EFFECTS OF STABILIZERS ON FAT AGGLOMERATION AND MELTING RESISTANCE IN ICE CREAM

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ABSTRACT

Fat network is known as one essential element in development of ice cream infrastructure. The main goal in the study was to understand the effect of stabilizers on fat agglomeration during freezing in the presence and absence of emulsifier. Eight commercial ice creams were analyzed for particle size and melting properties. Additionally, ice cream mix was formulated to contain 10% milk fat, 10% milk solids-not-fat, 12% sucrose, 6% corn syrup solids, and 0.15% carboxymethylcellulose (CMC). The formulations also included mixes with and without 0.15% mono-and di-glycerides (MDG). Fat aggregation was indicated by D[4.3] and % particles above 10 µm as measured by a Malvern Mastersizer. Melting rate was defined as amount of dripped loss divided by melting time. Commercial ice cream analysis showed that ice cream with egg yolks (EY) and no stabilizers had no fat aggregates. Particle size distributions varied between ice cream brands. Ice creams with MDG or those with gums in addition to EY showed an increased aggregation. Ice cream without stabilizer had no fat aggregates and melted at the fastest rate. Gums decreased the melting rate and the melting properties were independent from particle size. Ice cream with only CMC showed the highest amount of fat aggregates and highest melting resistance. The effect was followed by ice cream made with both CMC and MDG, and only MDG. The amount of fat aggregates was highly correlated to the melting resistance of the ice creams. Ice cream with most melting resistance had greater amount of fat aggregates.

INTRODUCTION

Ice cream is a complex food colloid that consists of fat globules, air bubbles, air crystals and an frozen serum phase. The fat globules are coated with protein-emulsifier layer. During freezing this fat molecules form a network of fat agglomerate (Goff, 1997). Up to certain amount, fat agglomeration contributes to smoother and better mouthfeel ice cream. Emulsifier is known to promote fat destabilization during freezing of Ice cream and thus enhance texture. However, no information is available about contribution of stabilizers in fat destabilization. Stabilizers or gums are commonly used in ice cream to improve mouth feel by influencing water mobility, but their affect on fat agglomeration during freezing is unknown. Fat agglomeration can be used to predict ice cream stability and quality.

OBJECTIVES

To investigate the effect of stabilizers used in commercial ice cream to fat agglomeration and to study the effect of CMC as stabilizer on fat agglomeration during freezing in the presence and absence of emulsifier.

MATERIALS AND METHODS

- Eight commercial ice creams were purchased from local supermarket
- Four different ice creams were made at OSU pilot plant.

Table 1 . Ice cream mix treatments

Treatment*	MDG	CMC
T1	-	-
T2	-	+
T3	+	+
T4	+	-

*Treatments: **T1** = control;
T2 = with 0.15% CMC;
T3 = with 0.15% MDG and 0.15% CMC;
T4 = with 0.15% MDG.

Mix and Ice cream preparation

- Ice cream mix composition : 10% milk fat, 10% milk solids-not-fat, 12% sucrose, 6% corn syrup solids (42 D.E., Tate & Lyle distributed by Cleveland Syrup Corp., Cleveland, OH 44127), MDG (AIC, Kansas City, MI 64111) and CMC (Hercules Inc., Aqualon 7H4F, Hopewell, VA).
- All of the dry ingredients were dry blended and mixed with the liquid portion at 48°C for 10 minutes. Mixes were pasteurized at 70°C, 30 min, homogenized at 2000/500 psi (two stage homogenizer) and aged overnight at 4°C .
- Ice cream mixes were frozen in a batch freezer (Coldelite LB252) – 1.25 gallon of mix per batch. Draw temperature and overrun were obtained
- Fresh mixes, aged mixes and ice cream were analyzed for particle size distribution and melting rate.

Analysis

- Particle size distribution was obtained by integrated light scattering using Malvern Mastersizer Microplus, Malvern Instruments Ltd., Worcs., UK)
  - Obscuration: 16% to 19%
  - D[4,3] and cumulative % of particles greater than 10 µm to indicate fat agglomeration

Analysis

- Melting test
  - 30 ± 0.5g at room temperature
  - Melting rate = dripped loss / time
  - Dripped loss was defined as the weight of material passing through the screen.

Statistical Analysis

- Analysis of Variance (ANOVA)(SPSS version 14.0, SPSS Inc., city, state) at p<0.05
- Correlation coefficient between particle size value and melting rate (r^2)

RESULTS

Table 2. Commercial Ice cream characteristics

Sample	Stabilizer	Emulsifier	Estimated % overrun	D[4,3]	% particle >10 µm	Melting rate (g/min)
A		Egg yolks	20.77	1.76	0.00	0.4897
B	Cellulose gum Guar gum Carrageenan	MDG	94.07	11.89	32.19	0.4411
C	Natural tara gum	Egg yolks	102.24	11.63	18.92	0.3193
D	Guar gum Carrageenan	Egg yolks	25.15	4.08	6.51	0.4473
E	Cellulose gum Guar gum Carrageenan	MDG	93.94	18.91	41.43	0.4691
F	Cellulose gum Guar gum Carrageenan	MDG	86.55	10.19	24.77	0.4655
G	Cellulose gum Guar gum Carrageenan	MDG	84.44	12.7	26.66	0.4759
H	Cellulose Carob bean gum Guar gum Carrageenan	Egg yolks	52.87	6.21	14.61	0.4715

Fig 1. Melting profile of commercial ice creams

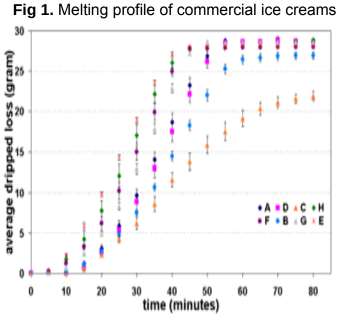


Fig 2. Melting profile of pilot plant ice creams

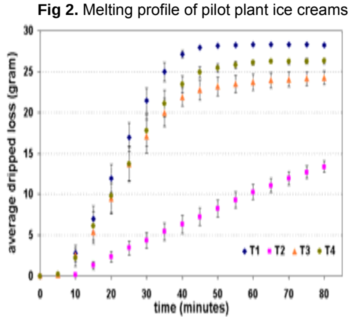


Fig 3. Particle size distribution of commercial ice cream with egg yolks

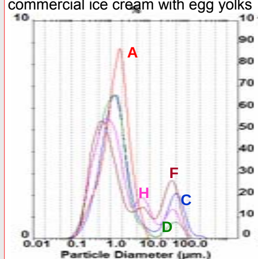


Fig 4. Particle size distribution of commercial ice cream wi th MDG

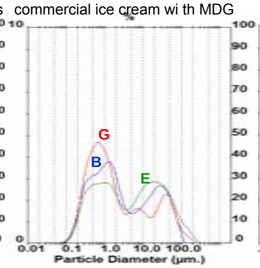


Fig 5. Particle size distribution of pilot plant ice cream

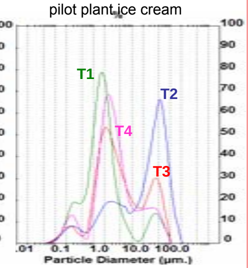


Table 3. Pilot plant ice cream characteristics

	Draw Temp. (°C)	Overrun (%)	D[4,3]	% particle >10µm	Melting rate (g/min)**
T1	-6.5	35.16	6.5140 [a]	11.5040 [a]	0.4721[b]
T2	-6.4	40.11	36.3560 [b]	67.6740 [b]	0.1713 [c]
T3	-6.6	49.45	13.8600 [c]	34.2280 [c]	0.3954 [a]
T4	-7.0	36.58	9.0120 [a]	21.8740 [d]	0.4351 [a, b]

[a – d] Means in the same column without common superscripts differ (P<0.05)

Fig 6. Correlation between D[4,3] and melting rate

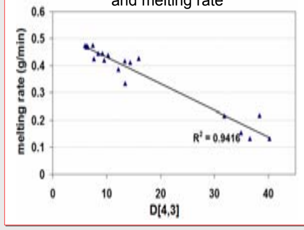
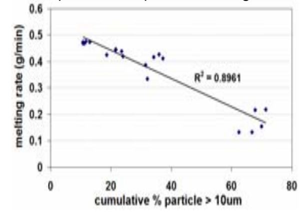


Fig 7. Correlation between cumulative % particle > 10µm and melting rate



SUMMARY

Commercial ice creams

- There were differences of fat globule distribution and melting rate among different brands of ice cream. Sample A, with the lowest D[4,3] value had no fat aggregates and melted at the fastest rate.
- Ice cream with MDG as emulsifier had more fat agglomeration compare to ice cream with EY as emulsifier (Table 2).
- The melting rate are independent of fat aggregates.

Ice cream made in OSU pilot plant

- Ice cream with CMC (T2) had highest amount of fat aggregates (Table 3 and Fig. 5) and slowest melting rate (Fig. 2).
- The presence of MDG decreased the amount of fat aggregates and increased the melting rate of ice cream.
- The melting rate highly correlated with the amount of fat agglomeration (Fig. 6 and Fig. 7) as indicated by D[4,3](r^2=0.9416) and cumulative % particle greater than 10 µm (r^2=0.8961).
- Ice cream without emulsifier and stabilizer (T1) had the lowest fat agglomeration and higher melting rate.

CONCLUSIONS

- Ice cream with stabilizers had higher amount of fat aggregates.
- The presence of emulsifier reduced the amount of fat aggregates formed during freezing.
- Fat agglomeration influences the melting rate of ice cream. The higher the amount of fat aggregates, the higher the melting resistance of the ice cream.
- Stabilizers affect fat agglomeration during freezing by somewhat modifying the fat structure.

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