EFFECT OF MILK FAT MIX PRODUCTS ON QUALITY, CONSUMER PREFERENCE, AND COST OF ICE CREAM AND ICE MILK PRODUCTS

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INTRODUCTION

Along with population increases, consumption of frozen desserts has increased consistently over the past 15 to 20 years, with ice cream and ice milk showing the largest increases. According to estimated figures, all frozen dessert products except mellorine showed production increases in 1968 (16). In 1968, overall frozen dessert consumption reached a new high of 1.18 billion gallons with an estimated value in shipments for ice cream and frozen desserts of 1.19 billion dollars (26). Ice cream production increased five percent over 1967 and at a total production of 7.81 million gallons accounted for 66.2% of total frozen dessert production. In 1968, ice milk at a production of 2.56 million gallons was up four percent over the 1967 production and accounted for 21.7% of the total frozen dessert production. Mellorine-type frozen desserts which are currently legal in thirteen states accounted for 4.3% of the total frozen dessert production (2,16). In 1968, their total production was 0.51 million gallons, a decrease of six percent from 1967 (26).

Large amounts of milk solids are used annually in ice cream and ice milk formulations with milk fat being the most expensive dairy ingredient. The need by processors for a more economical and dependable source of milk fat, especially during recurring periods of shortages, becomes more acute as frozen dessert production increases.

The total raw milk production in the U. S. in 1968 was about 117.3 billion pounds, of which 10.9 billion pounds were used in the manufacture of ice cream and related products. In addition, approximately 2.0 billion pounds of milk in the form of other manufactured dairy products were used. This gave a total of 12.9 billion pounds milk used in the production of frozen dairy products in 1968 (26).

Sources of milk fat for manufacture of frozen desserts are fresh cream, whole milk, butter, frozen cream, and milk fat mix (MFM) products. MFM products are defined (6) as blends of milk fat with sucrose alone or a blend of sucrose, and milk solids. Large amounts of imported MFM products recently were used because of their availability and cost advantage.

This greater demand for milk fat by the frozen desserts industry partly accounted for the recent increased usage of imported MFM products. In 1966, 106 million pounds were imported into the United States primarily for use in frozen desserts. Prior to the Presidential Proclamation of July 1967, MFM products were non-quota items with no limitations on their sucrose content. This Proclamation limited MFM products to a total of 2.58 million pounds in 1967, a reduction of 97.5% from the 106 million pounds imported in 1966. This limitation on imports created a market for surplus milk fat produced in the U. S. Currently, fresh cream is the principal source of milk fat for frozen desserts. Other sources of milk fat can be used as effectively by ice cream processors if they were readily available at an economical cost.

As demonstrated by foreign processors, MFM products can be economically produced and shipped long distances. If good quality MFM products were manufactured domestically, frozen dessert processors might use them as a supplemental source of milk fat during periods of shortage. Information showing advantages such as price and quality relationships could encourage continued use of domestically-produced MFM products.

Because of the significance and impact of imported MFM products on the dairy industry, this study was undertaken to obtain more information on the use of MFM products in selected frozen desserts.

The specific objectives of this study were: a) to determine the effects of MFM products on quality, relative consumer preference and cost in the manufacture of ice cream and ice milk products containing different levels of fat; and b) to ascertain recommendations needed for continued use of MFM products in ice cream and ice milk products.

REVIEW OF LITERATURE

Butterfat mix products originally were blends of milk fat and sucrose (34). However, these products now include blends of milk fat with sucrose and milk solids-not-fat (6,40), and in this study are referred to as milk fat mix (MFM) products.

The use of MFM or similar products in ice cream is not new. Frozen cream with added sucrose was used in the 1930's (25,31). MFM products have been available in this country on a limited scale for more than 15 years.

Milk production in the United States dropped 3.5 billion pounds to a total of 120 billion pounds in 1966 (10,29). As a result, shortages of milk fat developed; prices advanced for milk and milk products, large amounts of MFM products were imported from Europe during 1965-67. The use of imported MFM had a great impact on the frozen desserts industry, due mainly to their cost advantage. A renewed interest in MFM products developed during 1965-67 even though they were not new as ingredient sources of fat in frozen dessert formulations.

Dairy imports have been limited since 1953 by authority of Section 22 of the Agricultural Adjustment Act of 1933 (22,29). Quotas were established, however, only on specifically defined dairy products such as Cheddar cheese and butter. Limitations were not established on other imported dairy products. To get around the 1953 U. S. import quota, milk fat was imported as butteroil, frozen cream, and as milk fat and sugar mix products.

In 1966, the U. S. Tariff Commission placed a quota of 1.2 million pounds per year on butteroil. Following the quotas restricting the flow or importation of butteroil, MFM products immediately began to appear. Controls were established next under provisions of Section 14.6 (A) of the Customs Regulations, which states, "where there is a possibility of products being imported, to be sold at less than fair market value, within the meaning of the Anti-Dumping Act of 1921 amended, the Department of Treasury, Bureau of Customs, will act on complaints received, to ensure that either such products do not enter, or that the price is raised sufficiently so that the domestic structure is not undermined (10)."

The importation of MFM products were made available when, under provisions of the Customs Act, importation was permitted for a product having 44 percent milk fat or less and permitting a sucrose content between 50 and 60 percent (15). MFM products not only allowed circumvention of the quotas on butter and butteroil, but (because of the rapid growth and usage of this product) it also circumvented the U. S. Sugar Act and its quotas.

In July of 1966, the U. S. Secretary of Agriculture limited the importation of milk fat and sucrose mixtures to a maximum of 25 percent on the sucrose content, so that the U. S. sugar quotas would not be violated. The importers again circumvented these regulations by altering the composition of the MFM products by reducing the sucrose percentage and adding nonfat dry milk (NDM) (6,22).

In order to curb the upsurge of imports, the President of the United States, by Proclamation of July 1, 1967, placed quotas on a number of dairy products for the first time. Under this Proclamation, dairy imports were reduced from 4.3 billion to about one billion pounds milk equivalent. This reduction brought imports to less than 1% of domestic milk production, which was about 120 billion pounds annually (1).

Imported MFM products were restricted from 106 million pounds to 2.58 million pounds annually. This is approximately the 1961-65 average before the 1966 surge of imports began (1,17).

The composition of imported MFM's have varied with provisions of the U. S. Customs Act. Before any provisions were made, these MFM products had a composition of 44.0% milkfat and approximately 56.0% sucrose. Prior to 1966, provisions of the Customs Act permitted importation of MFM products containing 44.0% milkfat or less with no limit on sugar content imposed. The new blends consisted of 44.0% milkfat, 24.0% or less sucrose and 31.0 - 33.0% NDM or 44.0% milkfat, 20.0 - 24.0% sucrose and 21.0 - 26.0% NDM. These MFM products contained approximately 1.0% moisture if made from butteroil and 10.0% moisture if made from butter (Table 1).

The MFM products are packaged in even weight 50/60 pound portions in polyethelene bags, placed in a cardboard box and stored at 0°F or below for shipment. Manufacture of MFM products is not complicated. Equipment needed is generally found in most dairy plants.

Ice cream manufacturers purchased these imports for several reasons (34): a) There was a decrease in government stocks of milk products in 1966, along with a shortage of milk fat in some forms because of the continued reduction in cow numbers on the farm, however government stocks increased greatly in 1967 due primarily to the increased usage of MFM products; b) a surplus of milk and milk products existed, especially in Europe and the common market countries; c) the United States faces more trade restrictions and price regulations on imported products;

Table 1.

Composition of Imported Milk Fat Mix Products[a]

	Type Product			
	Fat and Sucrose		Fat, Sucrose and MSNF	
Ingredient	Butteroil	Butter	Butteroil	Butter
	(%)			
Milk Fat	43-44	43-44	43-44	43-44
Sucrose	56-57	46-47	23-24	20-24
NDM[b]	-	-	31-33	21-26
Moisture	1.0 max.	10	1.0 max.	10

[a]Ice Cream World

[b]Non-fat Dry Milk

d) a cost savings could be realized on imported MFM products, with possible savings of up to 20% on full ingredient costs; e) MFM products could be easily utilized in the manufacturing process; f) a processor was able to contract his entire season's requirements; and g) these MFM products could be stored for long periods of time.

Availability of milkfat is continually changing. Milkfat has become more readily available and in larger quantities to the ice cream manufacturer. This is because of a declining butter market, the increased use of imitations and the rising sales and consumption of low fat dairy products (28).

Ice cream processors realize that, in the future, they will face rising ingredient costs. The expanding ice cream and ice milk industry has made it necessary to store excess milkfat for use in times of shortage and during periods when the price is unfavorable (28). Milkfat can be stored as butter, butteroil, frozen cream, plastic cream, frozen MFM products, and condensed milk (28). In the late 1940's, Bell of the United States Department of Agriculture advocated storage of milk products for extended periods of time to provide processors with readily available supplies of milkfat during periods of shortage and higher prices (12,13,14).

During the past decade (24) per capita consumption of milk fat in beverages dropped three percent. However, total milk fat consumption decreased 23 percent, and MSNF consumption increased 20 percent. The use of milk fat in ice cream and ice milk continues to increase.

While the over-all consumption of all types of fat continues to increase, the consumption of milk fat continues to decline for these reasons: a) cheaper sources of vegetable fats are available; b) claims of some influential people that milkfat is high in cholesterol content and is composed of saturated fatty acids, both of which allegedly effects the health of the consumer; and c) effective advertising by competitors. In the future, competition will have to be based on novelty and innovation, rather than the price, if milk fat is to maintain its market. New uses are needed for milk fat. Modification and new technology can be applied to milk fat to develop new products (24). In this way the fabrication of new specialty products with specific properties can be made to meet a variety of consumer demands.

One way milkfat can be prepared for use in ice cream and ice milk is to convert it to butteroil. Products similar to butteroil have been prepared for centuries in Egypt, India, and countries of the Middle East. These products are respectively called Samn, Ghee, and Maslee. Butteroil was first made by a process known as "boiling-off" (18). The origin of this process is not known. Later, centrifugal methods were used in the production of butteroil (37).

In the U. S., butteroil is processed directly from cream (37). Special separators are used that will yield butteroil of 90-95 percent fat. The butteroil is reseparated, heated under vacuum, steam-distilled and cooled in a vacuum chamber. This procedure is limited in use because of its complexity and the need for expensive equipment. The most economical and efficient method of preparing butteroil is by de-emulsification of cream (37). The equipment needed in this process is a vat equipped with an agitator and a cream separator. Incoming milk is agitated, heated and then run through a cream separator. The cream portion is developed by using surface-active agents (38) to de-emulsify the cream. The developing oil layer is then separated from the serum by siphoning, draining or decantation. High fat creams are recommended because they require less agent for de-emulsification and yield less serum. To insure that the de-emulsification process is complete, increase the temperature and/or prolong the holding time of the cream-agent mixture.

Anhydrous or dry milk fat is another source of fat which can be used in ice cream and ice milk products. This dry milk fat is made only from high quality fresh sweet cream. The cream is heated to 170°-190°F, separated to contain 80% fat, run through a homogenizer into a continuous type settling tank. A product containing approximately 98% fat and 2% moisture is secured. By centrifuging, a dehydrated milk fat is obtained (32).

Increased use of concentrated milk fat products in frozen desserts appears favorable. Arbuckle (9) _et al._ used a special heat-treated milk fat (HTMF) that was developed by USDA. This fat provided satisfactory flavor characteristics (9), which can be used in the production of ice cream and ice milk. Products were prepared using HTMF heated to five different temperatures: a) 230°F; b) 248°F; c) 266°F; d) 284°F; and e) 302°F. These HTMF products were used at the rate of 2 1/2 to 3 percent of the weight of the mix in providing a portion of the fat for the ice milk mix. During a six week storage period, flavor deterioration was less for products made from HTMF than for the control mix. This was because the higher heat treatment of the milk fat prolonged the keeping qualities of the ice cream products by controlling oxidation, thus assuring a better shelf life. The ice cream made from a mix using a milk fat processed at 266°F, had the most desirable flavor characteristics. The HTMF ingredients had no effect on body and texture of the ice cream. The results indicated that HTMF imparted a desirable flavor that was acceptable to the consumer (9). The HTMF products also had desirable storage properties and other characteristics that made them desirable as ingredients for ice cream and ice milk processing.

In further research, Arbuckle (6), has shown that MFM products vary in quality and that these quality aspects are closely related to the characteristics of ice cream made from these MFM products. It was observed that MFM products produced more desirable ice cream when used in combination with cream. MFM products imparted more desirable characteristics to mixes and to the finished ice cream products when they contained sucrose (6). More desirable results were obtained when cream was used to supply 50 percent of the fat in combination with the MFM product. A combination of MFM and cream compared favorably to ice cream made from fresh cream. Therefore, to be used in ice cream manufacturing, MFM products must be of good quality.

Arbuckle and Bell (8) studied the effects of fat sources on the properties of ice cream. Concentrated sweetened cream compared favorably with fresh cream in producing desirable flavor, body and texture characteristics in the finished ice cream. Also, ice cream made with concentrated sweetened cream was superior to ice cream made with frozen cream or butter. Results also showed that concentrated sweetened cream had better storage properties than frozen cream or butter.

Based on the results of earlier work on concentrated milk fat and on the recent use of MFM products, continued use of these products in the frozen desserts industry appears favorable. Processors have found that MFM products can satisfactorily meet seasonal requirements as sources of fat for frozen desserts.

PROCEDURES

Determination of Fat

The amount of fat in ice cream and ice milk was determined by the Banco procedure (3,5), a modification of the A.O.A.C. Babcock Method (20,30). A 9-gram sample was weighed directly into a 9-gram paley, 20% ice cream test bottle and 10 ml of hot water were added. The mixture was heated to 90°C in a water bath, 2 ml of 5 normal NaOH were added, and the contents were mixed until no lumps remained. Then four 5-ml portions of Banco Reagent B were added. The contents were mixed thoroughly with rotary motion and held in a boiling water bath for 15 to 20 minutes. The fat column was brought into the graduated portion of the test bottle by adding 50% methanol-water solution. The bottles were centrifuged for 5 minutes, placed in a tempering bath at 60°C for 4 minutes and a drop of reading oil was allowed to run down the inside of the neck of the bottle to the top of the fat column. The percentage of fat was measured with dividers. When MFM or high-fat cream products were tested, 4.5 g of sample were weighed into a 9-gram 50% paley bottle, 10 ml of hot water were added, and the procedure for testing ice cream was followed, except that the reading of percentage fat was multiplied by two.

Determination of Moisture

Total solids were determined by the Mojonnier Method (20), and the percentage moisture was calculated by subtracting percent total solids from 100% (% moisture = 100% - % T.S.).

Determination of Copper

The copper content of the cream and MFM products was determined by atomic absorption (23). A 15 g sample was charred in a platinum dish and ashed in a muffle oven at 550°C for 5-10 hours. After ashing, the residues were dissolved in 1:1 HCl, evaporated to dryness on electric hot plate, and diluted to standard volume with 0.5 normal HCl. Measurements were made with a Perkin-Elmer model 303 atomic absorption spectrophotometer at 325 mu.

Determination of Iron

The iron content of the cream and the MFM products was determined by a modification of the A.O.A.C. procedure (30). A 15 g sample was weighed into a platinum dish, charred by heating on a hot plate, and heated 5-10 hours in a muffle oven at 550°C to produce a white ash. The ash was dissolved in 1:1 HCl; transferred to a 125 ml separatory funnel; and 5 ml of concentrated HCl, 1 ml of 2% potassium persulfate, and 10 ml of 20% potassium thiocyanate were added. The color was allowed to develop and was extracted with isobutyl alcohol. Optical density was measured with a Bausch and Lomb spectrophotometer at a wavelength of 495 mu, and the concentration of iron was then determined from a previously established standard curve.

Peroxide Values

The peroxide value of the fat of MFM products was determined by a modification of the procedures recommended by Holloway (21). A 2-3 g sample was weighed into a paley bottle, 25 ml of de-emulsification reagent were added, and the mixture stirred until evenly dispersed. The sample was placed in a boiling water bath until the fat separated, then centrifuged for five minutes. Hot distilled water was added to bring the fat column up in the neck of the bottle. The sample was centrifuged again for one minute, and tempered for five minutes in a 50° water bath. The fat sample (0.5 ml) was removed and placed in a 25 ml volumetric flask (duplicate sample and blank). Chloroform-methanol (70:30 v/v) solvent (9.4 ml) was added and the flask was inverted slowly for fat dispersion. One drop each of ferrous chloride and ammonium thiocyanate solution was then added, the sample was slowly inverted 2-3 times and allowed to stand five minutes in subdued light for color development. Optical density was determined at a wavelength of 505 mu. From a predetermined standard curve, the concentrations of the sample and blanks were calculated in terms of net ug of iron per 10 ml. The peroxide value (P. V.), expressed as m. equivalent of oxygen per kg of fat, was calculated:

$$P.\ V. = \frac{\text{net ug iron/10 ml}}{\text{weight of fat in grams x 55.85}}$$

Determination of Protein

Protein determinations were made by a slight modification of the official A.O.A.C. method (30). To a 100 ml Kjeldahl digestion-distillation flask, 0.15 g of sample, 4.0 ml of concentrated sulfuric acid and a Hengar granule were added. This mixture was digested by boiling for four hours, cooled to 20°C, and 20 ml of distilled H_2O were added. After mixing and cooling to 20°C, 20 ml of concentrated NaOH were added, and the mixture was distilled for 10 minutes into a 150 ml beaker containing 20 ml of 2.0% Boric Acid and four drops of indicator. Titration was to the first shade of purple with 0.02 N hydrochloric acid. The percent nitrogen was first determined and from this result the percent protein was calculated.

The percent nitrogen and protein were calculated by the following formulas:

$$\text{Percent Nitrogen} = \frac{\text{ml} \times \text{N} \times 0.014}{\text{g}} \times 100$$

where:

ml = milliliters of standard HCl
N = normality of HCl
0.014 = milliequivalent weight of nitrogen
g = grams of sample used
Percent Protein = % nitrogen x 6.38 (nitrogen factor for milk protein)

Experimental MFM

The commercial butteroil was heated to 120-130°F and 25% sugar was added. This mixture was pasteurized at 160°F for 10 minutes and then homogenized and cooled to 130°F. Eighty p.p.m. of antioxidant and 0.05% sorbic acid were added to retard oxidation and mold growth, respectively (4,11,19,39). The MFM products (experimental and imported) were stored at 50°F and were tempered to 80 to 90°F before incorporating them into the formulas of the ice cream and ice milk mixes (Tables 2,3).

Manufacture of Mixes

Fresh cream, the experimental MFM, and the three different imported MFM products were used in the manufacture of the ice cream and ice milk products. Fifteen experimental batches of ice cream and 15 experimental batches of ice milk were made. All of the mixes were calculated in 90-lb batches, except mixes made with Ernex and Lorex. These mixes were made in 50-lb batches, since a limited amount of these MFM products was available. The ingredients of each ice cream and ice milk batch were mixed in a steam-jacketed vat at 120-130°F, pasteurized at 155°F for 30 minutes, and homogenized at 2500 psi (1st stage) and 500 psi (2nd stage), cooled to 70°F, and put in storage for 24 hours at 40°F. After this period of storage (to age mix), vanilla flavoring was added at a rate of 3 1/2 oz. per five gallon mix.

The ice cream and ice milk mixes were made according to the formulas in Tables 2 and 3. The ice cream mixes contained 10.0%, 12.0%, and 14.0% milkfat (Table 2) and the ice milk products contained 2.0%, 4.0%, and 6.0% milkfat (Table 3). The nonfat constituents (milk solids not fat, sucrose and stabilizer) in the ice cream and ice milk mixes were held constant at the various levels of fat. Only the water level varied with each formulation. The ice cream and ice milk products made with cream as the source of fat were designated as controls and were compared with the products made from experimental MFM (butteroil) and from the imported MFM products.

Freezing and Handling of Mixes

All mixes were frozen in an Emery Thompson Batch Freezer (2 1/2 gallon capacity) to an overrum of 90 percent. The percent overrun was calculated by the formula of Sommer (35) as follows:

$$\% \text{ overrun} = \frac{\text{wt. of mix} - \text{wt. of same volume of frozen dessert}}{\text{wt. of same volume of frozen dessert}}$$

Table 2.

Formulas for Ice Cream Containing Different Levels of Fat

Constituents	Percentage of Mix		
		(%)	
Fat	10.0	12.0	14.0
Nonfat Dry Milk[a]	11.5	11.5	11.5
Sucrose[a]	15.0	15.0	15.0
Stabilizer-Emulsifier[a]	0.3	0.3	0.3
Total Solids	36.8	38.8	40.8

[a]NDM, sugar and stabilizer-emulsifier were constant in all ice cream products. Vanilla flavoring was added at the rate of 3 oz per five gal of mix.

Table 3.

Formulas for Ice Milk Containing Different Levels of Fat

Constituents	Percentage of Mix		
		(%)	
Fat	2.0	4.0	6.0
Nonfat Dry Milk[a]	12.0	12.0	12.0
Sucrose[a]	15.0	15.0	15.0
Stabilizer-Emulsifier[a]	0.5	0.5	0.5
Total Solids	29.5	31.5	33.5

[a]NDM, sugar and stabilizer-emulsifier were constant in all ice milk products. Vanilla flavoring was added at the rate of 3 oz per five gal mix.

After freezing, the products were drawn from the freezer at 22°F, and packaged in half-gallon containers and stored at -10°F until needed for evaluation.

Quality Rating Evaluations

The quality of ice cream and ice milk is judged by rating its flavor, body and texture, melting quality, package, color and keeping quality characteristics. Two experienced judges rated the products for flavor, body, texture, color and melting quality by the procedure of Nelson and Trout (27).

The scorecard suggested by Nelson and Trout was revised (Fig. 1) and used to measure the degree of perfection or quality of a given ice cream or ice milk sample. This scorecard lists the factors contributing to the quality of a product with a numerical value assigned to each factor. These factors add up to a sum of 100 and are arranged on the scorecard in the order of their importance with the sum of the numerical ratings or evaluations acting as a standard for which the quality of the product is measured.

The numerical range for flavor score on the ice cream scorecard is from 31 to 40 (Fig. 1). A product that scores 40 is considered ideal and is not criticized. The body and texture score ranges from 25 to 30 and a product that scores 30 is considered ideal (Fig. 1).

The Nelson and Trout procedure (27) permits the rating of products also for melting quality. Four to five points are allowed for this property with a score of 5 considered ideal and is not criticized. In this study, the factors of color, package and bacteria (Fig. 1) were not

Name ______________________________ Date ______________________

Numerical Ratings	Criticisms	Sample No. 1	2	3	4	5	6	7	8	9	10	Total Grades
Flavor 40	Judges Score											
No Criticism 40	Cooked											
	Lacks Flavoring											
	Too High Flavor											
	Unnatural Flavor											
	High Acid											
	Lacks Fine Flavor											
	Lacks Freshness											
	Metallic											
Normal Range 31-40	Old Ingredient											
	Oxidized											
	Rancid											
	Salty											
	Storage											
	Lacks Sweetness											
	Syrup Flavor											
	Too Sweet											
Body and Texture 30	Judges Score											
	Coarse/Icy											
No Criticism 40	Crumbly											
	Fluffy											
	Gummy											
	Sandy											
Normal Range 25-30	Soggy											
	Weak											
Melting Quality 5	Judges Score											
No Criticism 5 Normal Range 4-5												
Color[a] 5	Allowed Perfect	5	5	5	5	5	5	5	5	5	5	
Package[a] 5	Allowed Perfect	5	5	5	5	5	5	5	5	5	5	
Bacteria[a] 15	Allowed Perfect	15	15	15	15	15	15	15	15	15	15	
Total 100	Total score of each sample											

[a]This item was not considered in this study; allowed perfect in scoring to maintain uniformity in numerical ratings.

Fig. 1. Revised scorecard for ice cream and ice milk products.

being considered, so were allowed a perfect score with no criticism.

Melting quality was determined by placing a sample into a petri dish at room temperature (50° to 68°F) and observing its response to melting. This is usually done while the other qualities are being examined.

All the products were tempered from 5° to 10°F and were rated individually without consultation among the judges.

Preference Testing Procedure

In testing ice cream and ice milk samples for flavor, there are some samples whose differences are obvious and other samples whose differences are not as readily determined. In order to compensate for this difficulty, the "Triangular Taste Test" (33) or odd sample method was found to be most satisfactory in comparing samples which are almost alike. Based on their ability to distinguish between products consistently, 20 voluntary consumer panelists were selected from the secretarial, graduate and teaching staffs in the Department of Dairy Science. Ten persons from this group were used in each triangular taste test. In the Triangular Taste Test, the consumer preference panelist (taster) is served three samples identified only by letters or numbers and is told that two of the samples are identical and the other different. Initially the taster is asked to answer two questions: "Can you detect a difference in the samples?" and "Which two samples are alike?" He is given a consumer preference testing form (Fig. 2) upon which he marks which samples he prefers. A space is also provided on this form for him to describe the difference between the samples if he can. Each panelist is instructed to

TRIANGULAR TASTE TEST

Name ____________________

Date ____________________

Product ____________________

Two samples are alike; one is different. Identify the one or two sample(s) that you like best by placing a check in the appropriate square under the sample number.

Sample No.	1	2	3				
Sample(s) Preferred							

Comments: ____________________

____

Fig. 2. Preference Testing Form

rinse his mouth with water after tasting each product.

A coding system is devised in which the samples are provided in six possible orders, as follows: AAB, BAA, ABA, BBA, BAB, ABB. This test lends itself to statistical analysis in two ways. First, it can be used by an expert panel to determine if a difference exists, and secondly, it can be used by a large number of people to determine consumer acceptability of either or both samples.

Cost Analysis Procedure

Using the formulas in Tables 2 and 3, ingredient costs for ice cream and ice milk mixes were calculated per 100 pounds mix and per one-half gallon of finished product with 90% overrun. The percent savings or loss was also calculated using the control as the base cost.

A procedure similar to Arbuckle's method (7) was used. The cost per pound of each basic ingredient in the mix was determined and the price per pound was multiplied by the amount of ingredients used. The summation of the total costs of all the ingredients in 100 pounds was the total ingredient costs of the mix. From the total cost, the cost of producing one-half gallon of ice cream or ice milk was calculated at a 90% overrun (7) and 21.1 gallons of ice cream can be made from 100 pounds of mix.

The percentage of savings was calculated by subtracting the difference between the prices of a one-half gallon of control and experimental milk fat mix product and then dividing by the ingredient cost of the control (made with cream),

$$\% \text{ Savings or Loss} = \frac{C - E}{C} \times 100$$

where C is the ingredient cost of one-half gallon of control made from cream and E is the ingredient cost of one-half gallon of experimental milk fat mix.

The scope of this study did not consider the influence of processing and distribution costs on price of one-half gallon of ice cream.

RESULTS AND DISCUSSION

Composition

The cream, experimental (butteroil) MFM, and the imported MFM products, Lorex, Ernex and Isex, were checked for flavor before any analytical tests were run on their composition. Both batch A and B cream were found to be slightly cooked in flavor. The comment on the flavor of the experimental (butteroil) MFM was good. The imported products, Lorex and Ernex, were slightly oxidized in flavor. The imported MFM, Isex, had the most undesirable flavor of any of the products. Both oxidized and stale flavors were identified.

The fat content of the cream and MFM products varied from 43.5% to 84.6% (Table 4). The experimental MFM contained the highest fat level of 84.6%.

The fat levels of the Isex and Ernex imported MFM products were within the range of 44.0% or less as was established by provisions of the Customs Act (6). Their fat levels were 44.0% and 43.5%, respectively. The MFM, Lorex, contained 50% fat, which indicated that it was imported before provisions of the Customs Act were established. The percentage of fat in batch A cream was 63.4% and in batch B cream, 54.9%.

The protein content of the cream and MFM products was calculated as percent nitrogen x 6.38 as outlined in the ninth edition of A.O.A.C. manual (30). The protein contents of the cream and MFM products varied widely from 1.1% in cream A to 1.3% in cream B to 0.3% for the Lorex and Ernex MFM products. The imported MFM, Isex, had the highest protein content of 11.8%. This high content of protein was attributed to

Table 4.

Flavor and Composition of Cream and Milk Fat Mix Products

Product	Flavor Comment	Fat	Protein	Sucrose	MSNF	Moisture
		(%)				
Cream A (Control)	Slightly cooked	63.4	1.1[a]	-	3.2	33.4
Cream B (Control)	Slightly cooked	54.9	1.3	-	4.0	41.1
Butteroil - MFM[b]	Good	84.6	-	15.3	-	0.1
Isex - MFM[c]	Oxidized and stale	44.0	11.8[d]	21.0	33.0	2.0
Ernex - MFM[c]	Slightly oxidized	43.5	0.3[d]	56.0	-	0.5
Lorex - MFM[c]	Slightly oxidized	50.0	0.3[d]	50.0	-	0.1

[a]Estimated from percentage of NDM in the cream

[b]Experimental milk fat mix

[c]Imported milk fat mix

[d]6.38 x percent nitrogen

additions of nonfat dry milk (NDM). The experimental MFM protein content was too low to calculate.

All of the imported MFM products contained sugar. The Ernex and Lorex products contained approximately 56.0% and 50.0%, respectively. These contents were high, which means they entered this country before July of 1966, at which time a maximum limit of 25.05% sugar was imposed (22). The cream products did not contain any sugar. The experimental MFM contained 15.3% sugar and the imported MFM, Isex, contained 21.0% sugar (Table 4).

The non-fat solids content of the cream and MFM products were all low, except the Isex, which contained 33.0% MSNF. Isex was the only product in which MSNF was added as part of its blend.

The moisture content varied over a wide range from less than 0.1% for the Lorex and experimental MFM to 41.1% for the cream B products. All other MFM products contained 2.0% or less moisture (Table 4).

The copper levels of the cream and MFM products were measured with a PE-303 (Perkin-Elmer Model 303) by the atomic absorption method and expressed as parts per million (ppm). The results varied from a low of 0.02 ppm for the Lorex to a high of 0.40 ppm for the Isex product. The experimental MFM and the import, Ernex, had copper contents of 0.17 ppm and 0.19 ppm, respectively. The cream product contained 0.21 ppm copper. There was not a good relationship between the copper content of the ingredients supplying fat and flavor quality of 14% ice cream (Table 5).

The iron content of the ingredients (Table 5) varied considerably from a low of 0.33 ppm for the Lorex MFM to a high of 1.13 ppm for

Table 5.

Relationship Between Peroxide Values, Copper and Iron Content of Fat Ingredients, and Flavor of Ice Cream Containing 14 Percent Fat

Fat Ingredient	P.V.[c]	Copper[d]	Iron[f]	Flavor comment
		(ppm)[e]	(ppm)[e]	
Cream A	0.86	0.21	0.93	Slightly cooked
Cream B	0.86	0.21	0.93	Slightly cooked
Butteroil - MFM[a]	1.36	0.17	0.73	Good
Isex - MFM[b]	4.88	0.40	0.77	Oxidized and stale
Ernex - MFM[b]	2.54	0.19	1.13	Slightly oxidized
Lorex - MFM[b]	3.56	0.02	0.33	Slightly oxidized

[a]Experimental milkfat mix

[b]Imported milkfat mix

[c]Peroxide Value - m equivalent of oxygen per kg of fat

[d]Perkin-Elmer Model 303 - atomic absorption method

[e]Parts per million

[f]A.O.A.C. method (Association of Agricultural Chemists)

the Ernex MFM. The experimental MFM and Isex MFM contained 0.73 ppm and 0.77 ppm, respectively. The cream product had the next to the highest iron content at 0.93 ppm. There was not a good relationship between levels of iron in the ingredients supplying fat and flavor quality of 14% ice cream.

The peroxide value (P. V.) of fat in the cream and MFM products was determined from duplicate samples of 14% ice cream (Table 5). The 14.0% ice cream was selected because it was easier to obtain a representative sample of fat from this product.

The P. V. of the fat from cream was lowest at 0.86 and the P. V. of the fat from the experimental MFM product was next lowest at 1.36. The imported MFM products, Ernex, Lorex and Isex, had peroxide values of 2.54, 3.56 and 4.88, respectively.

The cream product had a low P. V. and a good flavor, but was slightly cooked. The experimental MFM with the next lowest P. V. had a very good flavor. The Isex MFM had the highest P. V. and the poorest flavor. The flavor comments were oxidized and stale.

When an oxidized flavor was observed in MFM products (Table 4), this flavor carried over into the ice cream and ice milk products (Table 5). The cream products had a slightly cooked flavor that was also observed in the 14% ice cream products (Table 5). The peroxide value of fat was a good indicator of the quality of ingredients supplying fat in ice cream products.

Quality Rating

Before a "Quality Rating Test" can be conducted by experts who score the ice cream and ice milk for flavor, body and texture, and melting properties, quality needs to be defined. According to Arbuckle (7), the "ice cream that is of high quality is one that is made from good mix ingredients properly balanced so as to produce a desirable composition, along with proper sanitary conditions by quality-minded people." Steinitz (36) collaborates this definition of quality; however, he goes further by stating that "quality is the interrelationship and interaction of many factors," with there being "no single cause or reason for quality in ice cream."

Another type of quality in dairy products is that which is called "eating quality" (36). This type of quality includes all the sensations such as feel, taste, and smell which the judge, taster or consumer experiences when the product is taken into the mouth. Since the essentials that go to make up the "eating quality" of a dairy product cannot be measured by any ordinary chemical or physical means then it stands to reason that sensory evaluation (feel, taste, smell) methods must be used.

The control ice cream products scored perfect for flavor, body and texture, and melting quality in every instance, except at the 10% fat level (Table 6). A slightly cooked flavor was observed in this product and the body and texture defects were slightly coarse and icy.

The ice cream product made from butteroil scored almost perfect (Table 7). Its only criticism was that it lacked freshness at the 10% and 12% fat levels. Body and texture were observed to be slightly weak. The melting quality was good for the ice creams made with cream and

Table 6.

Effect of Levels of Fat on Quality of Ice Cream Made with Cream

Fat[a] Content of Ice Cream	Flavor		Body and Texture		Melting Quality	
	Score	Observation	Score	Observation	Score	Observation
(%)						
10	40.0	Sl.[b] cooked	29.5	Sl.[b] Coarse/Icy	5.0	Good
12	40.0	No criticism	30.0	No criticism	5.0	Good
14	40.0	No criticism	30.0	No criticism	5.0	Good

[a]From fresh cream as the source of fat

[b]Slightly

Table 7.

Effect of Levels of Fat on Quality of Ice Cream
Made with the Butteroil MFM Product

Fat[a] Content of Ice Cream	Flavor		Body and Texture		Melting Quality	
	Score	Observation	Score	Observation	Score	Observation
(%)						
10	39.0	Lacks freshness	29.0	Sl.[b] weak	5.0	Good
12	39.5	Lacks freshness	29.0	Sl.[b] weak	5.0	Good
14	40.0	No criticism	29.5	Sl.[b] weak	5.0	Good

[a]Butteroil MFM product

[b]Slightly

and experimental MFM.

The ice cream made from Ernex scored the highest among the imports in flavor (Table 8). Its main criticism was in flavor, which was oxidized. The Isex (Table 9) and Lorex (Table 10) ice cream products both scored low on flavor. At every fat level they had an old ingredient and oxidized flavor. The body and texture of the Isex and Lorex ice cream products was criticized as slightly weak. The main criticisms of their melting quality were foamy and watery.

The control (cream) ice milk product (Table 11) scored a perfect 40 on flavor at the 2%, 4%, and 6% fat levels with only a slightly cooked flavor. The body and texture of the control ice milk products was slightly coarse and icy. The melting quality was slightly watery at the 2% fat level and foamy at the 4% fat level.

The ice milk products made from butteroil scored slightly higher overall in flavor, body and texture than the control ice milk products (Table 12). This is due to the butteroil imparting a more pronounced flavor at the lower fat levels than does cream.

Of the imports used in the ice milk products (Tables 13 through 15), it was easier to criticize the properties of ice milk at the 6% fat level than at the 2% and 4% fat levels. This is because at the higher fat percentage levels, imports imparted more flavor due to a higher total solids content.

The main criticisms in flavor for all the imported ice milk products, except the Lorex product (Table 14) were that they lacked freshness and had an old ingredient flavor. The Lorex and Ernex imports (Tables 14 and 15) were oxidized at the 6% fat level. All of the ice milk products

Table 8.

Effect of Levels of Fat on Quality of Ice Cream
Made with the Ernex MFM Product

Fat[a] Content of Ice Cream	Flavor		Body and Texture		Melting Quality	
	Score	Observation	Score	Observation	Score	Observation
(%)						
10	38.0	Oxidized	29.5	Gummy	5.0	Good
12	38.0	Oxidized	30.0	No criticism	5.0	Good
14	38.0	Oxidized	30.0	No criticism	5.0	Good

[a]Ernex imported MFM product

Table 9.

Effect of Levels of Fat on Quality of Ice Cream
Made with the Isex MFM Product

Fat[a] Content of Ice Cream	Flavor		Body and Texture		Melting Quality	
	Score	Observation	Score	Observation	Score	Observation
(%)						
10	35.0	Old ingredient, oxidized	29.5	Sl.[b] weak	4.0	Foamy
12	36.0	Old ingredient, oxidized	29.5	Sl.[b] weak	4.0	Foamy
14	36.0	Old ingredient, oxidized	29.5	Sl.[b] weak	4.0	Foamy

[a]Isex imported MFM product

[b]Slightly

Table 10.

Effect of Levels of Fat on Quality of Ice Cream
Made with the Lorex MFM Product

Fat[a] Content of Ice Cream	Flavor		Body and Texture		Melting Quality	
	Score	Observation	Score	Observation	Score	Observation
(%)						
10	37.5	Old ingredient	29.5	Sl.[b] weak	4.0	Foamy, watery
12	35.5	Old ingredient, oxidized	29.5	Sl.[b] weak	4.0	Foamy, watery
14	35.5	Old ingredient, oxidized	29.5	Sl.[b] weak	4.0	Foamy, watery

[a]Lorex imported MFM product

[b]Slightly

Table 11.

Effect of Levels of Fat on Quality of Ice Milk Made with Cream

Fat[a] Content of Ice Milk	Flavor		Body and Texture		Melting Quality	
	Score	Observation	Score	Observation	Score	Observation
(%)						
2	40.0	Sl.[b] cooked	28.0	Sl.[b] coarse/icy, weak	4.5	Watery
4	40.0	Sl.[b] cooked	29.0	Sl.[b] coarse/icy	5.0	Sl.[b] foamy
6	40.0	Sl.[b] cooked	29.0	Sl.[b] coarse/icy	5.0	Good

[a]From fresh cream as the source of fat

[b]Slightly

Table 12.

Effect of Levels of Fat on Quality of Ice Milk
Made with the Butteroil MFM Product

Fat[a] Content of Ice Milk	Flavor		Body and Texture		Melting Quality	
	Score	Observation	Score	Observation	Score	Observation
(%)						
2	40.0	Sl.[b] cooked	28.0	Coarse/icy, weak	4.5	Sl.[b] foamy
4	40.0	No criticism	29.0	Coarse/icy	4.5	Sl.[b] foamy
6	40.0	No criticism	30.0	No criticism	5.0	Good

[a]Butteroil MFM product

[b]Slightly

Table 13.

Effect of Levels of Fat on Quality of Ice Milk Made with the Isex MFM Product

Fat[a] Content of Ice Milk	Flavor		Body and Texture		Melting Quality	
	Score	Observation	Score	Observation	Score	Observation
(%)						
2	39.0	Lacks freshness	29.0	Weak	4.0	Foamy
4	37.0	Old ingredient	29.5	No criticism	4.0	Foamy
6	35.0	Old ingredient (strong)	29.5	No criticism	4.0	Foamy

[a]Isex imported MFM product

Table 14.

Effect of Levels of Fat on Quality of Ice Milk
Made with the Lorex MFM Product

Fat[a] Content of Ice Milk	Flavor		Body and Texture		Melting Quality	
	Score	Observation	Score	Observation	Score	Observation
(%)						
2	40.0	No criticism	29.5	Sl.[b] coarse/icy	3.5	Foamy, watery, low melting resistance
4	40.0	No criticism	29.5	Sl.[b] coarse/icy	3.5	Foamy, watery, low melting resistance
6	38.0	Oxidized	29.5	Sl.[b] coarse	4.0	Sl.[b] foamy, watery, low melting resistance

[a]Lorex imported MFM product

[b]Slightly

Table 15.

Effect of Levels of Fat on Quality of Ice Milk
Made with the Ernex MFM Product

Fat[a] Content of Ice Milk	Flavor		Body and Texture		Melting Quality	
	Score	Observation	Score	Observation	Score	Observation
(%)						
2	40.0	No criticism	29.5	Sl.[b] weak	4.0	Sl.[b] foamy, watery, low melting resistance
4	39.0	Lacks freshness	29.5	Sl.[b] weak	4.0	Sl.[b] foamy, watery, low melting resistance
6	36.0	Old ingredient, oxidized	29.5	Gummy	5.0	Good

[a]Ernex imported MFM product

[b]Slightly

made from imports scored high in body and texture. The only principal criticism on body and texture was slightly weak. The Lorex ice milk product was slightly coarse and icy.

The melting quality of the ice milk made from imported MFM products did not score as high as the ice milk products made from cream and the butteroil MFM. All of the ice milk made from the imported MFM products had melting qualities that were foamy and watery. The Lorex and Ernex ice milk products, in addition, had a low melting resistance.

Relative Consumer Preference

Tables 16 through 28 show the results of relative consumer preference for ice cream and ice milk made from cream and MFM products at different fat levels. The control ice cream products were compared at fat levels of 10% vs 14%, 12% vs 10%, and 12% vs 14% (Table 16). This test was used to determine if a difference between these control products could be determined and at what fat level they were preferred. Most of the panelists correctly identified the difference between these products; however, the panelists preferred the 12% control ice cream over both the 10% and the 14% ice cream. The results show that the medium (12%) fat level ice cream product is the most preferred.

At the 10%, 12%, and 14% levels of fat, comparisons were made between the control ice cream and ice cream made from the experimental (butteroil) MFM product (Table 17). The panelists could not distinguish between these ice cream products, except at the 12% fat level where differentiation was significant ($P<0.05$). A definite preference was not indicated for control ice cream over ice cream made from the experimental

Table 16.

Relative Consumer Preference for Ice Cream
Containing Different Levels of Fat

Comparisons Between:	CIT[b]	IIT[c]	Differentiation Significance	Preference Distribution of Panelists in CIT Tests	
C[a] - 10% vs C[a] - 14%	9	1	$P<0.01$	5 C[a] - 10%	4 C[a] - 14%
C[a] - 12% vs C[a] - 10%	7	3	$P<0.10$	6 C[a] - 12%	1 C[a] - 10%
C[a] - 12% vs C[a] - 14%	7	3	$P<0.10$	6 C[a] - 12%	1 C[a] - 14%

[a]Cream as the source of fat

[b]Correctly identified triangulation

[c]Incorrectly identified triangulation

Table 17.

Relative Consumer Preference for Ice Cream Made with Butteroil as the Source of Fat

Comparisons Between:	Fat Levels	CIT[c]	IIT[d]	Differentiation Significance	Number of Panelists in CIT Tests Preferring: C[a]	B[b]
	(%)					
C[a] vs B[b]	10	4	6	NS[e]	2	2
C[a] vs B[b]	12	8	2	$P<0.05$	5	3
C[a] vs B[b]	14	5	5	NS[e]	2	3

[a]Control ice cream made with cream

[b]Experimental MFM (butteroil)

[c]Correctly identified triangulation

[d]Incorrectly identified triangulation

[e]Not significant

MFM product.

Comparisons were made between the control and Ernex ice cream products at the 10%, 12%, and 14% fat levels (Table 18). At the 10% and 12% fat levels, nine of the panelists correctly identified the difference between these products ($P<0.01$). At the 14% fat level only six panelists correctly identified the difference and four incorrectly identified the difference between these products with no significant difference. Of the nine panelists who could distinguish the difference at the 10% fat level, eight preferred the control product and one the Isex product. At the 14% fat level there was no preference. The results show that the control ice cream product was preferred at the 10% and 12% fat levels.

In Table 19 comparisons were made between the control and Isex ice cream products at the 10%, 12% and 14% fat levels. The panel of ten tasters correctly identified the samples every time, indicating a highly significant difference ($P<0.01$) between samples. At the 10% fat level, a slight preference was indicated for the Isex product over the control (ratio of 6 to 4 in the CIT tests). At the 12% fat level, all ten panelists preferred the control product over the ice cream made from the imported Isex. At the 14% fat level, eight panelists indicated a preference for the control product, and two indicated a preference for the Isex ice cream. The trend was for the panelists to prefer the control ice cream products at the higher fat levels.

In Table 20 comparisons were made between the control ice cream and the Lorex ice cream product at the 10%, 12%, and 14% fat levels. At the 10% and 12% fat levels, nine panelists correctly identified the difference

Table 18.

Relative Consumer Preference for Ice Cream Made
with Ernex MFM as the Source of Fat

Comparisons Between	Fat Levels	CIT[c]	IIT[d]	Differentiation Significance	Number of Panelists in CIT Tests Preferring: C[a]	E[b]
	(%)					
C[a] vs E[b]	10	9	1	$P<0.01$	8	1
C[a] vs E[b]	12	9	1	$P<0.01$	6	3
C[a] vs E[b]	14	6	4	NS[e]	3	3

[a]Control ice cream made with cream

[b]Ernex, imported MFM

[c]Correctly identified triangulation

[d]Incorrectly identified triangulation

[e]Not significant

Table 19.

Relative Consumer Preference for Ice Cream Made with Isex MFM as the Source of Fat

Comparisons Between	Fat Levels	CIT[c]	IIT[d]	Differentiation Significance	Number of Panelists in CIT Tests Preferring: C[a]	I[b]
	(%)					
C[a] vs I[b]	10	10	0	P<0.01	4	6
C[a] vs I[b]	12	10	0	P<0.01	10	0
C[a] vs I[b]	14	10	0	P<0.01	8	2

[a]Control ice cream made with cream

[b]Isex, imported MFM

[c]Correctly identified triangulation

[d]Incorrectly identified triangulation

Table 20.

Relative Consumer Preference for Ice Cream Made with Lorex MFM as the Source of Fat

Comparisons Between:	Fat Levels	CIT[c]	IIT[d]	Differentiation Significance	Number of Panelists in CIT Tests Preferring: C[a]	L[b]
	(%)					
C[a] vs L[b]	10	9	1	$P<0.01$	8	1
C[a] vs L[b]	12	9	1	$P<0.01$	8	1
C[a] vs L[b]	14	10	0	$P<0.01$	10	0

[a]Control ice cream made with cream

[b]Lorex, imported MFM

[c]Correctly identified triangulation

[d]Incorrectly identified triangulation

between these products and at the 14% fat level, all the panelists correctly identified the difference at a significant difference of $P<0.01$. The panelists showed a preference for the control product of 8 to 1 over the Lorex product at the 10% and 12% fat levels. At the 14% fat level, all the panelists preferred the control product. The results show the control ice cream product is preferred at every fat level over the Lorex product.

In Table 21 relative consumer preference for ice cream made with various MFM Products is shown. The results verify that Isex ice cream products were least preferred. The butteroil and Ernex ice cream products were correctly identified in most cases when compared with the other ice cream products. As shown by the preference distribution, no significant preference was indicated when all the products were compared, except that butteroil ice cream was slightly preferred over Ernex ice cream. The butteroil ice cream was preferred by seven of the ten panelists.

The control ice milk products are compared in table 22 at fat levels of 2% vs 4%, 4% vs 6%, and 2% vs 6%. These tests were run to determine which fat level was preferred and if a difference could be determined. The control ice milk products were used since they were preferred in most instances over ice milk products made with imported MFM products. Most of the panelists correctly identified the difference when 2% and 4% and when 2% and 6% fat levels were compared, but there was no significant difference between 4% and 6% ice milk. The panelists indicated a preference for 4% over 2% ice milk and for 6% over 4% ice milk.

Comparisons were made between control and butteroil ice milk at fat levels of 2%, 4%, and 6%. Table 23 shows that at the 2% and 6%

Table 21.

Relative Consumer Preference for Ice Cream Made with Different MFM Products as Sources of Fat

Comparisons Between:	CIT[e]	IIT[f]	Differentiation Significance	Preference Distribution of Panelists in CIT Test:	
I[a] - 10% vs I[a] - 12%	7	3	P<0.10	4 I[a] - 10%	3 I[a] - 12%
I[a] - 10% vs E[b] - 10%	8	2	P<0.05	3 I[a] - 10%	5 E[b] - 10%
I[a] - 10% vs L[d] - 10%	3	7	NS[g]	1 I[a] - 10%	2 L[d] - 10%
E[b] - 10% vs L[d] - 10%	10	0	P<0.01	5 E[b] - 10%	5 L[d] - 10%
B[c] - 10% vs E[b] - 10%	10	0	P<0.01	7 B[c] - 10%	3 E[b] - 10%

[a]Isex, imported MFM

[b]Ernex, imported MFM

[c]Experimental MFM (butteroil)

[d]Lorex, imported MFM

[e]Correctly identified triangulation

[f]Incorrectly identified triangulation

[g]Not significant

Table 22.

Relative Consumer Preference for Ice Milk Containing Different Levels of Fat

Comparisons Between Fat Levels:	CIT[b]	IIT[c]	Differentiation Significance	Preference Distribution of Panelists in CIT Tests:	
C[a] - 2% vs C[a] - 4%	8	2	$P<0.05$	1 (2%)	7 (4%)
C[a] - 4% vs C[a] - 6%	5	5	NS[d]	0 (4%)	5 (6%)
C[a] - 2% vs C[a] - 6%	8	2	$P<0.05$	2 (2%)	6 (6%)

[a]Cream as the source of fat

[b]Correctly identified triangulation

[c]Incorrectly identified triangulation

[d]Not significant

fat levels, six out of ten panelists incorrectly identified the difference between the products. At the 4% fat level, seven out of ten panelists correctly identified the difference. These results show that the panelists had a difficult time determining the difference between these ice milk products, and that there was no significant preference for the control over the butteroil ice milk.

Comparisons were made in Table 24 between control and Ernex ice milks at the 2%, 4%, and 6% fat levels. Most panelists identified a difference between the control and Ernex ice milks. There was a significant difference ($P<0.10$) at the 2% and 4% fat levels and at the 6% fat level ($P<0.05$). Also, preference for the control was indicated at every percentage of fat.

Comparisons were made between the control and Isex ice milk at fat levels of 2%, 4%, and 6%. Table 25 shows that at the 2% fat level there was no significant difference, but at the 4% and 6% fat levels significant differences between products were shown. A preference was indicated for the control ice milk, except at the 2% fat level.

In Table 26 comparisons were made between the control and Lorex ice milk at 2%, 4%, and 6% fat levels. Out of ten panelists who took part in the tests, six correctly identified the difference at the 2% fat level; seven correctly identified the difference at the 4% fat level; and eight correctly identified the difference at the 6% fat level. Also, at every level of fat, preference was indicated for the control. Out of ten, seven panelists preferred the 6% control ice milk.

In Table 27 comparisons were made between 4% ice milk made from the butteroil and imported MFM products. Most of the panelists could

Table 23.

Relative Consumer Preference for Ice Milk Made with Butteroil as the Source of Fat

Comparisons Between	Fat Levels	CIT[c]	IIT[d]	Differentiation Significance	Number of Panelists in CIT Tests Preferring: C[a]	B[b]
	(%)					
C[a] vs B[b]	2	4	6	NS[e]	1	3
C[a] vs B[b]	4	7	3	$P<0.10$	3	4
C[a] vs B[b]	6	4	6	NS[e]	2	2

[a]Control ice milk made with cream

[b]Experimental MFM (butteroil)

[c]Correctly identified triangulation

[d]Incorrectly identified triangulation

[e]Not significant

Table 24.

Relative Consumer Preference for Ice Milk Made with Ernex MFM as the Source of Fat

Comparisons Between	Fat Levels	CIT[c]	IIT[d]	Differentiation Significance	Number of Panelists in CIT Tests Preferring: C[a]	E[b]
	(%)					
C[a] vs E[b]	2	7	3	P<0.10	5	2
C[a] vs E[b]	4	7	3	P<0.10	5	2
C[a] vs E[b]	6	8	2	P<0.05	7	1

[a]Control ice milk made with cream

[b]Ernex, imported MFM

[c]Correctly identified triangulation

[d]Incorrectly identified triangulation

Table 25.

Relative Consumer Preference for Ice Milk Made with Isex MFM as the Source of Fat

Comparisons Between	Fat Levels	CIT[c]	IIT[d]	Differentiation Significance	Number of Panelists in CIT Tests Preferring: C[a]	I[b]
	(%)					
C[a] vs I[b]	2	6	4	NS[e]	2	4
C[a] vs I[b]	4	7	3	P<0.10	7	0
C[a] vs I[b]	6	8	2	P<0.05	7	1

[a]Control ice milk made with cream

[b]Isex, imported MFM

[c]Correctly identified triangulation

[d]Incorrectly identified triangulation

[e]Not significant

Table 26.

Relative Consumer Preference for Ice Milk Made with Lorex MFM as the Source of Fat

Comparisons Between	Fat Levels	CIT[c]	IIT[d]	Differentiation Significance	Number of Panelists in CIT Tests Preferring: C[a]	L[b]
	(%)					
C[a] vs L[b]	2	6	4	NS[e]	4	2
C[a] vs L[b]	4	7	3	$P<0.10$	5	2
C[a] vs L[b]	6	8	2	$P<0.05$	7	1

[a]Control ice milk made with cream

[b]Lorex, imported MFM

[c]Correctly identified triangulation

[d]Incorrectly identified triangulation

[e]Not significant

Table 27.

Relative Consumer Preference Among Ice Milk Products Made with MFM Products as the Source of Fat

Comparisons Between	Fat Level	CIT[e]	IIT[f]	Differentiation Significance	Preference Distribution of Panelists in CIT Tests:	
	%					
I[a] vs E[b]	4	4	6	NS[g]	1 (I[a])	3 (E[b])
I[a] vs L[d]	4	4	6	NS[g]	2 (I[a])	2 (L[d])
E[b] vs L[d]	4	10	0	$P<0.01$	6 (E[b])	4 (L[d])
B[c] vs E[b]	4	8	2	$P<0.05$	5 (B[c])	3 (E[b])

[a]Isex, imported MFM

[b]Ernex, imported MFM

[c]Experimental MFM (butteroil)

[d]Lorex, imported MFM

[e]Correctly identified triangulation

[f]Incorrectly identified triangulation

[g]Not significant

not significantly distinguish between Isex and Ernex ice milks and between Isex and Lorex ice milks. However, all panelists correctly distinguished between Ernex and Lorex ice milks and, between butteroil and Ernex ice milks. A slight preference was indicated for the Ernex ice milk over the Isex and Lorex ice milks. The experimental butteroil ice milk was slightly preferred over Ernex ice milk.

In Table 28, 10% control ice cream and 6% control ice milk are compared. Out of ten panelists, six correctly identified the difference; and all six panelists preferred the 6% ice milk over the 10% ice cream. These results partly substantiate the increasing sales and demand for ice milk products.

Cost Analysis

In the cost analysis of ice cream and ice milk products, the cost per 100 lbs of mix, cost per 1/2 gal. of ice cream and percent savings were calculated for cream and for each of the MFM products. The MFM products used in this study were the experimental (butteroil) and the three imports - Lorex, Ernex and Isex. The costs were calculated and analyzed at the 10%, 12% and 14% fat levels for ice cream and at the 2%, 4% and 6% fat levels for ice milk.

The cost of the ingredients used in this study is presented in Table 29. The current price of milk fat in manufacturing grade cream was \$0.86 per lb at the time of this study. Forty percent cream contains 5.4% MSNF (milk solids not fat), and as a result has a slight advantage in price over butteroil, when used in the same products and at the same basic price. These results are shown in Tables 30 through 35.

Table 28.

Relative Consumer Preference for Ice Cream
and Ice Milk Made with Cream as the Source of Fat

Comparisons Between Fat Levels:	CIT[b]	IIT[c]	Differentiation Significance	Number of Panelists in CIT Tests Preferring C[a]	
C[a] - 10% vs C[a] - 6%	6	4	NS[d]	0	6

[a]Control ice cream and ice milk made with cream

[b]Correctly identified triangulation

[c]Incorrectly identified triangulation

[d]Not significant

The cost of the imported MFM products, Lorex and Ernex, was $0.38 per lb of product, and the cost of Isex was $0.35 per lb product at the plant (Table 29). All the imported MFM products had a cost advantage over the products made with cream or butteroil. The ice cream made with Isex MFM was much cheaper to produce by two to four cents per one-half gallon than ice cream made with the other imported MFM products, (Tables 30 through 32).

The market cost of NDM, sucrose, stabilizer-emulsifier, vanilla flavoring, product package, and water were $0.22/lb, $0.10/lb, $0.60/lb, $15.40/gal., $0.045 each, and $0.001, respectively. When the market cost of the sucrose and NDM in the imported MFM products was considered, the cost per pound of fat in the Lorex, Ernex and Isex was respectively, $0.66, $0.74 and $0.58 (Table 29).

There was a very substantial savings, essentially from the cost of milk fat, when imported MFM products were used as sources of fat in ice cream. The savings were greater at higher fat levels (Tables 30 through 32). A 20.7% saving was realized when Isex was used in manufacture of ice cream containing 14% fat (Table 32).

The saving was greater in the ice milk for every 2% increase in fat (Tables 33-35). Little saving was realized at the 2% level of fat when different fat sources are used (Table 33); however, at the 4% and 6% levels, the savings are more substantial (Tables 34 and 35). Next to Isex, Lorex MFM was the most influential in savings with Ernex showing the least amount of saving over cream or butteroil (Tables 33 through 35).

A cost analysis of ice cream at the 10% fat level is presented in Table 30. The cost per 100 lb mix varies from a low of \$11.83 for Isex to a high of \$14.60 for the butteroil MFM. This caused the cost of 1/2 gal. of 10% ice cream to vary from \$0.2802 for Isex to \$0.3461 for the butteroil MFM. The percent savings were quite substantial, from 18.4% savings when using Isex to a loss of 0.8% when using butteroil MFM as the source of fat. When using the Lorex and Ernex, cost per 1/2 gal. of 10% ice cream was \$0.2987 and \$0.3188, respectively, with a savings of 13.0% and 7.2%. The control ice cream was next to the highest in cost at \$0.3434 per 1/2 gal.

In Table 31 the cost of 12% ice cream is analyzed. The trend is still the same with butteroil 12% ice cream costing \$0.3868 per 1/2 gal. at a loss of 1.1% as compared to the control ice cream. At the same rate, Isex ice cream costs \$0.3084 per 1/2 gal. at a savings of 19.4% over the control ice cream.

In Table 32 the cost of 14% ice cream is analyzed. The cost of ice cream per 100 lb mix made from the butteroil MFM is still running at a higher rate than the control ice cream. In comparing costs, butteroil ice cream at the 14% fat level is still the highest of the MFM products at \$0.4276 per 1/2 gal. and showed a 1.1% loss. Isex ice cream continues to show the lowest cost at \$0.3354 per 1/2 gal. and at a saving of 20.7%.

The trend in the 10%, 12%, and 14% ice cream products is for the butteroil ice cream to be the most expensive, showing a loss at every fat level. Isex ice cream was produced at the lowest cost and showed the highest percent saving. Lorex was the next lowest in cost with Ernex being the highest among the imports in cost.

The cost analysis of ice milk products at the 2% fat level is presented in Table 33. The cost of 100 lb of ice milk mix was less than 100 lb of ice cream mix, mainly because of the lower fat content. Butteroil ice milk mix cost $7.97 per 100 lb as compared to a low of $7.40 per 100 lb of Isex mix. The cost per 1/2 gal. of 2% ice milk varied from $0.1888 for butteroil ice milk to $0.1753 for Isex ice milk. The 2% butteroil ice milk showed a loss of 0.1% when compared to the control ice milk. Isex ice milk had the highest percent saving at the 2% fat level of 7.1%.

The cost analysis of ice milk products at the 4% fat level is presented in Table 34. Butteroil ice milk products at the 4% fat level were highest among the MFM products, per 100 lb mix and per 1/2 gal. ice cream. Butteroil ice milk costs $0.2295 per 1/2 gal. and showed a loss of 0.4% when compared to the control. Of all the products, Isex 4% ice milk was cheapest to produce. It costs $0.2035 per 1/2 gal. at a savings of 10.9% over the control 4% ice milk.

The cost analysis of ice milk products at the 6% fat level is presented in Table 35. Butteroil ice milk costs $11.41 per 100 lb of mix as compared to a low of $9.59 for Isex ice milk at the 6% fat level. The cost varied from $0.2703 per 1/2 gal. ice milk to a low of $0.2281 per 1/2 gal. for Isex. Butteroil ice milk showed a loss of 0.7% when compared to the control 6% ice milk. Isex ice milk at the 6% fat level showed a saving of 15.1% when compared to the control.

The cost trend of ice cream and ice milk products was for the cream and butteroil products to cost more than ice cream and ice milk made from imported MFM products. This study did not take into account labor and distribution costs since they vary from plant to plant.

In conclusion, imported MFM products can be used successfully in the manufacture of ice cream and ice milk products, provided their quality is comparable to fresh, domestic fat sources. They were a less expensive source of fat, providing a substantially higher saving over domestic cream and butteroil per 100 lb of mix and per 1/2 gal. of finished product. The percent saving realized by the use of MFM products in ice cream products are very significant.

Table 29.

Basic Ingredient Costs

Ingredients Used in Ice Cream and Ice Milk Products	Cost	
	Per Pound Product	Per Pound Fat
Cream - 40% B.F., 40 qt. can (wt. 83 lbs)	$0.47	$0.86
Butteroil	0.86	0.86
Isex Milk Fat Mix (Import)	0.35	0.58
Ernex Milk Fat Mix (Import)	0.38	0.74
Lorex Milk Fat Mix (Import)	0.38	0.66
Nonfat Dry Milk Powder	0.22	-
Sucrose	0.10	-
Stabilizer-Emulsifier	0.60	-
Vanilla Flavoring @ $15.40 per gal.	1.97	-
Package @ $0.045 each	-	-
Water @ $0.001 per gal.	-	-

Table 30.

Cost Analysis of 10 Percent Ice Cream Products

Source of Fat	Cost per 100 lbs mix	Cost per 1/2 gal. ice cream	Percent Savings
	(dollars)	(cents)	(%)
Cream (control)	$14.49	.3434	-
Butteroil - MFM[a]	14.60	.3461	0.8 (loss)
Lorex - MFM[a]	12.61	.2987	13.0
Ernex - MFM[a]	13.46	.3188	7.2
Isex - MFM[a]	11.83	.2802	18.4

[a]Milk fat mix

Table 31.

Cost Analysis of 12 Percent Ice Cream Products

Source of Fat	Cost per 100 lbs mix	Cost per 1/2 gal. ice cream	Percent Savings
	(dollars)	(cents)	(%)
Cream (control)	$16.17	.3827	-
Butteroil - MFM[a]	16.33	.3868	1.1 (loss)
Lorex - MFM[a]	13.93	.3299	13.8
Ernex - MFM[a]	14.95	.3541	7.5
Isex - MFM[a]	13.02	.3084	19.4

[a]Milk Fat Mix

Table 32.

Cost Analysis of 14 Percent Ice Cream Products

Source of Fat	Cost per 100 lbs mix	Cost per 1/2 gal. ice cream	Percent Savings
	(dollars)	(cents)	(%)
Cream (control)	$17.85	.4230	-
Butteroil - MFM[a]	18.59	.4276	1.1 (loss)
Lorex - MFM[a]	15.25	.3613	14.6
Ernex - MFM[a]	16.72	.3890	8.0
Isex - MFM[a]	14.16	.3354	20.7

[a] Milk fat mix

Table 33.

Cost Analysis of 2 Percent Ice Milk Products

Source of Fat	Cost per 100 lbs mix	Cost per 1/2 gal. ice milk	Percent Savings
	(dollars)	(cents)	(%)
Cream (control)	$7.96	.1886	-
Butteroil - MFM[a]	7.97	.1888	0.1 (loss)
Lorex - MFM[a]	7.57	.1793	4.9
Ernex - MFM[a]	7.74	.1833	2.8
Isex - MFM[a]	7.40	.1753	7.1

[a]Milk fat mix

Table 34.

Cost Analysis of 4 Percent Ice Milk Products

Source of Fat	Cost per 100 lbs mix	Cost per 1/2 gal. ice milk	Percent Savings
	(dollars)	(cents)	(%)
Cream (control)	$9.64	.2285	-
Butteroil - MFM[a]	9.69	.2295	0.4 (loss)
Lorex - MFM[a]	8.89	.2106	7.8
Ernex - MFM[a]	9.23	.2186	4.3
Isex - MFM[a]	8.59	.2035	10.9

[a]Milk fat mix

Table 35.

Cost Analysis of 6 Percent Ice Milk Products

Source of Fat	Cost per 100 lbs mix	Cost per 1/2 gal. ice milk	Percent Savings
	(dollars)	(cents)	(%)
Cream (control)	$11.33	.2685	-
Butteroil - MFM[a]	11.41	.2703	0.7 (loss)
Lorex - MFM[a]	10.21	.2418	9.9
Ernex - MFM[a]	10.72	.2539	5.4
Isex - MFM[a]	9.59	.2281	15.0

[a]Milk fat mix

SUMMARY AND CONCLUSIONS

This research was designed: a) to determine the effects of MFM products on quality, relative consumer preference and cost for manufacture of ice cream and ice milk products containing different levels of fat; and b) to ascertain recommendations needed for continued use of MFM products in ice cream and ice milk products.

Thirty experimental batches of ice cream and ice milk products were made. The ice cream products contained 10%, 12%, and 14% fat, and the ice milk products 2%, 4%, and 6% fat. The ingredients for supplying fat in the ice cream and ice milk formulations were: cream, an experimental MFM, made from butteroil; and three imported MFM products, Isex, Lorex, and Ernex. The frozen products made with cream were designated as controls and were compared with the ice cream and ice milk products made with the experimental and imported MFM products. All mixes were frozen to an overrun of 90 percent, packaged in half-gallon containers and stored at -10°F until needed for evaluation.

Quality of the cream, and of the MFM products, was determined before they were used in the ice cream and ice milk formulations. The cream and the experimental MFM products were rated as having good flavor quality. Oxidized and stale flavors were observed in the imported MFM products. The Peroxide Value of fat was a good quality control test. It indicated the degree of oxidation of the fat.

The flavor defects of MFM products carried over into the ice cream and ice milk products and lowered their flavor quality as rated by the technical panel. The body and texture and melting properties, however, were of an equal quality to the control products.

The off-flavors, resulting from the use of MFM products, significantly lowered relative consumer preference for ice cream and for ice milk containing 6% fat. Relative consumer preference for the ice milk products containing 2% or 4% fat was not significantly different from the respective control ice milk product. These results showed that MFM should not be used in ice cream and 6% ice milk formulations unless they are free of flavor defects. Companies planning to use MFM products should provide a means for determining their quality before purchasing and during storage. Cosgrove (15) recommends that 50 percent of the dairy products going into a mix should be fresh.

Among good quality ice cream products (made with cream) containing 10%, 12%, or 14% fat, there was not a significant difference in relative consumer preference. At the higher fat percentages, consumer preference for ice cream and ice milk made from cream or butteroil was significantly higher than for ice cream and ice milk products made with imported MFM products that had objectionable flavor defects.

When a high quality, low fat ice cream (10%) was compared with a high fat ice milk (6%), consumer preference was significantly higher for the 6% ice milk. These results partly explain the increasing sales and demand for ice milk products.

In the cost analysis of ice cream and ice milk products, the ingredient costs for the mixes were calculated for 100 lbs of mix and for one-half gallon of the frozen product with 90% overrun. The control products (made with cream) were used as the base cost from which the percent savings or loss were calculated. The percent savings were calculated by subtracting the difference between the prices of a one-half gallon of control product and experimental or imported MFM product and then dividing by the ingredient cost of the control product.

The use of the experimental MFM made with butteroil in ice cream and ice milk products did not lower quality and consumer preference. This experimental MFM, however, did not show a cost advantage because the cost of the fat was similar to that of fresh cream. If butteroil could be made readily available at a competitive cost, the potential use of a butteroil-type MFM product appears highly favorable.

There was a significant cost advantage by using imported MFM products as the source of fat in ice cream. The percent savings were more substantial as the level of fat was increased. In the manufacture of 14% ice cream, a 20% savings were realized over an ice cream product made with cream as the source of fat. The influence of processing and distribution costs on the price of ice cream and ice milk products was not considered because of the scope of this study.

RECOMMENDATIONS

Based on the results of this study, the following recommendations are made:

Companies that use MFM products in their frozen dessert production should establish a quality control program which provides a system for checking the quality of these products. This is necessary since the results of this study have shown that the flavor quality of MFM products varies widely. Oxidative rancidity and old ingredient were the principal off-flavors that were observed.

Since the flavor defects found in MFM products carried over into the ice cream and ice milk products, it is necessary that a flavor analysis on these products be undertaken by a technical panel periodically, accompanied by a peroxide test. The peroxide test was shown to be quite successful in determining oxidation in fat source ingredients.

Flavor and quality analyses need to be made upon receipt and during storage of MFM products to assure good quality. It is necessary that quality be maintained, since the presence of off-flavors in ice cream and ice milk products made with MFM products significantly lowers relative consumer preference for these products.

There is a significant cost advantage in using imported MFM in ice cream products. The results of this study verify that the percent saving realized can be substantial, especially at the higher fat levels, if the MFM products are of high quality. The percent saving will depend upon the quality of the MFM product and how much of it is used to replace the milkfat requirements in ice cream and ice milk products. A program that provides for a systematic rotation in the use of these MFM products will help to assure a saving in cost.

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EFFECT OF MILK FAT MIX PRODUCTS ON QUALITY,
CONSUMER PREFERENCE, AND COST OF ICE CREAM AND ICE MILK PRODUCTS

Kenneth A. Gardner

Abstract

An investigation was made to determine: a) the effects of milk fat mix products (MFM) on quality, relative consumer preference and cost for manufacture of ice cream and ice milk products, and b) to make recommendations for continued use of MFM products in ice cream and ice milk.

The study consisted of 15 experimental ice cream and 15 experimental ice milk products. The ice cream contained 10%, 12% and 14% fat and the ice milk 2%, 4% and 6% fat. Ice cream and ice milk made with cream as the source of fat were designated as controls. These products were compared with ice cream and ice milk made with a butteroil MFM and three imported MFM products.

The ice cream and ice milk products were scored for flavor, body and texture and melting quality. Relative consumer preference was determined by ten consumer panelists using the Triangular procedure. Results showed that the control and the butteroil ice cream and ice milk products were superior in quality and were preferred by the consumer panel.

When off-flavors were observed in MFM products, they carried over into the ice cream and ice milk and significantly lowered relative consumer preference. The peroxide test indicated oxidation of the fat.

There was a significant cost advantage in using imported MFM products in ice cream and ice milk with the percent saving being more substantial as the fat levels increased.