Preparation and Evaluation of Chocolate-Flavored Shakes of Reduced Sweetener Content

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ABSTRACT

Initial acceptance by an internal panel of a formulation for a chocolate milk shake limited to 6% sweetener was confirmed in a lunch program at two high schools. The shakes supplied nutrients equal to 237 ml of fluid milk. The 2-d average rating with a 5-point hedonic scale was 4.56 at one school that had never served shakes compared with 4.34 at the other school where commercial shakes with higher sweetener content were served daily. Average scores for both schools fell between the "like slightly" and "like very much" categories. Reduced sweetener shakes were acceptable even to students used to receiving commercial-type shakes at school.

INTRODUCTION

For many years, regulations governing the use of milk in the several child nutrition programs of the USDA Food and Nutrition Service have required that 237 ml of fluid whole milk be served as part of the meal requirements. Present regulations state that 237 ml of fluid milk be offered as a beverage; two varieties of milk must be available, one of which must be unflavored fluid lowfat milk, skim milk, or buttermilk (2).

Because of the nationwide publicity given some school food services for their ability to minimize plate waste through the serving of milk shakes, which have been certified as fluid milk by state or local authorities, there has been strong pressure from other areas to permit the serving of shakes as an allowable alternative to the fluid milk requirement of the type A school lunch. Such an action would add flexibility to the lunch program and perhaps encourage greater participation, because shakes are purportedly more acceptable to older children than milk. The serving of shakes is permitted for *a la carte* school lunches (5).

Many commercial shake mix formulations contain milk fat and milk solids-not-fat (MSNF) equal to those found in fluid whole milk (1); equivalent nutrients supplied in equivalent servings by weight is not a problem. However, shakes frequently contain not less than 10% sucrose as a sweetener; if corn syrups are also used, concentration of added sweetener is even higher (1).

One of the recommended United States dietary goals is to reduce the consumption of processed and refined sugars (10). Because shakes add both sugar and milk fat to the diet, nutritionists might be alarmed at their inclusion in the school lunch program. However, the service of chocolate milk is permitted (3), and chocolate milk contains 5 to 7% added sugar (7).

The purpose of this study was to evaluate the acceptability of special shake formulations containing no more sweetener than that found in chocolate milk. The information gained would aid the Food and Nutrition Service in developing a uniform policy concerning shakes that can be equitably administered throughout the country.

MATERIALS AND METHODS

Materials

A pasteurized skim milk concentrate, containing 25.3% total solids, was prepared from fresh raw whole milk and stored frozen until needed. Fresh pasteurized cream was purchased from a local dairy.

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Low heat, spray process, nonfat dry milk manufactured in January 1978 and packed in 22.7-kg bags was obtained from a local facility where it had been stored as part of the USDA Commodity Credit Corporation operations. Spray-dried sweet cheese whey solids were purchased in 22.7-kg bags from Lehigh Valley Dairy[4] (Allentown, PA). High fructose corn syrup was Corn Sweet 90 donated by Archer-Daniels-Midland (Decatur, IL); it contained 80% total solids and 72% fructose. Sucrose used was Domino brand. Frodex 42 dextrose equivalent (DE) corn syrup solids were obtained from American Maize Company (Hammond, IN).

Natural process cocoa powder, containing 10 to 12% fat, was purchased from US Cocoa Corporation (Pennsauken, NJ). Dutch process cocoa powder was #2 ICM 10 to 12 Red Dutch and was supplied by a local dairy.

Two stabilizers, designed especially for use in shakes dispensed from automatic milk shake machines, were obtained from the Germantown Manufacturing Corporation (Germantown, PA). Both stabilizers contained cellulose gum, gum karaya, salt, carrageenan, and sodium bicarbonate standardized with dextrose. In addition, one stabilizer contained monoglycerides and diglycerides as emulsifiers. Vanilla extract was Virginia Dare brand fourfold concentrate natural vanilla and vanillin.

Formulations

All formulations evaluated at Eastern Regional Research Center (ERRC) were prepared and tested in the dairy laboratory pilot plant by the same general procedure.

Dry ingredients were weighed and blended dry before they were added to the liquid. After thorough mixing, formulations were vat-pasteurized at 71.1°C for 30 min, homogenized double-stage at 175.8-35.2 kg/cm^2, cooled over a surface cooler, and stored at 4°C until used. Vanilla flavoring was added just prior to being frozen and tasted. Lot sizes varied from 9.1 to 18.2 kg.

All shake mixes formulated to contain 22.5% total solids or less were prepared with the stabilizer containing added monoglycerides and diglycerides to acid in maintaining overrun at about 50% at low drawing temperatures. The stabilizer without emulsifiers was added to the commercial-type formulations.

All samples were frozen in a Taylor Freezer Model 452 direct-draw milkshake machine borrowed from the Philadelphia School System. Freezing was carried out in accordance with manufacturers' instructions except that 4.73 L (5 qt) of mix were used to prime the machine instead of 3.78 L (4 qt).

Three pairs of chocolate-flavored shake mixes of reduced sweetness were prepared for sensory evaluation (Formula A, Table 1). All sample pairs were prepared with natural process cocoa powder (1 g/100 g mix) and stabilizer (.3 g/100 g mix). One sample of each pair was sweetened with 6 g/100 g mix added sucrose; the other sample was sweetened with 7.5 g/100 g mix high fructuose corn syrup (6 g/100 g, moisture-free basis).

The first sample pair was formulated with 41.5 g/100 g mix condensed skim milk as the source of MSNF and the second pair with 10.93 g/100 g mix nonfat dry milk. The third sample pair was formulated with 30.6 g/100 g mix condensed skim milk and 2.75 g/100 g mix sweet cheese whey solids; whey was substituted for the condensed skim milk at 25% of MSNF, the maximum permitted in ice cream (3). In the formulations containing nonfat dry milk, allowance for 4% moisture was made when the powder was weighed.

The cream used for the three sample pairs contained 40.5% milk fat; 8.02 g/100 g mix were added to yield 3.25% milk fat in the finished mix. The contribution of the cream to the MSNF content was included in calculation of the desired ingredient concentration to be added.

A chocolate-flavored shake mix of reduced sweetness and with a milk fat content of 2% was prepared (Formula B, Table 1). The MSNF content was increased from 11 to 12.25% to compensate for the reduced fat content. The sample was formulated with 12.28 g of nonfat dry milk, 6 g of sucrose, 5.25 g of cream (38% milk fat), 1 g of natural process cocoa powder, and .3 g of stabilizer/100 g of mix. Vanilla flavoring (3 ml/L mix) was also added.

Because commercial manufacturers would be more likely to use a Dutch process cocoa

[4] Reference to brand or firm name does not constitute endorsement by the US Department of Agriculture over others of a similar nature not mentioned.

TABLE 1. General formulations for chocolate-flavored shake mixes.

Ingredient	Formula A Reduced sweetener	Formula B Reduced sweetener reduced fat	Formula C Commercial
Milk fat, %	3.25	2.0	3.25
Milk solids-not-fat, %	11.0	12.25	11.0
Sweetener, %	6.0	6.0	11.0
Cocoa powder, %	1.0	1.0	1.5
Stabilizer, %	.3	.3	.3
Vanilla flavoring, ml/L	3	3	3
Total solids, %	21.55	21.55	27.05

powder, this ingredient was substituted for natural process cocoa powder in a formluation of reduced sweetness prepared according to Formula A, Table 1. The MSNF was supplied by nonfat dry milk (10.85 g/100 g mix) and sucrose was the sweetener. The cream had been UHT pasteurized and contained 32% milk fat and added microcrystalline cellulose; 10.16 g/100 g mix were added.

To test the reaction of the panel to a shake mix of "normal" sweetness, a commercial-type formulation was prepared (Formula C, Table 1). This mix was formulated with the same ingredients and the same weights of ingredients used in the preceding test except that the sucrose content was increased to 9.0 g/100 g mix, 2.0 g/100 g mix of 42 DE corn syrup solids were added to increase sweetness further, Dutch process cocoa powder was increased to 1.5 g/100 g mix, and the stabilizer contained no emulsifiers. Total solids of the finished mix were 27.05%.

Upon completion of preliminary tests at ERRC, 950 L of a chocolate-flavored shake mix of reduced sweetness (Formula A, Table 1) were prepared by a local dairy under contract with the Food and Nutrition Service for acceptability tests in two Philadelphia high schools. Delivery was made directly to the schools. The shake mix was packaged in 3.8-L cardboard containers; shelf life was given as 10 d. The mix was formulated with sucrose, nonfat dry milk, natural process cocoa powder, cream, and vanilla flavoring. Stabilizer was added in accordance with manufacturers' instructions.

Analytical Methods

Although data are not shown, all shake mix formulations were tested for total solids and total fat by standard procedures (6). To ensure adherence to the specified formulation, the sample prepared commercially was also checked.

Overrun was measured on all samples upon completion of the first freezing cycle by drawing 474 ml of frozen mix and weighing on a Pelouze ice cream scale, Model Y-80, calibrated to read percent overrun directly. Drawing temperatures were measured at the same time.

Meltdown was measured by drawing frozen mix into a 300-ml tall form beaker. If the sample held a constant temperature for 10 min, meltdown characteristics were considered adequate. The time required for separation of melted mix into the bottom of the beaker was also noted.

Stability of the chocolate-flavored shake mix of the reduced sweetness (Formula A, Table 1) was evaluated in terms of texture, drawing temperature, and overrun characteristics during an "all-day" freezing and dispensing operation. Samples were drawn for evaluation once every hour for 6 h. Ingredients used in preparation of the mix were nonfat dry milk, sucrose, cream, natural process cocoa powder, stabilizer with emulsifiers, and vanilla flavoring.

Taste Panel Operations

For sensory evaluations at ERRC, a nine-point hedonic scale was used for all ratings (8).

Only one shake per day was evaluated because of equipment limitations.

A consumer-type taste panel was gathered from ERRC personnel; judges consisted mainly of college students working as cooperatives in the laboratories, some of the younger secretaries, and other young ERRC personnel. The size of panels varied from 23 to 31 judges out of a pool of 39, consisting of 16 women and 23 men. Ages ranged from 18 to 28; average age was 21.4 yr.

Judges reported directly to the dairy pilot plant where the milkshake machine was set up so that all judges would receive freshly drawn samples. Samples were served in 148-ml cups with spoons or straws, whichever was preferred by the judge. No attempt was made to isolate judges during the tests.

All data obtained were analyzed by ANOVA and the means separated by Duncan's multiple range test. Because only one shake per day was tested, comparisons between treatments were made on the assumption that day-to-day variability among panelists was negligible.

Two suburban high schools in the Philadelphia area were selected for evaluations of the chocolate-flavored shake for reduced sweetness. One school had never served shakes as part of the school lunch program; because this school had no milk shake machine, the machine used at ERRC was moved to the school for tests. The other school had commercial-type shakes available daily.

A modified hedonic score sheet was developed for use in the schools (Figure 1); samples were rated on a five-point hedonic scale because the nine-point scale was judged by Food and Nutrition Service personnel to be too complicated. In addition, students were asked whether they would choose the shake again; space was provided for any other comments they wished to make.

Shake servings of 355 ml each were dispensed during the lunch periods to 10th and 11th grade students on 2 successive d in each of the two high schools. Ninth grade students were also served shakes at one school. Shakes were placed in the cafeteria lunch line adjacent to the refrigerated case where fluid milk was stored. Students were permitted free choice of either a shake or fluid milk with their lunch. Evaluation sheets were distributed by the cashier and collected by ERRC and Food and Nutrition Service personnel. Approximately 200 students were served in each school daily. Both schools had *a la carte* snack bars where shakes were also available.

MILK SHAKE EVALUATION

PLEASE CHECK (✓) THE PHRASE WHICH TELLS HOW YOU FEEL ABOUT THE MILK SHAKE.

LIKE VERY MUCH	
LIKE SLIGHTLY	
NEITHER LIKE NOR DISLIKE	
DISLIKE SLIGHTLY	
DISLIKE VERY MUCH	

WOULD YOU CHOOSE THIS TYPE OF SHAKE AGAIN?
YES NO UNDERSCORE.

OTHER COMMENTS:

Figure 1. Five-point hedonic rating sheet used for evaluation of milk shakes in the public high schools.

Because of the short lunch periods, it was necessary to draw about three-fourths of the shakes to be served beginning about 45 min in advance of each lunch period. Drawn samples were held in freezers until just before serving.

Data obtained were analyzed by ANOVA and Duncan's multiple range test.

RESULTS AND DISCUSSION

Two general criteria were established as guidelines for shake formulations so this product could be considered for use as a possible alternative to fluid milk in the school lunch program. First, the shake could contain no more added sweetener than that found in chocolate milk (6% by weight) and, second, the nutrient content of a serving of shake had to be equivalent to that of 237-ml (.5 pt) of milk. The shake also had to be appealing to the young people for whom it was intended.

Because the criteria required that no more than 6% sweetener could be used in the formulation, no sweetener-containing flavorings could be added to the shake mix or to the frozen shake. Chocolate syrup would increase the

sweetener content of the shake as would any other syrup-based flavoring. Therefore, the formulation selected had to be a flavored direct-draw type shake mix to be frozen without the addition of any other ingredients in a special freezer designed to dispense a desired serving with a correct shake consistency.

The reduced sweetener formulation chosen for extensive testing (Formula A, Table 1) meets both criteria. Flavoring was added by incorporation of 1% cocoa powder into the mix formula for the chocolate shake. The same formula without the cocoa powder sufficed for the vanilla or strawberry-flavored shake mixes. The maximum permitted sweetener content could be maintained because the freezer operator had nothing to add.

With this formulation, nutritional equivalency presented no problem, provided the overrun was carefully controlled in the finished shake. At 50% overrun, a 355-ml serving would yield 237-ml of air free shake. If the formulation contained less than 3.25% milk fat, it might be deficient in fat-soluble vitamins unless it was fortified in the same way as required for lowfat milk (3).

A concentration of 11% MSNF in the formulation would provide nutritional equivalency even if 25% of the serum solids were to be replaced by sweet cheese whey solids (Table 2). The shake would still supply more proteins and other water-soluble nutrients than milk on an equivalent weight basis. This would not be the case if the MSNF content of the shake mix was 10% or below and a 25% substitution of sweet whey solids was made.

Limitation of the added sweetener content to 6% in the shake mix formulation significantly reduced calories per serving compared with commerical shake mix formulation. When calculated on an equivalent weight basis of 244 g, the weight of 237-ml of fluid whole milk (9), a serving of chocolate-flavored shake mix formulation with 6% added sucrose would contain 230 kcal compared with 281 kcal for a commercial-type shake mix with 11% added sweetener. An equivalent serving of whole chocolate milk contains 203 kcal. The calorie content of the shake can be reduced further (to 214 kcal/serving) when fat content decreased to 2%. Even though shakes of reduced sweetness supply more calories per serving than chocolate milk, the additional calories in the shakes are supplied by the MSNF and not be carbohydrate in the form of sucrose or other sweetener.

Several ingredient variations were tested for

TABLE 2. A comparison of selected nutrients in 100 g of whole milk and reduced sweetener shake mix formulations.[1]

Nutrient	Whole[2] milk	Shake mix formulations: MSNF[3] = 11% skim milk solids	Shake mix formulations: MSNF = 8.28% skim milk solids, 2.75% sweet whey solids
Protein, g	3.29	3.98	3.34
Fat, g	3.34[4]	3.25	3.25
Carbohydrate, g	4.66	5.72	6.34
Ash, g	.72	.87	.88
Added carbohydrate, g	...	6.0	6.0
Calcium, mg	119	138	126
Phosphorus, mg	93	106	106
Riboflavin, mg	.16	.27	.19
Vitamin A,[5] IU	126	123	123

[1] Calculated from Posati and Orr (9).

[2] If vitamin D is added, each 946 ml contains 400 IU.

[3] MSNF = Milk solids-not-fat.

[4] Lipid value based on all-market average.

[5] Value based on data for butter.

acceptability in the reduced sweetener shake formulation, because we decided that any ingredient permitted in ice cream could be used except artificial coloring. This would give commercial manufacturers the widest latitude possible in choice of ingredients yet ensure an all-dairy product.

The critical question to be answered was whether 6% sweetener in the shake mix formulation was sufficient for acceptance. Because of its greater sweetness, high fructose corn syrup was substituted for sucrose in chocolate-flavored mixes formulated with condensed skim milk solids, condensed skim milk solids and sweet cheese whey solids, or nonfat dry milk as the source of MSNF. Use of nonfat dry milk as the source of MSNF reduced cost, because USDA price support operations have resulted in considerable quantities of stored surplus nonfat dry milk. Substitution of sweet whey solids for up to 25% of the MSNF not only reduced costs but also had a favorable effect on sweetness because of its additional lactose.

Chocolate-flavored shakes prepared with fresh fluid skim milk concentrate as the source of MSNF received the highest hedonic ratings of any of the reduced sweetener formulations, whereas samples prepared with nonfat dry milk received the lowest (Table 3). The shake of "normal" sweetness received a higher score than any of the reduced sweetener shakes. The score was significantly higher ($P<.05$) than the scores received by the reduced sweetener shakes prepared with nonfat dry milk and sweetened with sucrose or high fructose corn syrup and the shake prepared with 2% milk fat; but the score for the "normal" shake was not significantly different from the other five chocolate-flavored shake mixes tested.

There were no significant differences in score attributable to the substitution of either whey solids or nonfat dry milk for the skim milk concentrate in the reduced sweetener formulations (Table 3). There also was no significant difference in score between pairs of samples because of the difference in sweetener.

TABLE 3. Acceptability on a nine-point hedonic scale of chocolate flavored shake mixes formulated with varied ingredients.

Ingredient	Average hedonic rating	Overrun
		(%)
	Reduced sweetness	
Fluid condensed skim milk		
Sucrose	7.82[ab]	58
High fructose corn syrup	7.96[ab]	55
Fluid condensed skim milk		
Plus whey solids		
Sucrose	7.74[ab]	70
High fructose corn syrup	7.63[ab]	55
Nonfat dry milk		
Sucrose	7.54[b]	55
High fructose corn syrup	7.28[b]	68
Nonfat dry milk, sucrose		
Dutch process cocoa powder	7.65[ab]	48
Nonfat dry milk, sucrose		
2% milkfat	7.41[b]	46
	Normal sweetness	
Nonfat dry milk		
Sucrose plus 42 DE[1]		
corn syrup solids	8.28[a]	50

[a,b]Means associated with different letters are significantly ($P<.05$) different.

[1] Dextrose equivalent.

On the basis of these results, the remaining formulations tested were prepared with nonfat dry milk and sucrose because of the greater ease in handling dry ingredients. Replacement of the natural process cocoa powder with Dutch process cocoa powder had no significant effect on acceptability. The low fat chocolate-flavored formulation was rated equally acceptable even though the body was coarse; obvious large crystals were present in the drawn material after 30 min in the freezing compartment of the milkshake machine. If a lowfat reduced sweetener formulation is desired, additional work would be necessary to improve body and texture; further increase in the MSNF might be sufficient. All scores fell between the "like moderately" and "like very much" categories of the hedonic rating sheet used, showing a high degree of acceptance for each of the chocolate flavored formulations containing reduced levels of sweetener.

Drawing temperatures of all samples varied from −2.8 to −1.7°C; shakes containing high fructose corn syrup had the lower drawing temperatures. All drawn samples held their temperature for 10 min; however, the time required to form a melted layer was halved (from 23 to 11 min on the average) if whey solids were used as an ingredient in the shake formulation. Some trouble was encountered in obtaining the desired overrun of 50% in some cases (Table 3) because of mechanical difficulties with the milkshake machine.

Near the end of the tests conducted at ERRC, a questionnaire was submitted to the judges to gain some information about how frequently they consumed shakes, what flavors were liked, and how they thought the reduced sweetener shakes compared with commercial shakes. Of the 32 replies, 28 judges claimed they ordered shakes occasionally; first choice of flavors was evenly divided between vanilla and chocolate. Sixteen of the 32 respondents indicated they thought the experimental formulations were the same as commercial shakes.

Based on the foregoing information, the full-fat, chocolate-flavored shake mix of reduced sweetness (Formula A, Table 1) was chosen for further testing in the schools. However, it was necessary to gain some additional information about the physical stability of the formulation before the tests were carried out.

The total solids in the basic reduced sweetener formulation (Formula A, Table 1) were low, suggesting that the mix might lack stability in the freezer and become progressively coarser with time. Stability of the chocolate-flavored mix with 21.5% total solids was tested; the mix was held in the freezing compartment of the milk shake machine for 6 h. The results showed that 2 h was the maximum holding time for this formulation in the freezing compartment without addition of mix if a shake of acceptable texture was to be obtained (Table 4). Both drawing temperature and overrun decreased slightly with time.

Although data are not shown, the capacity of the milkshake machine to deliver shakes of acceptable texture with this formulation was also evaluated. If 355-ml servings were drawn from the machine as rapidly as possible, after 5 min, the drawing temperature had increased from −2.8 to −1.4°C, the overrun decreased to 40%, and the shake was almost fluid. Under these conditions, the mix had insufficient time

TABLE 4. Stability of a chocolate flavored shake mix of reduced sweetness with time.

Time	Drawing temperature	Overrun	Texture
(h)	(°C)	(%)	
Initial	−2.2	50	Smooth
1	−2.2	48	Smooth
2	−2.2	50	Slightly coarse
3	−2.8	52	Coarse
4	−2.8	60	Coarse, watery
5	−3.3	45	Icy
6	−2.8	40	Very icy

TABLE 5. Acceptability on a five-point hedonic scale of a chocolate-flavored shake mix of reduced sweetness by high school students.

Item	No. of judges	Average rating
School A (Never served shakes)		
Day 1	174	4.49[ab]
Day 2	181	4.63[a]
School B (Commercial shakes available daily)		
Day 1	173	4.32[b]
Day 2	150	4.37[b]

[a,b]Means with different letters are significantly ($P<.05$) different.

to freeze. Shakes of acceptable texture and overrun were obtained when drawn at a maximum rate of 2/min.

The change in stability of the mix after 2 h in the freezer was not a serious defect, because in the school lunch situation, protracted stability would not be required. A lunch period is brief, usually 45 min or less; during that period, a large number of shakes would be served, probably a number greater than the capacity of the machine. Therefore, servings would have to be drawn in advance and kept cold until the rush period. Under these conditions, the low solids formulation would produce a shake of acceptable consistency.

A brief test was also conducted to determine if leftover shake mix could be removed from the milk shake machine, melted, and reused the following day after overnight storage in the cold. Results showed no effect on drawing temperature and overrun; the texture was slightly coarse but still acceptable. This suggests that the mix prepared according to the reduced sweetener formulation had the necessary stability to enable it to be refrozen and served the next day, provided it is handled in a sanitary manner and kept refrigerated between servings.

Acceptance ratings of the chocolate-flavored shake mix resulting from the 2-d tests were high, even at the school at which commercial shakes were available (Table 5). The students who selected the shake as part of their lunch rated the product without any knowledge of how this shake differed from the usual ones. Ratings at school A, where shakes were not available daily, were slightly higher because more students rated the shake in the "like very much" category of the hedonic rating sheet used.

Statistical analyses showed that the shakes served at school B, received a significantly ($P<.05$) lower mean score of 4.34 (323 responses) compared with a mean score of 4.56 (355 responses) at school A. However, the values were judged not to show any practical significant difference because the scores given were discrete values. Scores at both schools fell between the "like slightly" and "like very much" categories, indicating that the reduced sweetener shake was acceptable even to students who had shakes of "normal" sweetness available every day.

Not all the students answered the question of whether they would choose a reduced sweetener shake again. Of those that responded, 94% at school A and 89.5% at school B indicated that they would choose the shake again.

A satisfactory milk shake can be easily prepared that supplies all the nutrients of whole milk. Limitation of the added sweetener to 6%, equivalent to that found in chocolate milk, reduces calories per serving significantly from those in commercial formulations. Variation of ingredients in the formulation did not affect flavor acceptability of chocolate shakes. If a reduced fat formulation is desired, additional work would be necessary to improve body and texture of the finished shake. Based on the results of tests in two high schools, the

reduced sweetener, chocolate-flavored formulation proved very acceptable, even to a group accustomed to receiving commercial shakes of normal sweetness. It is highly likely that a shake of reduced sweetness that supplies all the nutrients of whole milk could be successfully introduced into the school lunch program as an alternative means of meeting the milk requirement of the type A school lunch.

Future developments could include increased sweetness of the shakes without increased added sweetener. With enzymatic lactose hydrolysis becoming an accepted and efficient procedure, additional sweetness, equivalent to perhaps as much as 1% sucrose, could be contributed by lactase-treated milk and whey solids (4). Use of the sweeter milk solids might also permit a reduction in added sweetener while maintaining the same sweetness.

Different stabilizers were not tested in this study, but some stabilizer combinations might impart different body and texture characteristics. Because different physical attributes of a product could aid in gaining a competitive edge, stabilizers remain an option for the mix manufacturer to investigate.

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