Observations on the Whipping Characteristics of Cream

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ABSTRACT

With the application of UHT technology to the processing of whipping creams, consumers may purchase creams with whipping characteristics different from creams processed by conventional pasteurization. This study observed differences in whipping properties among raw, pasteurized, and UHT whipping creams. Whipping time to reach maximum volume, number of days before and after retail sell-by date, and overrun were recorded. Mean whipping time and maximum overrun varied significantly by processor, product composition, and retail cream age. Mean whipping time ranged from 1.6 min for raw unpasteurized creams to 3.4 min for UHT heavy cream without whipping aids. Mean maximum overrun ranged from 141% for UHT heavy creams without whipping aids to 216% for UHT whipping creams with aids. There was considerable variation in mean whipping time and mean maximum overrun among processors for creams of the same composition. Regression analysis between whipping time and retail cream age revealed a positive relationship for some product types and a negative relationship for others. Whipping time and maximum overrun of retail whipping creams vary substantially by product type, processing treatment, and processor.

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INTRODUCTION

Whipping cream is not an everyday purchase in most households and is often used for special occasions only. Consumers and the dairy industry have certain expectations for the quality of whipping creams with regard to taste, shelf-life, and whipping characteristics. Whipping characteristics recognized within the industry are speed of whipping, overrun, firmness of whipped product, and stability (8).

The whipping process forms air cells that are stabilized at the air-water interface by fat globules (8, 12). During whipping, the globules attach to air bubbles; as these air bubbles break and coalesce, the fat clumps. As whipping continues, air cells become smaller and more numerous, fat clumping continues, and the foam increases in volume and rigidity. If whipping continues still further, the fat clumps become so large they rupture the lamellae that enclose the air cells. Air bubbles start to coalesce, overrun decreases, and churning results.

Researchers agree that milk fat content, cream temperature, homogenization and pasteurization conditions, and presence of stabilizers and emulsifiers influence whipping creams' functional properties (2, 7, 8, 10, 11, 12). Higher milk fat increases foam firmness and stability but decreases overrun. Because fat solidification is necessary in the formation of a satisfactory foam, cream must be chilled prior to whipping. Pasteurization temperature affects whipping characteristics; higher temperatures generally increase whipping time and reduce overrun. When whipping cream is UHT heated it can also be homogenized to prevent cream-plug formation during prolonged storage (8). Homogenizer valve type and pressures, as well as number of homogenization stages, influence overrun through the production of fat clusters of varying sizes (8, 11). Surface-active agents and stabilizers, often added to creams that

undergo UHT treatment, produce a finer foam and affect overrun and foam stability (1, 5, 8, 11).

Other factors that influence the whipping characteristics of cream may be less important in today's market. For example, early work by Babcock on the influence of aging on the whipping characteristics of pasteurized cream are irrelevant today since the effects are noticeable only up to 24 h after pasteurization (2). The time required for distribution to the market and the long shelf-life of today's products make it unlikely that consumers buy freshly processed creams. Seasonal variations in composition and properties of raw cream are known to influence whipping cream functionality (6, 8). These variations may be of little importance in the California market, since dairy farms maintain herds in uniform states of lactation throughout the year. Dairy cattle feed composition used in California dairies is also relatively uniform throughout the year.

The temperature of processing influences whipping characteristics. In the past, whipping creams were HTST pasteurized, typically at 74°C for 18 s. Such creams have a longer shelf-life and different whipping properties than the raw product. Currently, many whipping creams are processed by UHT methods, at about 138°C for 4 s. The longer shelf-life of these UHT products makes this technology attractive to dairy processors.

There has been little recent literature regarding the whipping characteristics of the long-life creams available to consumers today. This study was designed to update the data and identify differences in whipping properties of raw, HTST, and UHT creams. The results of the study could help answer consumer questions regarding the whipping properties of the "new" creams and help establish a current data base on the whipping characteristics of creams.

MATERIALS AND METHODS

During a 15-mo period in 1984 to 1985, samples of whipping cream and heavy whipping cream were purchased from retail dairy cases. Samples were transported at 4°C to the laboratory and refrigerated until analyzed. California standards require a minimum of 30% milk fat for whipping cream and 36% milk fat, or more, for heavy whipping cream. Either type of cream may have up to .6% stabilizers and emulsifiers (3). Samples from the six major processors of UHT whipping creams in California were obtained. There was only one plant processing raw and one processing pasteurized whipping cream for retail sale in California. Purchased samples represented: raw whipping cream (one processor), pasteurized whipping cream (one processor), UHT whipping cream (four processors), UHT heavy whipping cream (two processors).

In order to test for processor variation, 15 samples of pasteurized whipping cream were collected from retail stores in Oregon. Because no variation in functional properties was observed, these samples were included with the pasteurized whipping creams collected in California. Information on the specific time, temperature, and homogenization pressures used in the UHT creams was unavailable due to proprietary considerations.

Products were stored at 4 to 5°C a minimum of 24 h before whipping to allow for temperature stabilization and solidification of fat. Whipping creams were evaluated throughout their shelf-lives: from 46 d before to 28 d after the retail sell-by date coded on the carton for UHT whipping creams, from 4 d before to 17 d after for pasteurized whipping creams, and from 11 d before to 2 d after for raw whipping creams.

Half-pint (.24-L) samples were whipped in a chilled bowl to maximum overrun in a Kitchenaid mixer model K5A operating at speed six (about 150 rpm). Whipping times were taken at 15-s intervals for products that reached maximum overrun in less than 2.5 min and at 30-s intervals for products that required more than 2.5 min. Experience showed that overrun did not vary within these time intervals and that variation due to subjective visual evaluation was reduced. Maximum overrun and whipping time to reach maximum overrun were recorded. Overrun was calculated using a 112-ml container and the standard overrun formula: [(weight liquid − weight foam)/weight foam)] × 100 = percent overrun.

According to package labels, all raw and pasteurized whipping creams and one UHT heavy cream contained no additives. Processor 3 used carrageenan, dextrose, and guar gum for both whipping and heavy cream. Plant 4 used mono- and diglycerides, polysorbate 60, and

carrageenan. Plants 5 and 6 used mono- and diglycerides, polysorbate 80, and carrageenan. Plant 6 used this combination in both whipping and heavy cream.

RESULTS AND DISCUSSION

Whipping times required to reach maximum overrun varied significantly according to processing method and product type (Table 1). Whipping time was shortest for raw cream; pasteurized cream required the next shortest time. These findings are consistent with Babcock's early work (2) and may be due to changes in the fat globule membrane (9). The UHT products required longer whipping times than raw or pasteurized products. The UHT heavy whipping creams required slightly less whipping time to reach maximum overrun than UHT regular whipping creams. The UHT heavy creams without additives required the longest whipping time.

Mean overrun of all creams varied from a low of 143% for UHT whipping cream from one processor to a high of 216% (Table 2). Raw cream had intermediate overrun values. Within any processor, heavy whipping creams achieved lower overruns than regular whipping creams. This result is consistent with earlier work that showed that increases in fat content decreased overrun (7, 12). The UHT heavy cream without additives achieved a lower overrun than raw or pasteurized regular whipping cream. That additives or processing technique can overcome the lower whippability of UHT products is apparent from the high overrun for creams from processors 4 and 6.

To determine the effects of product age on whipping qualities, regression analyses were completed in which whipping time and overrun were each regressed against days before retail sell-by date (4). A positive correlation was found between whipping time and cream age for pasteurized cream and both heavy UHT creams that contained additives (Figure 1). As the creams approached sell-by date, they required longer whipping times. In contrast, UHT heavy cream without additives required shorter whipping times as the cream aged. Raw cream exhibited a negative correlation with age significant only at 10%. No correlation was found between age and whipping time for the UHT regular whipping creams.

A negative correlation was revealed between cream age (as measured by retail sell-by date) and overrun for raw cream and for one proces-

TABLE 1. Mean whipping times to reach maximum overrun for different whipping creams.

Processor	Method[1]	Samples[2]	Whipping cream	Heavy cream
			(min)	
1	Raw	30	1.6[a]	. . .
2	HTST	71	1.9[b]	. . .
3	UHT	21 (28)	2.5[c,d,e] (additives)	2.0[b,c] (additives)
4	UHT	19	2.7[e] (additives)	. . .
5	UHT	15	2.7[e] (additives)	. . .
6	UHT	23 (30)	2.8[e] (additives)	2.3[d] (additives)
6	UHT	(30)	. . .	3.4[f] (no additives)

[a,b,c,d,e,f]Whipping times with different superscripts are statistically different ($P<.05$).

[1] RAW = Raw product.

[2] Numbers in parentheses refer to sample numbers for heavy cream.

TABLE 2. Mean maximum overrun for different whipping creams.

Processor	Method[1]	Samples[2]	Overrun	
			Whipping cream	Heavy cream
			(%)	
5	UHT	15	143[a] (additives)	...
2	PAST	71	158[b]	...
1	RAW	30	172[c]	...
3	UHT	21 (28)	180[c] (additives)	160[b] (additives)
4	UHT	19	198[d] (additives)	...
6	UHT	23 (30)	216[e] (additives)	141[a] (no additives)
6	UHT	(30)	...	194[d] (additives)

[a,b,c,d,e]Overrun values with different superscript letters are statistically different ($P<.05$).

[1] PAST = Pasteurized; RAW = raw product.

[2] Numbers in parentheses refer to sample numbers for heavy cream.

sor's UHT heavy cream that contained additives (Figure 2). As these creams aged, overrun decreased. The UHT heavy cream without additives exhibited a positive trend ($P<.10$), i.e., overrun increased with cream age. Therefore, both whipping time and overrun were related to cream age, but these relationships appeared to be unique for each processor and product.

To identify additional factors related to volume increase in whipping cream, regression analysis was completed in which overrun was the dependent variable and time to reach maximum overrun was the independent variable. This analysis related whipping time to maximum overrun for many samples, rather than the change in overrun obtained as a single sample of cream was whipped. The analysis revealed that overrun was positively related to whipping time for raw cream, for pasteurized cream, and for one processor's UHT whipping cream (Figure 3). These findings mean that those products that required a longer whipping time reached a higher overrun than those that reached maximum overrun quickly. A negative correlation was found for whipping time and overrun for one processor's heavy cream that contained additives. There was no significant relationship between whipping time and overrun for the other processor's products.

Of what significance are these data? Whipping creams were viewed historically as one of the most troublesome dairy products because

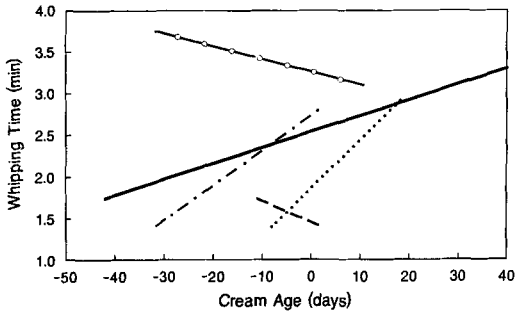

Figure 1. Whipping time required to reach maximum overrun as influenced by the age of the cream. Cream age was determined in relation to retail sell-by-date, which was called 0. Cream types and significance: raw, plant 1 (– – – –), $P<.10$; pasteurized, plant 2 (· · · · ·), $P<.01$; heavy creams, UHT: no additives, plant 6 (–o–o–), $P<.10$; additives, plant 6 (————), $P<.01$; additives, plant 3 (–·–·–), $P<.01$.

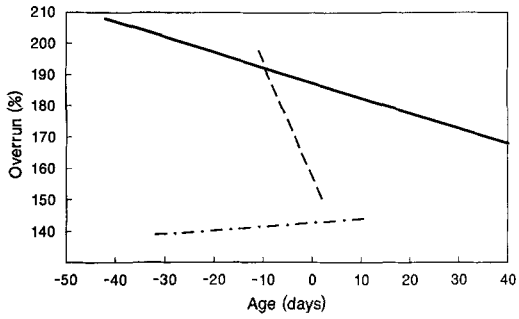

Figure 2. The effect of cream age on maximum overrun. Age is determined in relation to retail sell-by date, which is called 0. Cream types and significance: raw, plant 1 (– – – –), $P<.05$; UHT: heavy cream, additives, plant 6 (————), $P<.01$; heavy cream, no additives, plant 6 (–·–·–), $P<.1$.

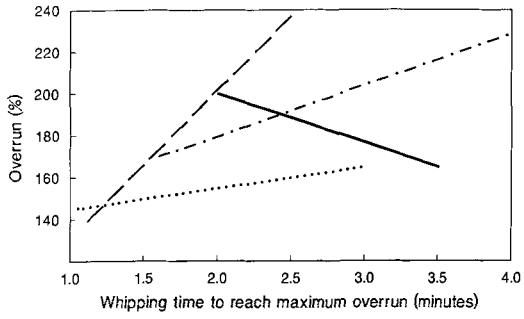

Figure 3. Whipping time required to reach maximum overrun as related to maximum overrun. Cream types and significance: raw, plant 1 (– – – –), $P<.01$; pasteurized, plant 2 (· · · · · ·), $P<.05$; UHT, plant 4 (–·–·–), $P<.01$; heavy cream, additives, plant 6 (————), $P<.01$.

they distressed consumers when they failed to whip or were spoiled before they could be used (9). The results of this study reveal that today's UHT whipping creams' functional qualities vary substantially among manufacturers. These variations could be attributed to differences in pasteurization or homogenization procedures and to the presence of additives.

Creams from those processors that used mono- and diglycerides, polysorbate 80, and carrageenan generally produced the greatest overrun (Table 3). Note that this group of whipping creams included the products with the highest overrun but also one with the lowest overrun. Creams that contained mono- and diglycerides, polysorbates, and carrageenan generally required the longest whipping times to reach maximum overrun (Table 4).

CONCLUSIONS

The UHT creams took about 40% longer to whip than raw and pasteurized creams. Heavy creams whipped in about 20% less time and to a lower overrun than regular whipping creams. Overrun was greatest from UHT products; however, this overrun varied significantly

TABLE 3. Relationship between additives and maximum overrun in whipping cream.[1]

Additives			
None	Carrageenan, dextrose, guar	Mono & Di Gly,[2] Poly-60, carrageenan	Mono & Di Gly, Poly-80, carrageenan
	Overrun (%)		
158[b]	180[c]	198[d]	143[a]
172[c]	160[b] (heavy)		216[e]
141[a] (heavy)			194[d] (heavy)

[a,b,c,d,e]Values with different superscripts are statistically different ($P<.05$).

[1] Samples are whipping cream unless identified as heavy whipping cream (heavy).

[2] Mono & Di Gly = Mono- and diglycerides, Poly = polysorbate.

TABLE 4. Relationship between additives and whipping time required to reach maximum overrun.

Additives			
None	Carrageenan, dextrose, guar	Mono & Di Gly,[2] Poly-60, carrageenan	Mono & Di Gly, Poly-80, carrageenan
		Time (min)	
1.6[a]	2.5[c,d,e]	2.7[e]	2.7[e]
1.9[b]	2.0[b,c] (heavy)		2.8[e]
3.4[f] (heavy)			2.3[d] (heavy)

[a,b,c,d,e,f]Values with different superscripts are statistically different ($P<.05$).

[1] Samples are whipping cream unless identified as heavy whipping cream (heavy).

[2] Mono & Di Gly = Mono- and diglycerides, Poly = polysorbate.

among processors. Greatest overrun among whipping creams (216%) was obtained with creams from a processor that used mono- and diglycerides, polysorbate-80, and carrageenan; lowest overrun (143%) was obtained with creams from a processor that used the same additives.

An important consideration for processors is whether the consumer can identify these differences. This study was not designed to evaluate consumer awareness or preference. We think that consumers can distinguish between the extremes—a cream that reaches maximum overrun after 1.5 to 2 min of whipping and one that requires 3 to 4 min. It is likely that a consumer can also distinguish between a cream that whips to approximately 140% overrun and one that whips to over 200% overrun. Processors who consider changing to UHT should be aware of the differences among these products.

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