13)	13.7 (13)	13.7 (13)	13.7 (13)	12.6 (12)	12.6 (12)	12.6 (12)	12.6 (12)	11.6 (12)	11.6 (12)	11.6 (12)	11.6 (12)
Sucrose	13	13	13	13	14	14	14	14	15	15	15	15
Stabilizer Emulsifier Blend	0.4	0.5	0.6	0.7	0.4	0.5	0.6	0.7	0.4	0.5	0.6	0.7
Flavour	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Total solids	34.55	34.65	34.75	34.85	34.55	34.65	34.75	34.85	34.55	34.65	34.75	34.85
*Fat content of cream used was 80%; **Content of MSNF of SMP used was 95%												

The pH, acidity, fat, total solids and meltdown rate were significantly affected ($p<0.05$%) by the use of the two stabilizer-emulsifier blend **(Table 3)**. pH values in ice cream ranged from 6.19 ± 0.23 to 6.41 ± 0.12, it was found high with (6.41) the ice-cream prepared using 0.5% of stabilizer-1 at 8% fat content while the lowest pH (6.19) was observed for product (10% milk fat) made using 0.6% of stabilizer-emulsifier blend-1. The acidity value of ice cream made using three different fat content ranged from 0.20 ± 0.01 to 0.21 ± 0.02% when using different levels of stabilizer-emulsifier blend. Fat affects all aspects of food perception including flavour, appearance, body and texture. The fat is most concentrated source of calories and contributes heavily to the energy value of ice cream. The overrun of Ice-cream samples prepared with 8%, 10% and 12% fat at 0.7% of stabilizer-emulsifier blend-1 were 117 ± 17.20%, 105.8±16.47%, and 96.8 ± 11.06% respectively whereas they were 76.2 ± 9.3%, 93 ± 4.0%, and 83.8±10.70% respectively when stabilizer-emulsifier blend-2 was used.

Table 3. Physicochemical properties of ice cream containing different fat levels made using two stabilizer-emulsifier blends.

Blend (%)	Fat %	pH		Acidity		Viscosity (cPs)		Total solids (%)		Melting rate (ml/10min)		Overrun (%)	
		S-1	S-2	S-1	S-2	S-1	S-2	S-1	S-2	S-1	S-2	S-1	S-2
0.4	8	6.3 ± 0.15	6.3 ± 0.15	0.2 ± 0.01	0.2 ± 0.01	370 ± 17	372 ± 25	37.41 ± 1.21	38.24 ± 1.70	12.33 ± 0.67	12.16 ± 1.76	93 ± 4.45	53.8 ± 5.15
	10	6.33 ± 0.15	6.33 ± 0.13	0.2 ± 0.02	0.2 ± 0.02	377 ± 23	382 ± 27	38.8 ± 1.99	38.37 ± 1.71	10.84 ± 1.68	11.55 ± 1.22	66.6 ± 15.0	54 ± 10.70
	12	6.33 ± 0.16	6.31 ± 0.16	0.2 ± 0.02	0.21 ± 0.01	405 ± 25	410 ± 28	39.07 ± 1.60	38.88 ± 1.48	10.1 ± 0.51	10.69 ± 0.45	68 ± 8.28	60.4 ± 6.95
0.5	8	6.41 ± 0.12	6.3 ± 0.12	0.2 ± 0.01	0.2 ± 0.01	365 ± 22	385 ± 25	37.91 ± 1.44	37.92 ± 1.47	9.58 ± 0.75	11.88 ± 1.82	97.6 ± 3.84	63.4 ± 5.43
	10	6.28 ± 0.16	6.27 ± 0.15	0.21 ± 0.01	0.2 ± 0.01	385 ± 23	420 ± 33	37.82 ± 1.36	37.69 ± 1.28	12.18 ± 2.01	10.1 ± 0.51	89.2 ± 7.61	73.6 ± 4.19
	12	6.3 ± 0.16	6.31 ± 0.15	0.2 ± 0.01	0.2 ± 0.01	408 ± 27	410 ± 28	38.63 ± 1.16	39.57 ± 1.78	12.01 ± 1.71	12.0 ± 2.18	88.8 ± 3.61	62.6 ± 11.14
0.6	8	6.26 ± 0.18	6.26 ± 0.20	0.2 ± 0.01	0.2 ± 0.01	395 ± 25	385 ± 22	37.65 ± 1.20	38.18 ± 1.47	9.98 ± 0.46	11.83 ± 1.41	103 ± 4.0	89.8 ± 12.81
	10	6.19 ± 0.23	6.27 ± 0.21	0.2 ± 0.01	0.2 ± 0.02	395 ± 25	402 ± 30	37.48 ± 1.36	38.29 ± 1.53	11.38 ± 2.01	11.76 ± 1.48	75 ± 10.0	59 ± 13.56
	12	6.23 ± 0.21	6.28 ± 0.19	0.2 ± 0.01	0.2 ± 0.01	410 ± 25	425 ± 20	38.65 ± 1.21	38.53 ± 1.15	12.32 ± 1.60	10.58 ± 1.37	77 ± 4.0	68 ± 8.28
0.7	8	6.16 ± 0.24	6.26 ± 0.18	0.2 ± 0.02	0.2 ± 0.02	428 ± 24	440 ± 15	38.35 ± 1.59	38.43 ± 1.65	6.18 ± 2.07	8.95 ± 1.88	117 ± 17.20	76.2 ± 9.30
	10	6.22 ± 0.21	6.26 ± 0.19	0.2 ± 0.01	0.2 ± 0.02	428 ± 28	433 ± 29	38.38 ± 1.60	38.65 ± 1.77	8.52 ± 0.41	9.28 ± 0.81	105.8 ± 16.47	93 ± 4.0
	12	6.25 ± 0.20	6.28 ± 0.20	0.2 ± 0.01	0.21 ± 0.02	440 ± 17	444 ± 24	39.32 ± 1.51	40.47 ± 2.27	8.52 ± 0.35	9.28 ± 1.15	96.8 ± 11.06	83.8 ± 10.70
Result of control ice cream - Melting resistance: 9.5 ± 1.75 ml/min; overrun: 101 ± 6.52%; Total solids: 34.5% and Viscosity: 325 ± 15 cPs													

Ice cream and related products are generally aerated and characterized as frozen foams. The gas phase volume varies greatly from a high of greater than 50% to a low of 10–15% [15]. Ludvigsen reported that the overrun of 185% with 6% fat ice creams, similarly Inoue et al. recorded overrun ranging from 20 to 110% with varying homogenization pressure and withdrawing temperature [16,17]. Goff and Hartel reported 100-120%, 60-90% and 20-50% overrun for standard, premium and super premium category of ice cream products respectively [18]. The melting rate of ice-cream samples prepared with different fat level using stabilize-emulsifier blend-1 at 0.4%, 0.5%, 0.6% and 0.7% dosage ranged between 6.18 ± 2.07 ml/10 min and 12.33 ± 0.67 ml/10 min (12 to 24% loss of total ice cream) and it was 8.95 ± 1.88 ml/10 min and 12.16 ± 1.76 ml/10 min (16 to 24% loss of total ice cream). Hansen reported 25-30% loss of total ice cream for 90 min at 25 °C [19]. Storage till 30d had no significant effect on the overall acceptability of the products, but on longer storage period (120d), samples made with low dosage of stabilizer had low score of overall acceptability **(Table 4)** and similar observation was made by Gwiszczynska and Kaluziak [20]. Singh et al. observed that sensory scores of all bakery flavoured ice cream samples decreased significantly with progress in storage period from 15 d to 60 d at -18 ± 1 °C [21].

Table 4. Overall sensory acceptability score (%) of ice cream with varying fat levels prepared using stabilizers-emulsifier blend-1 and blend-2.

Dosage	Blend-1			Blend-2			Commercial sample
	Fat - 8%	Fat - 10%	Fat - 12%	Fat - 8%	Fat - 10%	Fat - 12%	
0.40%	98 ± 1.2	90 ± 2.7	88± 1.1	88 ± 1.3	84 ± 4.1	86 ± 2.5	96 ± 3.0
0.50%	98 ± 1.1	92 ± 2.5	88 ± 1.5	89 ± 1.5	81 ± 4.0	78 ± 2.5	
0.60%	95 ± 2.2	95 ± 2.0	92 ± 1.3	81 ± 2.4	78 ± 3.8	80 ± 2.6	
0.70%	90 ± 2.3	84 ± 2.7	88 ± 1.4	85± 2.6	85 ± 4.5	90 ± 2.7	

Total solids play an important role in the overall quality and appearance of ice cream. The maximum total solid content (40.47 ± 2.27%) was found in ice-cream prepared using 0.7% dosage of stabilizer-emulsifier blend-1 at 12% fat whereas the least value of total solids (37.41 ± 1.21%) was in product from 8% milk fat using 0.4% dosage of stabilizer-emulsifier blend-1. Total solids was negatively correlated with meltdown rate in 0.4% dosage of stabilizer 1 in fat of 8%,10% and 12% (p=0.02; r=0.916), (p=0.01; r=0.925) and (p=0.005; r=0.876) and it was negatively correlated with meltdown rate in 0.7% dosage in 8% milk fat s1 stabilizer (p=0.001; r=-0.999), 0.7% dosage for 12% fat ice cream made using stabilizer-emulsifier blend-2 (p=0.001;r=-0.988). Post hoc Turkey's test showed that significant difference was noted for TS, overrun and meltdown rate of ice cream made using three different fat content as affected by the levels of stabilizer-emulsifier blend (p=0.00, p>0.05).

Viscosity of Ice Cream Mix

Viscosity is considered an important characteristic of ice cream, since it frequently accompanies the desirable body and texture [22]. In literature, reported that GG gives significantly less viscosity to the ice cream mix than LBG and CMC. In other words, LBG and CMC may be preferred to increase the viscosity of the mix or to limit the growth rate of ice crystals during recrystallization, it can be seen from **Table 3** that the stabilizer-emulsifier blend-1 where 25% GG and 5% LBG gave marginally lower viscosity values than blend-2 which had 30% of CMC [23]. Viscosity of all ice cream samples prepared ranged from 365 ± 22 to 444 ± 24 cPs, however it was found higher in ice cream samples prepared with 0.6% and 0.7% dosage of stabilizer-emulsifier i.e. 355 ± 25 to 444 ± 24 cPs than one prepared with low dosage (0.4% and 0.5%) irrespective of blends. Hansen reported that viscosity of ice cream mix at 80°C ranged from 300 to 500 cPs, hence all ice cream samples prepared were within the viscosity levels of commercial products.

Melting Behaviour

The melting resistance of experimental ice creams along with control ice cream is depicted in **Table 3**. The melting rate ranged between 6.18 ± 2.07 to 12.33 ± 1.60 per 10 min which could due to difference in dosage of stabilizer-emulsifier blends for varying milk fat level since melting of ice cream is influenced by its composition and fat globule size [24]. The maximum meltdown rate was observed in ice-cream sample made from 8% fat with 0.7% dose of stabilizer-1 and while the least meltdown rate was recorded from sample prepared with 8% fat and 0.4% dosage of stabilizer-emulsifier blend-1 and 2. Alamprese et al. reported that ice cream with higher fat content is softer and shows a slower melting rate. Similar results were obtained from our investigation **(Table 3)** but only in the ice cream samples prepared at 0.4 dosage of stabilizer-emulsifier blend-1 and blend-2 but in other samples prepared with higher dosages like 0.5%, 0.6% and 0.7% the melting rate trend was not clear **(Table 3)** [25]. Air in ice cream provides a light texture and influences the physical properties of melt down and hardness. Sofjan and Hartel reported that ice creams with lower overruns (80%) are harder than those made with 120% overruns but melt more rapidly, in the present study ice cream samples with higher overruns i.e. 117 ± 17.20% and 105.8 ± 16.47% had also lowest melt down rates i.e. 6.18 ± 2.07 and 8.52 ± 0.41 ml per 10 min respectively among all other samples prepared **(Table 3)** [26]. Meltdown was negatively correlated with overrun in 0.4% dosage in 8% fat ice cream made from stabilizer 2 (p=0.02; r=-0.901) while it was positively correlated with overrun in 0.5% dosage in 10% fat ice cream made from stabilizer 2 (p=0.01; r=0.923). Mostly meltdown ratio was negatively correlated with overrun.

Overrun

The overrun was more than 50% in all the cases tested in the present investigation **(Table 3)** and it was 52% as estimated with commercial ice cream sample. Ice creams made using stabilizer-emulsifier blend-1 (66.6 ± 15.01 to 117 ± 17.20) had higher overrun values than those made employing stabilizer-emulsifier blend-2 (53.8 ± 10.70 to 93±4 overrun) irrespective of the fat content in ice creams. Highest overrun accounted in the 0.7% dosage at 8% fat ice cream made from stabilizer-emulsifier blend-1, while the least overrun was associated with product (8% milk fat) made using 0.4% of stabilizer-emulsifier blend-2 **(Table 3)**. Pearson correlation analysis showed that overrun was significantly negatively correlated with total solids (p=0.01; r= -0.958) in 12% fat ice cream made with 0.4% dosage of stabilizer 2. It was significantly positively correlated with meltdown property in 8% fat made with 0.6% dosage of stabilizer 2 (p=0.001; r=1.000). Likewise it was negatively correlated with total solids in 10% fat made with 0.6% dosage of stabilizer-emulsifier blend-2 (p=0.05; r=-0.875).

Sensory Analysis

Ice-cream samples prepared using stabilizer-emulsifier blend-1 at dosage of 0.4% and 0.5% had good sensory score irrespective of the fat content of ice cream **(Table 4)**. The highest score (98%) with highly acceptable body, texture, taste and overall acceptability for ice cream samples (8% fat) prepared using 0.4% and 0.5% of stabilizer-emulsifier blend-1 while the least value was recorded for ice cream containing 12% fat irrespective of rate of addition of stabilizer-emulsifier blend-1 **(Table 4)**. Stabilizer-emulsifier blend-1 at dosage of 0.6% performed well with fat content of 10% and 12% and sensory score obtained was 95% and 92% respectively. Sensory score of ice cream made using stabilizer-emulsifier blend-1 at higher dosage level (i.e., 0.7%) did not yield product with sensorily acceptable product irrespective of the fat content **(Table 4)**. The sensory score of ice cream samples prepared using stabilizer-emulsifier blend-2 at 0.4% dosage for fat content of 8%, 10% and 12% were 88%, 84% and 86% respectively **(Table 4)**. The score of ice-cream samples prepared with dosage of 0.5%, 0.6% and 0.7% of stabilizer-emulsifier blend-2 were lower than one prepared with stabilizer-emulsifier blend-1 irrespective of the fat content of product; their sensory score ranged from 89% to 78% as shown in **Table 4**.

Effect of Storage on the Overall Acceptability Ice Cream

Though storage at 15d and 30 did not show much difference, results at 90d and 120d storage period showed that ice-cream samples prepared using high dosage of stabilizer/emulsifier (0.6% and 0.7%) in both blend-1 and blend-2 gave overall acceptability at par with commercial product (p>0.05) **(Table 5)**. Stabilizer-emulsifier blend created with calcium salts and semi-synthetic stabilizer Na-CMC had no significant effect on storage or overall acceptability ice cream products.

Table 5. Effect of storage on mean sensory scores (%) of ice-cream samples prepared along with commercial sample.

Dosage	Blend-1			Blend-2			Control sample
	Storage period-15 d						
	Fat - 8%	Fat - 10%	Fat - 12%	Fat - 8%	Fat - 10%	Fat - 12%	
0.40%	90	85	82	82	85	90	**96**
0.50%	92	85	85	85	82	80	
0.60%	92	90	85	80	80	95	
0.70%	90	85	85	80	85	90	
Storage period-30 d							
0.40%	82	80	75	70	80	85	90
0.50%	85	78	77	75	80	75	
0.60%	82	85	85	80	75	85	
0.70%	85	85	82	82	82	85	
Storage period 60 d							
0.40%	75	70	65	65	75	80	85
0.50%	70	70	70	65	78	72	
0.60%	80	80	78	82	80	82	
0.70%	85	80	75	85	88	85	
Storage period 90 d							
0.40%	66	70	70	70	70	75	75
0.50%	66	68	63	72	75	70	
0.60%	72	72	72	72	75	80	
0.70%	74	77	72	74	75	85	
Storage period 120 d							
0.40%	65	65	65	66	68	72	75
0.50%	60	72	65	60	77	68	
0.60%	62	77	71	73	76	76	
0.70%	72	70	70	75	78	75	

CONCLUSION

In conclusion, the results of the present study have shown that semi-refined carrageenans (kappa and iota) added in stabilizer-emulsifier blend-1 and 2 had yielded ice-creams with overall consumer acceptability and sensory attributes at par with control ice-cream sample. The ice cream samples prepared with low dosage of stabilizer-emulsifier blends (0.4% and 0.5%) scored high overall acceptability in fresh and shorter storage periods (15d and 30d), whereas samples prepared with high dosage (06% and 0.7%) had good storage life in longer storage periods (90d and 120d) regard less of the of the blends used and it was at par with commercial product (p>0.05) in terms of overall acceptability and sensory attributes and therefore, SRCs can be used in ice-cream production.

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REFERENCES

1. Goff HD. Instability and partial coalescence in whippable dairy emulsion. J Dairy Sci. 1997;80:2620-2630.
2. Hagiwara T and Hartel RW. Effect of sweetener, stabilizer and storage temperature on ice recrystallization in ice cream. J Dairy Sci. 1996;79:735-744.
3. Akesowan A. Effect of combined stabilizers containing konjac flour and k-carrageenan on ice cream. AU J Tech. 2008;12:81-85.

 e-ISSN:2322-0066

4. Hernandez JM, et al. Viscous synergism in carrageenans (κ) and locust bean gum mixtures: Influence of adding sodium carboxymethylcellulose. Food Sci Tech Intl. 2011;7:383-391.

5. Keeney PG. Development of frozen emulsions. Food Tech. 1982;36:65-70.

6. Arbuckle WS. Ice cream. 4th ed. The Avi Pub. Co, New York; 1986.

7. Marshall RT and Arbuckle WS. Ice cream. 5th ed. Chapman and Hall, New York; 1996.

8. Bhandari V. Ice cream manufacture and technology. Tata McGraw Hill Pub. Co. Ltd, India; 2001.

9. Naresh L and Shailaja UM. Stabilizer blends and their importance in ice cream industry – A review. New Zealand Magazine. 2006;1-8.

10. Varnam AH and Sutherland JP. Milk and milk products. Food Products Series, London;1994.

11. Davide CL. Laboratory Guide in Dairy Chemistry Practical. In Hellebust JA, Craigie JS (eds), Dairy Training and Research Institute. Cambridge University Press, England. 1977;95-97.

12. Kirk RS, et al. Composition and analysis of foods. 9th ed. Addison Wesley Longman, Inc. Harlow U.K; 1991.

13. Lee FY and White CH. Effect of ultra filtration retentate and whey protein concentrate on ice cream quality during storage. J Dairy Sci. 1991;74:1170-1180.

14. Steel RJ, et al. Principles and procedures of statistics: A biometrical approach. 3rd ed. Mc Graw Hill Book Co, New York; 1996.

15. Goff HD. Formation and stabilisation of structure in ice-cream and related products. Current Opinion in Colloid & Interface Science. 2002;7:432-437.

16. Ludvigsen HK. Manufacturing high quality ice cream with high overrun. Palsgaard Technical Paper Report. 2011;1-4.

17. Inoue K, et al. Effects of manufacturing process conditions on sensory attributes and microstructure of ice cream. Sensors and Materials. 2012;24:245-260.

18. Goff HD and Hartel RW. Ice cream. 7th ed. Springer, New York; 2013.

19. Hansen CP. Stabilization of ice creams produced with reduced level of saturated fat. Palsgaard Technical Paper Report. 2012;1-7.

20. Gwiszczynska A and Kaluziak H. Changes in Ice cream during storage. Przemysl Spozywczy. Food Sci Tech. 1971;25:66-69.

21. Singh A, et al. Effect of storage period on the physicochemical, sensory and microbiological quality of bakery flavoured ice cream. Intl J Eng Res Appl. 2014;4:80-90.

22. Innocente N, et al. Proteose-peptone whey fraction as emulsifier in ice cream preparation. Intl Dairy J. 2002;12:69-74.

23. Kurultay S, et al. The influence of different total solid, stabilizer and overrun levels in industrial ice cream production using coconut oil. J Food Proc Preserv. 2010;34:346-354.

24. Koxholt MMR, et al. Effect of the fat globule sizes on the meltdown of ice cream. J Dairy Sci. 2001;84:31-37.

25. Alamprese C, et al. Survival of *lactobacillus johnsonii* la1 and influence of its addition in retail-manufactured ice cream produced with different sugar and fat concentrations. Intl Dairy J. 2002;2:201-208.

26. Sofjan RP and Hartel RW. Effects of overrun on structural and physical characteristics of ice cream. Intl Dairy J. 2004;14:255-262.