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Effect of Different Stabilizers, Emulsifiers and Storage Time on Some Properties of Ice Cream

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ABSTRACT

Fourteen ice cream samples with stabilizers (0.30% salep or guar gum) and emulsifier (no emulsifier, 0.15 or 0.30% glycerol monostearate (GMS) plus 0.05 or 0.10% polysorbate 80 (PS80) were produced in this study. Physical and sensory properties of ice creams were determined during 3 months of storage. The types and rates of stabilizers and emulsifiers used slightly changed the chemical compositions of ice cream mixes. Using different types and rates emulsifiers with stabilizers had a significant effect on the penetrometer value, first and complete dripping, viscosity of ice creams (P<0.05). In terms of sensory properties of ice creams, the formula containing 0.30% guar gum, 0.30% GMS and 0.10% PS80 was the most preferred. The storage time had a significant effect on the pH, first and complete dripping, penetrometer values of ice creams (P<0.05). Results indicated that the storage time should not be more than 30 days because longer storage had an undesired effect on the physical and sensory properties of ice cream.

Key Words: Ice cream, Emulsifier, Stabilizer, Storage

Farklı Stabilizör, Emülsifiyer ve Depolama Süresinin Dondurmanın Bazı Özellikleri Üzerine Etkileri

ÖZET

Çeşitli emülsifiyer içerikli (emülsifiyersiz, (%0.15 veya 0.30 gliserol monostearat (GMS) artı (%0.05 veya 0.10 polisorbat 80 (PS80) ve stabilizatörlü (%0.30 salep veya guar gum) 14 dondurma örneği üretilmiştir. Dondurmaların fiziksel ve duyusal özellikleri 3 ay depolama süresince belirlenmiştir. Farklı tip ve oranda stabilizatör ve emülsifiyer kullanımı dondurma karışımının bileşimini değiştirmemiştir. Farklı tip ve oranda stabilizatör ve emülsifiyer kullanımının dondurmanın penetrometre değeri, ilk ve tam damlama ve viskozitesi üzerine etkisi önemli olmuştur (p<0.05). Duyusal özellikler açısında %0.30 guar gum, %0.30 GMS ve %0.10 PS80 içeren formül en çok tercih edilmiştir. Depolama süresi, pH, ilk ve tam damlama, penetrometre değerlerini etkilemiştir (p<0.05). Sonuçlar, daha uzun süreli depolamanın dondurmanın fiziksel ve duyusal özelliklerine olumsuz etkilediğinden dolayı, depolama süresinin 30 günden fazla olmaması gerektiğini ortaya çıkarmıştır.

Anahtar Kelimeler: Dondurma, Emülsifiyer, Stabilizatör, Depolama

INTRODUCTION

Ice cream is a complex dairy product, which is made by using milk and dairy products and other ingredients. The quality of ice cream is strongly depends on structure and resistance to melting [1]. It is essential that all the ingredients are properly mixed together and the fat globules and ice crystals should be as small as possible.

These conditions have to be maintained both during production and storage periods. To ensure this, not only demands a well balanced mix composition, but also the presence of two relatively minor but very important ingredients such as stabilizers and emulsifiers [2, 3]. Usually 0.1-0.5% stabilizer is used in the ice cream mix. Emulsifiers used in ice cream manufacture are usually added to mix between 0.05 and 0.5% [2]. The aim of this study was to investigate effect of stabilizers, emulsifier combinations and storage time on the properties of ice cream.

MATERIALS and METHODS

The cows' milk which is the material of this research was provided from the Çukurova University, Faculty of Agriculture, Applied Husbandry Stock-Breeding Department. The milk provided from the morning milking was brought to the Çukurova University Faculty of Agriculture Department of Food Engineering Milk Analysis and Research Laboratory and was applied to the ice cream. Of the other materials to be used in the research, the sweeteners (Aspartame and Acesulfam-K) were provided from Marsa Co. (Adana, Turkey), maltodextrin and polydextrose from Dalya Foreign Trade Co. (İstanbul, Turkey), the non-fat milk powder from Pınar Co. (İzmir, Turkey) and the stabilizers (Sodium alginat and CMC) were provided from Panda Co. (İstanbul, Turkey). In the production of the ice cream, the batch freezer was supplied by Uğur (Nazilli, Turkey).

Cow milk was filtered and standardized, sugar and non-fat milk powder were added. Then the milk was divided into 14 groups with 3 kg each. Stabilizer and emulsifiers were added according to Table 1. The ice cream mixes were pasteurized at 90°C for 10 minute, cooled to 4°C in a water pool. The ice cream mixes were left for 24 h at +4°C for ripening. The freezing process was carried on for 10 min at -15°C in the batch type freezing machine. The ice cream produced were placed into concealed plastic pots which were 125 mL, stored for 3 months at -25°C and during this period their physical and sensory properties were analyzed. Ice creams were manufactured twice as duplicate in a week interval. All analyses were triplicated.

Table 1. The rates of stabilizers and emulsifiers used in ice creams (%)

No	Stabilizer	Emulsifier
1	Salep (0.30)	-
2	Guar (0.30)	-
3	Salep (0.30)	GMS (0.15)
4	Guar (0.30)	GMS (0.15)
5	Salep (0.30)	GMS (0.30)
6	Guar (0.30)	GMS (0.30)
7	Salep (0.30)	GMS (0.15) + PS80 (0.05)
8	Guar (0.30)	GMS (0.15) + PS80 (0.05)
9	Salep (0.30)	GMS (0.15) + PS80 (0.10)
10	Guar (0.30)	GMS (0.15) + PS80 (0.10)
11	Salep (0.30)	GMS (0.30) + PS80 (0.05)
12	Guar (0.30)	GMS (0.30) + PS80 (0.05)
13	Salep (0.30)	GMS (0.30) + PS80 (0.10)
14	Guar (0.30)	GMS (0.30) + PS80 (0.10)

GMS: Glycerol monostearate, PS 80: Polysorbate 80

The acidity, pH, dry matter, fat, protein, lactose of the milk and mix were determined according to Ling [4]. Overrun, penetrometer values first dripping, complete melting times and viscosity were determined according to Cotrell et al., Bolliger et al., Koçan [3, 5, 6]. The sensory properties were determined according to Arbuckle [2]. The results were statistically evaluated using analysis of variance (one-way ANOVA). The differences between the samples were determined by the test of LSD [7].

RESULTS and DISCUSSION

The cows' milk used in the ice cream production had a normal composition with pH value of 6.65, titration acidity 0.196% (as lactic acid), 11.72% dry matter, 3.2% fat, 3.58% protein and 3.94% lactose. The chemical compositions of ice creams produced by using different combinations of stabilizers and emulsifiers were slightly changed according to types of stabilizers and emulsifiers used. Fat contents of the ice creams were changed between 7.02 to 8.64%, protein contents were between 3.11 to 3.22%, lactose contents were between 3.0 to 3.75% and dry matter were between 25.99 to 31.20%.

The pH and overrun value of ice creams are presented in Table 2. It was found that the stabilizers and emulsifiers used in ice cream had no significant effect on pH values ($p>0.05$). But storage time had a significant effect ($p<0.05$). The use of stabilizers and emulsifiers had no significant effect on overrun ($p>0.05$) but storage time had a significant effect ($p<0.05$). Our results were similar to those reported by Koçan [6] and Uraz [8].

The penetrometer and viscosity value of ice creams are given in Table 3. Penetrometer values showed that the use of salep resulted in much harder ice creams compared to ice creams made with guar gum ($p<0.05$). Our findings also showed that increased rate of emulsifiers in ice creams resulted in increase in penetrometer values, indicating that the ice creams became softer during storage ($p<0.05$). The ice creams made using Glycerol monostearate (GMS) was harder than the ice creams made using Glycerol monostearate (GMS)+polysorbate 80 (PS80). Our results confirmed the findings of other author [6]. Güven et al. [9] reported the effects of the use of various stabilizer combinations on the penetrometer values of the ice creams decreased during storage, indicated the development of a harder structure. Guar gum substantially increased the viscosity of ice creams compared to that of salep. The results showed that guar was more effective at binding free water than salep. However, emulsifiers did not significantly affect the viscosity values of ice creams ($p>0.05$) at the beginning of storage, but viscosity values of samples containing PS80 increased significantly at the end of storage ($p<0.05$).

Table 2. The pH and overrun value of ice creams during storage

Properties	Ice cream	Day			
		1	30	60	90
pH	1	6.43±0.03[a*]	6.56±0.08[b]	6.59±0.01[b]	6.62±0.03[b]
	2	6.48± 0.03[a]	6.58±0.07[ab]	6.60± 0.03[b]	6.61±0.03[b]
	3	6.51± 0.05[a]	6.60± 0.05[b]	6.62± 0.01[b]	6.64± 0.02[b]
	4	6.53±0.05[a]	6.62±0.04[b]	6.62±0.03[b]	6.62±0.01[b]
	5	6.54±0.02[a]	6.63±0.03[b]	6.65±0.04[b]	6.68±0.01[b]
	6	6.53±0.02[a]	6.63±0.03[b]	6.64±0.01[b]	6.67±0.03[b]
	7	6.52±0.03[a]	6.63±0.02[b]	6.64±0.03[b]	6.67±0.02[b]
	8	6.52±0.03[a]	6.62±0.02[b]	6.59±0.01[b]	6.65±0.05[b]
	9	6.51±0.05[a]	6.60±0.03[b]	6.60±0.02[b]	6.65±0.02[b]
	10	6.51±0.06[a]	6.62±0.04[b]	6.61±0.02[b]	6.64±0.02[b]
	11	6.52±0.07[a]	6.64±0.02[b]	6.65±0.01[b]	6.64±0.01[b]
	12	6.53±0.07[a]	6.66±0.03[b]	6.65±0.02[b]	6.66±0.02[b]
	13	6.52±0.07[a]	6.65±0.02[b]	6.63±0.01[b]	6.68±0.01[b]
	14	6.49±0.09[a]	6.67±0.01[b]	6.65±0.01[b]	6.70±0.02[b]
Overrun (%)	1	23.25±3.20[a]	20.00±3.27[a]	12.00±1.63[b]	11.00±2.58[b]
	2	26.75±2.22[a]	18.75±2.99[a]	13.00±2.58[b]	11.50±1.00[b]
	3	26.25±4.11[a]	16.50±5.51[b]	14.50±1.00[b]	12.00±0.00[b]
	4	24.00±3.37 [a]	16.00±3.65[b]	12.50±1.00[b]	11.00±1.15[b]
	5	18.50±8.10 [a]	15.00±2.94[a]	12.00±3.27[b]	10.50±1.00[b]
	6	17.25±6.95[a]	15.00±2.31[a]	12.00±2.00[b]	10.00±3.00[b]
	7	15.75±3.40[a]	10.75±2.06[b]	9.50±1.00[c]	9.00±1.63[c]
	8	20.25±1.50[a]	14.00±5.89[b]	10.00±3.27[c]	9.50±1.00[c]
	9	27.25±2.22[a]	16.50±5.74[b]	16.50±2.52[c]	15.00±1.37[c]
	10	24.50±4.04[a]	15.00±4.76[b]	12.00±0.00[c]	10.00±0.00[c]
	11	24.75±6.95[a]	19.00±2.58[b]	15.50±1.00[c]	14.00±1.15[c]
	12	22.25±6.95[a]	19.00±1.15[b]	18.00±0.00[c]	17.00±2.00[c]
	13	17.75±9.88[a]	15.75±1.71[b]	14.50±1.91[c]	12.00±1.63[c]
	14	12.00±4.69[a]	11.00±1.63[b]	10.50±1.00[c]	9.50±2.52[c]

*The mean values with different letters from left to right were significantly different ($p<0.05$)

Table 3. The penetrometer and viscosity value of ice creams during storage

Properties	Ice cream	Day			
		1	30	60	90
Penetrometer ($mmx10^{-1}$)	1	14.50±1.29[a]	13.00±2.16[a]	19.75±2.50[b]	22.25±1.26[c]
	2	18.75±0.50[a]	19.50±3.00[a]	21.00±0.82[b]	22.50±1.91[c]
	3	17.00±0.82[a]	17.00±3.56[a]	20.00±3.65[b]	20.50±1.29[b]
	4	20.75±0.50[a]	14.50±4.20[b]	19.75±0.50[a]	22.50±2.08[c]
	5	16.75±1.26[a]	17.00±3.56[a]	19.00±2.94[b]	22.00±1.63[b]
	6	19.25±3.40[a]	18.50±2.08[a]	20.00±1.41[b]	21.75±1.71[b]
	7	17.50±1.29[a]	16.00±1.83[b]	21.00±1.15[c]	21.75±1.26[ac]
	8	19.50±3.32[a]	16.00±4.08[b]	20.00±1.83[c]	20.75±0.96[ac]
	9	19.50±0.58[a]	17.75±3.86[b]	23.25±0.96[c]	23.75±0.96[ac]
	10	23.25±0.96[a]	16.50±2.38[b]	26.50±1.29[c]	24.25±1.71[ac]
	11	24.00±1.83[a]	20.75±6.65[b]	25.00±2.94[c]	23.25±0.96[ac]
	12	25.75±1.71[a]	23.00±7.02[b]	27.75±0.50[c]	23.75±0.96[ac]
	13	26.25±1.26[a]	24.75±5.56[b]	27.25±0.96[c]	25.75±1.71[ac]
	14	27.75±2.06[a]	26.75±3.20[b]	32.00±2.16[c]	29.00±2.58[ac]
Viscosity (mm^2/sec)	1	4.75±2.06[a]	8.75±1.50[b]	6.75±1.71[b]	6.75±0.96[b]
	2	4.75±2.40[a]	6.75±3.86[b]	7.00±2.45[b]	6.75±2.22[b]
	3	6.50±1.91[a]	9.50±4.93[b]	7.75±3.30[a]	7.00±1.83[a]
	4	4.25±2.22[a]	8.25±2.22[b]	6.25±0.96[b]	5.75±0.96[a]
	5	6.00±2.31[a]	11.75±3.30[b]	8.50±1.73[a]	10.00±1.41[b]
	6	6.50±2.65[a]	17.25±0.96[b]	11.25±0.96[a]	9.75±1.26[a]
	7	5.75±1.71[a]	13.75±2.06[b]	10.25±2.06[c]	9.75±1.25[c]
	8	5.00±1.41[a]	11.00±2.58[b]	9.00±1.15[c]	9.75±1.26[c]
	9	9.75±0.50[a]	15.50±4.20[b]	10.50±1.73[c]	11.00±0.82[c]
	10	10.25±2.06[a]	16.50±3.70[b]	13.00±1.83[c]	13.25±0.96[c]
	11	7.75±1.71[a]	17.00±3.92[b]	12.25±1.71[c]	13.50±0.58[c]
	12	7.75±1.71[a]	14.75±2.22[b]	12.75±1.71[c]	12.50±0.58[c]
	13	6.00±1.41[a]	13.75±3.30[b]	11.00±1.83[c]	11.00±1.83[c]
	14	9.25±0.96[a]	18.75±4.11[b]	13.75±2.06[c]	12.00±0.82[c]

*The mean values with different letters from left to right were significantly different ($p<0.05$)

Table 4. The first dripping time and complete melting time value of ice creams

Properties	Ice cream	Day			
		1	30	60	90
First dripping time (s)	1	576.8±37.8 [a]	421.3±15.7 [b]	414.8±12.0 [b]	408.3±10.4 [b]
	2	555.3±22.5 [a]	365.3±50.4 [b]	373.3±43.1 [b]	371.8±45.3 [b]
	3	616.3±90.2 [a]	337.8±17.3 [b]	361.0±10.8 [b]	345.2±12.2 [b]
	4	540.8±42.7 [a]	463.5±12.0 [b]	434.3±22.2 [b]	403.0±44.7 [b]
	5	334.3±31.5 [a]	325.3±18.8 [a]	320.3±22.4 [b]	317.3±20.0 [b]
	6	422.8±66.6 [a]	404.8±89.8 [b]	383.3±79.2 [b]	372.5±68.4 [b]
	7	477.3±42.1 [a]	396.3±24.8 [b]	383.3±28.9 [b]	371.0±25.8 [b]
	8	377.3±49.2 [a]	311.3±10.4 [b]	310.3±8.1 [b]	311.8±7.0 [b]
	9	410.5±63.0 [a]	296.5±19.9 [b]	298.5±7.9 [b]	296.0±10.0 [b]
	10	353.3±11.0 [a]	324.5±7.2 [b]	272.8±16.8 [b]	276.5±15.5 [b]
	11	354.3±44.0 [a]	303.3±30.0 [b]	263.5±7.9 [b]	264.8±21.8 [b]
	12	365.5±62.9 [a]	327.0±20.7 [b]	306.8±8.6 [b]	295.0±9.5 [b]
	13	391.0±42.9 [a]	319.0±26.4 [b]	305.5±24.7 [b]	295.8±21.9 [b]
	14	374.5±40.4 [a]	295.5±17.0 [b]	284.5±14.7 [b]	290.3±13.1 [b]
Complete melting time (s)	1	No melt	No melt	No melt	No melt
	2	3694.0±68.5 [a]	3655.5±36.9 [a]	3646.3±33.5 [a]	3622.3±16.6 [b]
	3	3626.5±124.2 [a]	3627.5±124.6 [a]	3629.8±125.6 [a]	3599.8±104.6 [b]
	4	3282.8±14.4 [a]	3228.8±14.8 [a]	3214.8±13.2 [a]	3191.8±10.1 [b]
	5	3841.0±30.8 [a]	3188.3±69.4 [b]	3172.0±62.0 [b]	3168.3±55.1 [b]
	6	3182.3±95.4 [a]	2201.3±58.7 [b]	2234.5±26.6 [b]	2231.5±25.5 [b]
	7	3497.3±22.8 [a]	3191.3±44.8 [b]	3175.5±38.7 [b]	3169.8±40.4 [b]
	8	3123.0±11.7 [a]	3451.5±35.9 [b]	3378.0±14.6 [b]	3331.0±29.9 [b]
	9	2775.5±23.6 [a]	2865.3±41.0 [b]	2866.3±49.2 [b]	2859.5±55.7 [b]
	10	2916.8±25.6 [a]	3120.5±10.3 [b]	3086.0±68.7 [b]	3079.0±68.8 [b]
	11	3329.0±19.6 [a]	3088.8±91.9 [b]	3087.3±93.1 [b]	3140.0±51.3 [b]
	12	3004.8±15.3 [a]	2467.3±44.0 [b]	2472.0±87.4 [b]	2478.8±88.7 [b]
	13	3039.3±20.5 [a]	2421.0±12.5 [b]	2336.5±36.7 [b]	2330.3±35.0 [b]
	14	3039.3±20.5 [a]	2421.0±12.5 [b]	2336.5±36.7 [b]	2330.3±35.0 [b]

*The mean values with different letters from left to right were significantly different ($p<0.05$)

The first dripping time and complete melting time value of ice creams are shown in Table 4. Stabilizers and emulsifiers significantly affected the first dripping and complete melting times of ice cream samples ($p<0.05$). The first dripping and complete melting times of ice cream samples were significantly reduced during storage ($p<0.05$). The use of PS80 reduced the first dripping times of ice creams. This effect can be related to the effect of emulsifiers on fat destabilization and thereby make an improvements in melting properties [1, 6, 10, 11]. It was found that the rates of emulsifiers were not adequate to extend first dripping and complete melting times of ice creams in this study. Muse and Hartel [12] found that the melting rates slowed with increasing levels of PS80.

The sensory properties of ice creams are given in Table 5. It was also found that the use of stabilizers and emulsifiers did not significantly affect the sensory properties of ice creams ($p>0.05$). Ice creams made with 0.15% salep, 0.15% salep+0.30% GMS and 0.10% PS80 were the most accepted ice cream samples. Akesowan [13] reported that combined stabilizers containing konjac flour and κ-carrageenan made ice cream more smooth, viscous texture and less ice crystal in the products. During the storage time, significant decreases were observed in the color and appearance, body and texture, taste and flavor scores of the ice cream ($p<0.05$).

Table 5. The sensory properties (total points) of the ice cream

Ice cream	Day			
	1	30	60	90
1	14.42 [a]	13.91 [a]	13.76 [a]	13.67 [a]
2	14.42 [a]	13.91 [b]	13.76 [b]	13.67 [c]
3	14.03 [a]	13.82 [b]	13.64 [b]	13.55 [c]
4	14.76 [a]	14.34 [b]	14.02 [b]	13.83 [c]
5	14.73 [a]	14.67 [a b]	14.60 [b]	14.40 [c]
6	14.23 [a]	14.22 [a]	14.09 [b]	14.03 [b]
7	14.84 [a]	14.79 [a]	14.63 [b]	14.48 [c]
8	14.72 [a]	14.57 [b]	14.46 [c]	14.36 [c]
9	15.60 [a]	15.35 [b]	15.25 [b]	15.05 [c]
10	15.96 [a]	15.88 [b]	15.82 [b]	15.82 [b]
11	16.95 [a]	16.77 [b]	16.82 [a]	16.82 [a]
12	17.32 [a]	17.28 [a]	17.22 [b]	17.20 [b]
13	18.30 [a]	17.86 [b]	17.97 [b]	19.06 [c]
14	18.61 [a]	18.53 [a]	18.41 [b]	18.47 [b]

*The mean values with different letters from left to right were significantly different ($p<0.05$)

CONCLUSIONS

In the production of ice cream using different rates of emulsifiers (GMS with or without PS80) had significant improvements on melting properties, consistency and softness of the ice cream. During the storage period, all the physical properties of the ice creams changed, and the sensory scores decreased significantly. The results indicated that the appropriate storage time for the ice cream should not be more than 30 days.

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REFERENCES

[1] Arbuckle, W.S., 1981. *Ice Cream*. 3rd Edition, the Avi Publishing Comp Inc., Connecticut, 105p.

[2] Rothwell, J., 1985. *Ice-Cream Making*. The University of Reading, London, 102p.

[3] Cotrell, J.I.L, Pass, G., Phillips, G.O., 1979. Assesment of polysaccharides as ice cream stabilisers. *J. Sci. Food Agric.* 30(11): 1085-1089.

[4] Ling, R.L., 1963. *Dairy Chemistry*. Vol. 1-2 Chapman and Hall Ltd., London, 227p.

[5] Bolliger, S., Goff, H.D., Tharp, B.W., 2000. Correlation between colloidal properties of ice cream mix and ice cream. *Int. Dairy J.* 10(4): 303-309.

[6] Koçan, D., 1999. Vanilyalı dondurma üretiminde Quest Admul MG 4143 emülgatörünün farklı kullanım oranlarının dondurma niteliklerine etkisi. Ankara Üniversitesi Fen Bilimleri Enstitüsü Süt Teknolojisi Anabilim Dalı Yüksek Lisans Tezi, Ankara, Türkiye, 69s.

[7] Steel, R.G.D., Torrie, J.H., 1980. Principles and Procedures of Statistics. McGraw Hill Book Co. Inc., Newyork, 612p.

[8] Uraz, T., 1979. Ankara'da tüketime sunulan taze dondurmaların bazı nitelikleri üzerine araştırma. *Ankara Üniversitesi Ziraat Fakültesi Dergisi* 28(3-4):994-1005.

[9] Güven, M., Karaca, O.B., Kacar, A., 2003. The effects of the combined use of stabilizers containing locust bean gum and of the storage time on Kahramanmaraş-type ice creams. *Int. Dairy J. 56(4): 223-228.*

[10] Flack, E., 1991. *Functional Ingredients in Frozen Desserts*. Grindsted Products Ltd. Suffolk, UK, 198p.

[11] Baer, R.J., Wolkow, M.D., Kasperson, K.M., 1997. Effect of emulsifiers on the body and texture of low fat ice cream. *J. Dairy Sci.* 80(12): 3123-3132.

[12] Muse, M.R., Hartel, R.W., 2004. Ice cream structural elements that affect melting rate and hardness. *J. Dairy Sci.* 87: 1-10.

[13] Akesowan, A., 2008. Effect of combined stabilizers containing konjac flour and κ-carrageenan on ice cream. *AU J.T.* 12(2): 81-85.