

Effect of Some Stabilizers on the Physicochemical and Sensory Properties of Ice Cream Type Frozen Yogurt

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Abstract: The effect of using some stabilizers on the viscosity, over-run, melting characteristics and sensory properties of frozen yogurt was investigated in this study. The ice cream mix in all groups was 10% fat, 13% sucrose, 13% MSNF (milk non-fat solids). stabilizers that were tried were Panisol ex (P), salab (s) and a mix of stabilizers and emulsifiers (M) include (sodium alginate (0.23%), guar (0.13%), carageenan (0.05%), propyleneglycole (0.48%), polysorbate80 (0.097%)) at concentrations 0.144, 0.198, 0.254%. No appreciable change was observed in the acidity and pH values of the products. Viscosity, over-run capacity and melting characteristics of ice cream were influenced significantly ($p < 0.05$) by type and concentration of stabilizers. The highest values for over-run and melting resistance was observed in samples include Panisol ex at 0.254% and the lowest values was observed in samples include salab at 0.144%. The results of the sensory scores showed that yogurt ice cream produced using mix of stabilizers/emulsifiers (M) at concentration of 0.254% had the highest scores in texture. Type and concentration of stabilizers has no significant effect on mouthfeel and flavour of samples.

Key words: Frozen yogurt % Stabilizers % Emulsifiers % Physicochemical properties % Sensory properties

INTRODUCTION

Frozen yogurt gets its unique flavor from strains of *Lactobacillus bulgaricus* and *Streptococcus thermophilus* [1]. The four main variables in the composition of frozen yogurt are fat, sugar, acid and total solids. Dairy fat and total solids are the main determinants of textural quality and sugar and acid are the main contributors to flavor [2]. In the preparation of soft serve and hard frozen products, it is desirous to have a final product that is not only stable, but is attractive in appearance as well as smooth and free from graininess [3]. Most prior art gums and blends have been found to react with the milk protein during the processing procedures resulting in yogurts with whey-off and coarse bodied, grainy yogurt. By the term, "whey-off" is meant the separation of fluid material from solid material [3, 4]. Carrageenan is used in low concentration in most blends to retard such separation [5]. The instant invention is directed to novel compositions of matter which act as a stabilizer for soft serve and hard frozen yogurt. The stabilizer and/or blend composition can be added to the milk before or after processing, i.e., pasteurization, homogenization or incubation [3]. Stabilizers, in the form of animal and vegetable gelatins, are added to the frozen

yogurt so that it maintains a smooth consistency in retail outlets, where temperature changes can coarsen the texture. Stabilizers reduce crystallization, hinder melting and improve the handling properties of the frozen yogurt [1].

The stabilizers also prevent the air bubbles from collapsing and promote good flavor release [6] and hold flavoring compounds in dispersion [7]. Each has a particular effect on body, texture, meltdown and stability in storage. Therefore, to gain synergism in function, proprietary manufacturers combine them with emulsifiers [8, 4]. A report by Kuntz [9] indicated that coarseness and iciness could be detected by sensory evaluation in frozen desserts with a mean ice crystal size of 30 to 40 μm [10, 9]. The percentage of stabilizer in the continuous phase of the final product is higher than the initial level because of freeze concentration. Under this condition, a weak gel structure may be formed that may inhibit ice crystallization. The uniform size distribution of many small crystals minimizes the influence of thermal shock from high or fluctuating storage temperatures and enhances storage stability and shelf-life [11]. Components selected vary with the composition of the mixes and the outcomes expected from their use. Attributes desired in blends are high rate of dispersion, dissolution at selected

temperatures, minimal dust formation and reasonable cost for the intended product [4]. The stabilizing ingredients most used in frozen dairy foods are guar gum, locust bean gum (carob bean gum), CMC, sodium and propylene glycol alginates, xanthan gum, gelatin and carrageenan. Pectin is useful in combination with the gums in sherbet and ices [12, 4, 8].

Ice cream mixes must be homogenized to obtain maximum benefit from emulsifiers and overemulsification may cause shrinkage, curdy meltdown, or an undesirable greasy mouthfeel [10]. Emulsifiers are also effective in destabilizing the fat emulsion during the freezing of an ice cream mix. These properties allow emulsifiers to enhance desirable qualities in ice cream by enhancing whipping ability, increasing overrun capacity, reducing whipping time, improving resistance to meltdown, reducing ice crystal growth, increasing dryness and stiffness, imparting a smooth texture and a desirable slightly greasy mouthfeel and enhancing product uniformity [10, 12, 12]. Emulsifiers that mostly used in ice cream have low HLB and studies showed emulsifiers with HLB=16 are suitable for using in ice cream [14]. The emulsifiers used in ice cream are primarily mono and diacylglycerides and the sorbitan ester, specially polysorbate 80. They are supplied to processors as blends with stabilizers [4, 14]. Typical emulsifiers that may be utilized in frozen yogurt include monoglycerides, diglycerides, lecithin, polysorbate 80 and polysorbate 65 [3]

The overall objective of this study was to observe the effects of stabilizers (panisol ex, saleb and a mix of stabilizer/emulsifiers), on physicochemical and sensory properties of frozen yogurt.

MATERIALS AND METHODS

In this study cow's milk (2.5% fat and 8.5% MSNF) was obtained from Pegah factory (Mashhad, Iran). Cream (30% fat, 0.06% MSNF) was obtained from Pegah factory, Mashhad, Iran. Commercial freeze dried lactic acid bacteria (*Streptococcus salivarius subsp. Thermophilus* and *Lactobacillus delbrueckii subsp. bulgaricus*; LAC 1/63) was obtained from Azma Labane Shargh (Mashhad, Iran). Sucrose and vanilla powder were purchased from a local producers (Mashhad, Iran). Stabilizers that were tried were Panisol ex (P), saleb (s) and a mix of estabilizers and emulsifiers (M) (sodium alginate (0.23%), guar (0.13%), carageenan (0.05%), propyleneglycole (0.48%), polysorbate 80 (0.097%) at concentrations 0.144, 0.198, 0.254%. All of them were purchased from Azma Labane

Shargh (Mashhad, Iran). In all groups, the ice cream mix was formulated as follows: 10% fat, 13% sucrose, 13% MSNF.

Preparation of Fermented Milk: Milk with 8.5gr/100gr SNF was heated at 90-95°C for 5 min and then concentrated by a batch evaporator (-0.8 bar and 55°C) to 13-13.5gr/100gr SNF and cooled to 42°C. Commercial freeze dried lactic acid bacteria (mixed flora of *Lactobacillus delbrueckii subsp bulgaricus* and *Streptococcus thermophilus*) were inoculated at the concentration of 0.1% in 10 ml sterilized skim milk (20-25°C) followed by incubation at 42-43°C for 10-15 min. 70% of the milk was used for preparation of yogurt as incubated with prepared culture at 42-43°C. When acidity reached to 0.9-0.94% , in about 4-4.5 h, the yogurt was cooled to room temperature. The rest of the milk was used for preparation of ice cream mix.

Preparation of Ice Cream Type Frozen Yogurt: For each batch of yogurt ice cream, natural cream (30% fat) and concentrated milk (MSNF=13, fat content must be determine by Gerber method) were mixed and heated to 40-45°C. Sugar, vanilla powder and stabilizer were mixed together and dissolved in the rest of the milk and pasteurized at 80°C for 26 s, cooled to room temperature and then blended with yogurt to obtain the final yogurt ice cream mix. Final mixture was stored at 4°C overnight for about 16 h. Freezing of the mix was carried out in batches of 1 kg in a home ice cream freezer for 20 min. The frozen ice cream were placed in plastic cups (50 mL in volume) and transferred to a freezer at -18°C for hardening. Samples were examined one day after freezing for physical and sensory properties. Experimental yogurt ice cream production was done in triplicate. The reported data are the mean values of three runs for each stabilizer concentration.

pH Measurements: The amount of pH was examined according to the National Standard of Iran (No: 2852) for yogurt samples (No:2450). The pH of yogurt was measured using a pH meter (Metrohm-691 model made in Swiss). Acidity was measured according to National Standard of Iran (No:2852) for yogurt samples and was expressed as a percentage of lactic acid in the samples.

Mix Viscosity: Measurements of the mix viscosities were taken after overnight aging at 4°C. Mix viscosity was measured at 5±1°C using a Brookfield viscometer, model DV-II with some modifications [15] spindle No 4 at 30 rpm after 30 s.

Over-run: Over-run was calculated using a standard plastic cup according to National Standard of Iran (No: 2450) and using the following equation:

$$\% \text{Over-run} = \frac{\text{Net wt of cup of mix_net wt of cup of ice cream}}{\text{Net wt of cup of ice cream}} \times 100$$

Melting Resistance: Melting resistance was evaluated according to national standard of Iran (no:2450) with some modifications. Blocks of ice cream (30 gr) at -18°C were placed on a stainless steel screen with openings of 1 x 1 cm, located on top of a beaker. The weight of melted ice cream after 45 min at 22-23°C was expressed as percent of the weight of the initial ice cream block.

Sensory Evaluation: After one day of storage at -18°C, samples were left to attain a temperature of -10 to -8°C before evaluation. The samples were evaluated by educated six-member panel from Food Science and Technology Students of Ferdowsi University of Mashhad. Panelists were required to assess the samples for mouthfeel, texture and flavour on a 5-point hedonic scale (1 very poor, 5 excellent).

Statistical Analysis: Statistical analysis of data for effects of the factors on mix viscosity, over-run, melting resistance and sensory properties was performed by two factor completely randomized design using MSTAT C software in three replication and analysis of variance was done with Duncan's multiple range test at P<0.05. The factors were: type of stabilizers (P, S, M) and concentration (0.144, 0.198 and 0.254%).

RESULTS AND DISCUSSION

Mix Viscosity: Type and concentration of stabilizers had a significant effect on mix viscosity (Fig. 1). Our results showed that by increase in stabilizers concentration, viscosity was increased significantly in all samples (P<0.05). Also there was significant difference in viscosity when the type of stabilizers changed. The highest and the lowest value for viscosity was obtained for saleb at concentration of 0.254% and for stabilizers /emulsifiers mix at concentration of 0.144% respectively (P<0.05). There was significant difference in viscosity of samples with different stabilizers at different concentrations [Table 1].

Table 1: The effect of type and concentration of stabilizers on viscosity, overrun and melting resistance of ice cream type frozen yogurt

Type of Stabilizers [†]	Concentration ^{**}	Viscosity (cp)	Overrun (%)	melting resistance (%)
M	L1	1066 ^g	41.16 ^e	78.73 ^{de}
M	L2	1959 ^g	41.25 ^e	80.79 ^d
M	L3	2807 ^c	45.46 ^b	90.40 ^b
P	L	11669 ^h	42.97 ^{cd}	84.68 ^c
P	L2	2445 ^e	43.91 ^c	88.10 ^b
P	L3	2691 ^d	47.14 ^a	63.62 ^a
S	L1	2341 ^f	39.92 ^f	76.47 ^e
S	L2	4232 ^b	41.05 ^e	80.88 ^d
S	L3	6479 ^a	42.60 ^d	84.05 ^c

a-i values in a column which do not share a common superscript are statistically different. * M: mix of emulsifiers and stabilizers as described in materials and methods, P: Panisole ex, S: salab ** L1: 0.144%, L2: 0.198% and L3: 0.254%

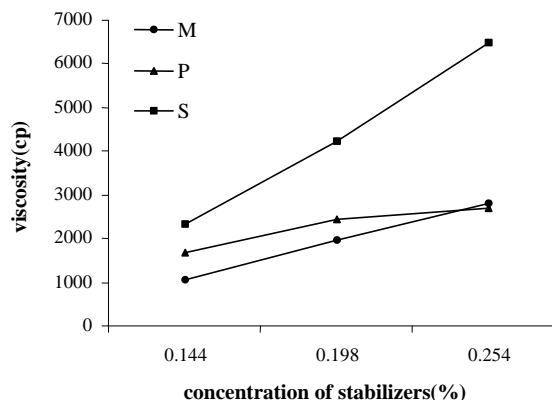


Fig. 1: The effect of type and concentration of stabilizers on viscosity of ice cream type frozen yogurt

Increase in fat and milk protein may cause increase in viscosity but whereas this components were equal in all samples so increase in viscosity was only due to differences in type and concentration of stabilizers [16]. Viscosity is an important characteristics that specific amount is require for achieving desirable whipping ability and holding the air bubbles [10, 16]. Many researches have been performed on the effect of several factors on viscosity of ice cream mix but there isn't any answer to this question that how much viscosity is suitable for ice cream making. Stabilizers have a high water holding capacity [7, 8] and can influence the reological properties of ice cream mix [7, 11] so undoubtedly increase in quantity of stabilizers, result in increase in viscosity [10, 12, 14].

Over Run: Type and concentration of stabilizers had a significant effect on over-run (P<0.05). Results showed

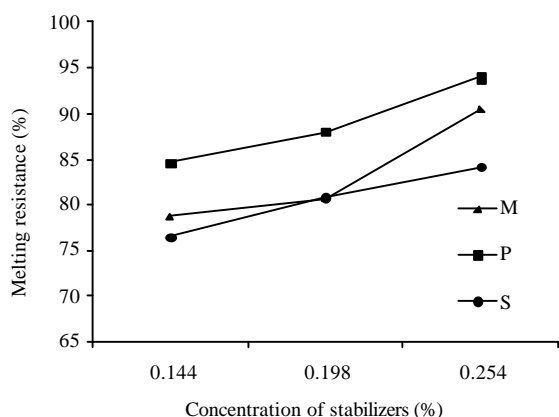


Fig. 2: The effect of type and concentration of stabilizers on over-run of ice cream type frozen yogurt

that in all samples over-run increased significantly with an increase in the concentration of stabilizers. No significant differences were observed in samples containing stabilizers/emulsifiers mix and Panisol ex at concentration of 0.144% and 0.198% [Table 1] but all concentration of saleb had significant differences with each others ($P < 0.05$). The highest value for overrun was obtained for Panisol ex at concentration of 0.254% (Fig. 2).

Over-run, which is directly related to the amount of air in ice cream, is important because it influences product quality and profits and is involved in meeting legal standards. The incorporation of too much air produces a fluffy ice cream and too little produces a soggy, heavy product [10, 13]. However there is a relation between viscosity and over-run [16] and in this study we found that type and concentration of stabilizers had a great effect on viscosity of samples so variation in over-run can be correlated to changes in viscosity. In all samples, increase in concentration of stabilizers and therefore increase in viscosity improved over-run but inordinate increase in viscosity had a negative effect on over-run and can reduce it so samples containing saleb had the lowest over-run ($P < 0.05$). Because of these properties during freezing, air cannot be dispersed in the body so the over-run reduced significantly [16]. Decreased over-run in samples containing saleb can be related to absence of emulsifiers in these systems. As mentioned above emulsifiers are effective in destabilizing the fat emulsion during freezing of an ice cream mix. These properties allow emulsifiers to enhance desirable qualities in ice cream by enhancing whipping ability and increasing overrun capacity [10, 13, 12]. It should be considered that using batch freezers affects the over-run, as it is increased when continuous freezers are used.

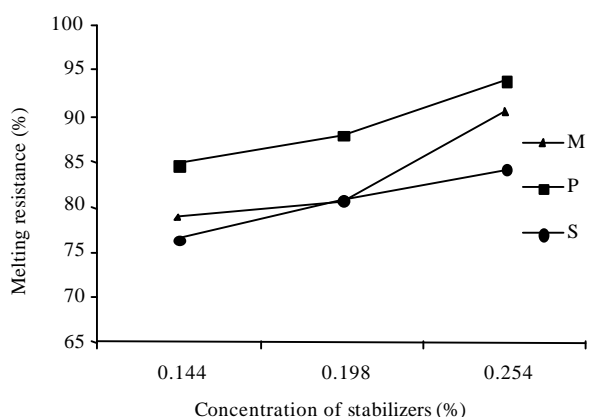


Fig. 3: The effect of type and concentration of stabilizers on melting resistance of ice cream type frozen yogurt

Melting Resistance: Type and concentration of stabilizers had a significant effect on melting resistance ($P < 0.05$). Results showed that in all samples as the concentration of stabilizers increased, melting resistance increased significantly. There were no significant differences in samples containing stabilizers/emulsifiers mix at concentration of 0.144% and 0.198% [Table 1], but significant differences were observed at all concentrations of saleb and Panisol ex ($P < 0.05$). The highest value for melting resistance was obtained for Panisol ex at concentration of 0.254% (Fig. 3). Results showed a direct correlation between results of this section and over-run as increase in over-run enhances melting resistance.

The melt-down rate of ice cream is affected by many factors, including the amount of air incorporated, the nature of the ice crystals and the network of fat globules formed during freezing. Sakurai *et al.* [5] found that ice creams with low overruns melted quickly, whereas ice creams with high overruns began to melt slowly and had a good melting resistance. This slower melting rate in the ice creams with high overruns was attributed to a reduced rate of heat transfer due to a larger volume of air but may also be due to the more tortuous path through which the melting fluid must flow [15, 5]. Rosalina *et al.* [17] found reported that ice creams with lower overruns were harder than those made with high overrun but melted more rapidly.

Sensory Properties: Mean scores of flavour, texture and mouthfeel of the samples are presented in Table 2. Results showed that type and concentration of stabilizers had no effect on flavour perception ($P < 0.05$). Differences in flavour scores were may be because of role of stabilizers

Table 2: The effect of type and concentration of stabilizers on sensory properties of ice cream type frozen yogurt

Type of Stabilizers [*]	Concentration ^{**}	Flavour	texture	mouthfeel
M	-	4.35 ^a	4.31 ^a	4.033 ^a
P	-	4.32 ^a	4.28 ^b	4.031 ^a
S	-	4.33 ^a	4.02 ^c	4.030 ^a
-	L1	4.33 ^a	4.14 ^b	4.029 ^a
-	L2	4.33 ^a	4.17 ^b	4.030 ^a
-	L3	4.34 ^a	4.30 ^a	4.034 ^a

a-c Values in a column which do not share a common superscript are statistically different. * M: mix of emulsifiers and stabilizers as described in materials and methods, P: Panisole ex, S: salab. ** L1: 0.144%, L2: 0.198% and L3: 0.254%

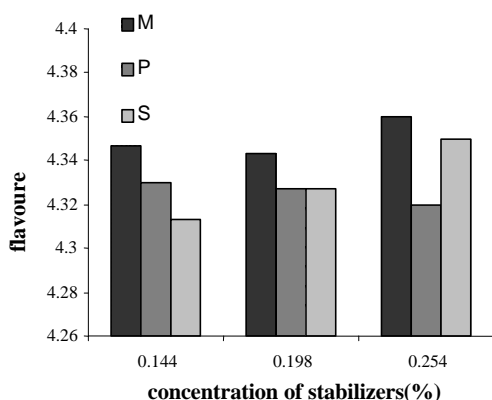


Fig. 4: The effect of type and concentration of stabilizers on flavour score of ice cream type frozen yogurt

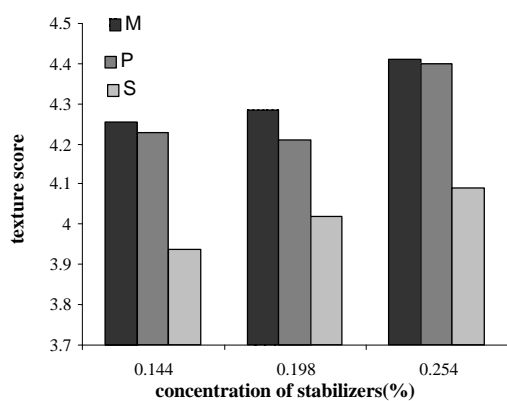


Fig. 5: The effect of type and concentration of stabilizers on texture score of ice cream type frozen yogurt

on holding flavoring compounds in dispersion [7], however these differences were not significant (Fig. 4). concentration of stabilizers had a significant effect on all samples only at concentration of 0.254%. In general, increase in concentration results in increase in scores of texture but in low concentration these differences were

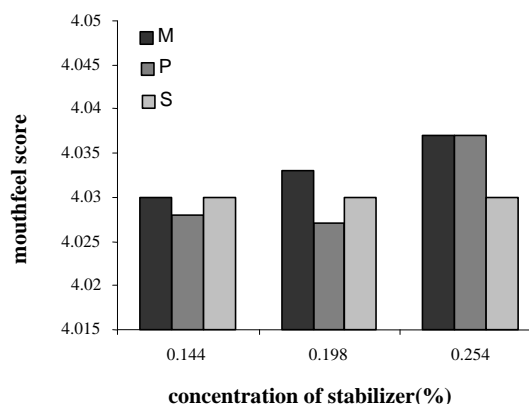


Fig. 6: The effect of type and concentration of stabilizers on mouthfeel score of ice cream type frozen yogurt

not significant (Fig. 5). Texture of samples were affected by type of concentration. Samples containing Panisole ex had significantly higher score of texture than samples containing salab (Fig. 6). Mouthfeel was not affected by either the type and concentration of stabilizers.

CONCLUSION

Ice cream type frozen yogurt with a combination of richness and sourness was prepared. Stabilizer that could be recommended for this product was Panisole ex at 0.254% for best viscosity, meltdown, over-run and sensory characteristics and it is suggested to investigate the effect of other stabilizers and emulsifiers on production quality of frozen yogurt. As this product has a great healthy properties, for developing it is required to improve its flavour and texture. We conclude that this ice cream type frozen yogurt has potential for commercialization.

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