Vegetable Protein Application in Whey Soy Drink Mix and Ice Cream

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ABSTRACT

Full fat and defatted soy flours have been used successfully as major ingredients in a low cost replacement for milk solids in beverages for human consumption in several countries of the world. Milk solids replacement products using vegetable protein may have limited potential as long as surplus milk solids exist on a world basis. Some of the milk trends that are occurring in the U.S. are discussed as they pertain to future use of vegetable protein. It appears likely that there will be a decline in milk production with a higher per capita disposable income available for the purchase of processed dairy products utilizing vegetable protein. Ice cream is one of the more sensitive test systems in which to evaluate the flavor and functional properties of vegetable protein for use in dairy products. Sensory panel data have shown that properly processed soybean isolate protein can be used as a 50% replacement for milk solids protein with no discernible differences from a control product. These sensory tests in ice cream show significant differences among commercial soy isolates.

INTRODUCTION

This presentation is to show some of the practical applications of vegetable protein in a beverage use, to extend nonfat dry milk in a very delicate flavor product, ice cream, and to show some of the milk trends that are occurring in the U.S. It may be unpopular or inappropriate to discuss an extension of milk solids at a time of great world surpluses. However, this situation may not always be with us. Most of us in the U.S. remember in 1973 when milk supplies were short, and we had a rapid escalation of milk prices and a shortage of cheese. This period of time caused many businesses in the dairy area to reconsider their position relative to the long term availability of milk so necessary to the manufacture of these important dairy food products.

WHEY-SOY DRINK MIX

During this same time, the U.S. government found itself in a similar short supply situation in fulfilling its commitment to the Title II food donation program in various parts of the world for the preschool child. In order to maintain and eventually increase the quantity of food available for foreign distribution at the least cost to the government, a new beverage product was developed and became known as whey-soy drink mix. Its intended use is to replace nonfat dry milk in beverage applications at a substantial cost reduction in overseas preschool feeding programs sponsored by U.S. aid.

A joint USDA-aid effort developed a nutritious beverage powder mix that was in several ways more adapted than was nonfat milk solids to the needs of the preschool children receiving inadequate protein. It was not intended to serve as a sole source of food, but to supplement their other dietary intake.

Objectives of the product were to use a high level of cheese whey and provide a high calorie density. The ingredient composition is shown in Table I. Defatted soy flour is used as an alternate to the full fat soy flour with the necessary oil addition to maintain the same composition. The high iron content of soy with some supplemental premix provides this nutrient in adequate amounts compared to milk solids.

Table II (1) shows the nutritional composition of the product. The powder is a high protein, high fat, high calorie product which has the same protein to fat balance as milk. The PER is 2.1 compared to casein at 2.5. The net protein utilization is 75 compared to 84 for casein.

Actual experience and controlled storage studies have indicated the dry powdered product has acceptable flavor when stored under normal temperatures 80 F (26 C) for at least one year. Natural antioxidants of soy have a strong protective effect on the high lipid content of the product.

Early acceptability field work (2) in Chile, Vietnam, India, Pakistan, and the Dominican Republic, representing

TABLE I

Composition of Soy-Whey Drink Mix

	%
Sweet cheese whey solids	41.7
Full fat soy flour	36.9
Soybean oil	12.3
Corn syrup solids	9.1
Supplemented with vitamins and minerals	

TABLE II

Nutritional Composition of Soy Whey Drink Mix

	%
Protein (N x 6.25)	21.2
Moisture	3.9
Ash	5.1
Fat	21.4
Fiber	0.8
Carbohydrates	47.6
Calories/100 g dry powder	468
Protein efficiency ratio	2.1

TABLE III

Whey Soy Drink Mix Shipments through PL 480 Title II (4)

Fiscal year	Quantity shipped lbs
1974	96,000
1975	6,416,000
1976	11,669,000
1977	4,156,000
1978	6,904,000 (approved for shipment)

TABLE IV

Average Milk Prices Received by Farmer Per CWT - U.S.

	Milk eligible for fluid market	Milk manufacturing grade
1950	$4.36	$3.16
1955	4.50	3.15
1960	4.69	3.25
1965	4.63	3.34
1970	6.05	4.70
1972	6.38	5.08
1974	8.66	7.13
1975	9.02	7.63
1976	9.93	8.56
1977	9.96	8.70

different cultures, showed a high level of acceptance among the children. In Sierra Leone, where milk is not as extensively used, the acceptance was not as good.

After the product had been shipped to several countries, the author was under contract (3) from the U.S. government to lend assistance and evaluate the acceptability of the beverage powder among the children using it in Guatemala, Costa Rica, Bolivia, Chile, Haiti, Upper Volta, Dahomey, Burundi, and Pakistan. Generally, the whey-soy drink mix was accepted as well as milk, sometimes better. In each of these countries, the beverage product is prepared with sugar and some type of flavoring. The most common and acceptable flavoring was cinnamon. The sugar addition significantly improved the beverage acceptance. The product is used either on site by the young children (8 oz. per day) in day schools or two pounds per month of the powder taken home for use. Many nutrition directors in these countries have been very complimentary of the quality of the product.

The French-speaking countries of Africa are basically nonmilk-drinking areas. Therefore, the use of this product as a beverage has limited use and acceptance. It is better accepted in solid foods.

Table III shows the shipment of whey-soy drink mix from 1974 to the present as distributed through the PL480 Title II donation program of the U.S. government. The drop in distribution from 1976 to the present reflects, in part, the great surplus of nonfat dry milk on a worldwide basis. As long as various governments are paying storage and have this large amount of milk solids to dispose of, the need or encouragement of a milk beverage alternate will be minimized. This supply situation is not a reflection of the acceptability of the whey-soy drink mix. We have indicated earlier that the product has been generally well accepted.

One of the problems with using alternate products in a given feeding program is the time necessary to train and condition a populace to accept a product that they are not accustomed to consuming. This takes time to properly introduce a new food. The agencies distributing these food commodities are frustrated when the program is changed too often or that one product substituted for another. In other words, they are not interested in switching from nonfat milk solids to vegetable protein altenates every time the availability or price changes.

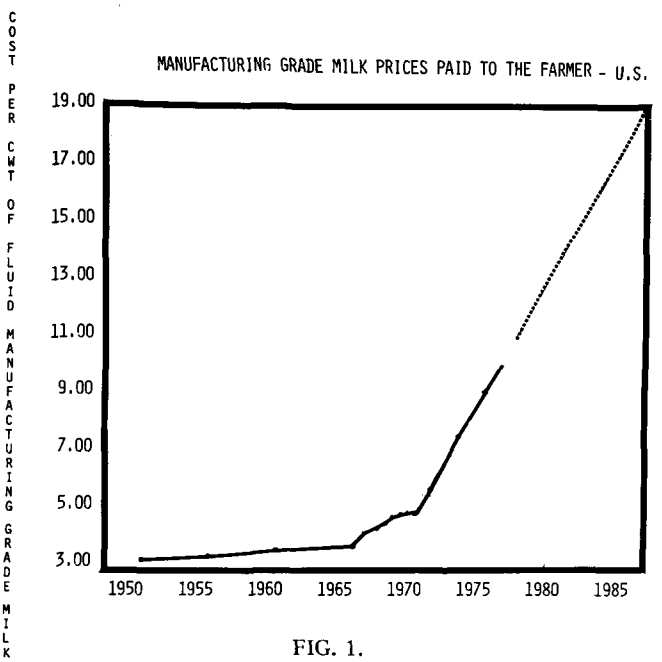

FIG. 1.

MILK PROTEIN PRODUCTION TRENDS

In considering vegetable protein as an alternate or extension of milk solids in the food sytem, it may be useful to discuss briefly current trends that exist in the U.S. which are somewhat reflective of the world situation.

Table IV shows that the cost of fluid manufacturing grade milk was relatively stable from 1950 to 1970. In the early 70s, some significant increases began to occur. There has been a two and one-half fold increase in the price of manufacturing grade milk since 1965. All indications suggest this upward trend will continue.

If we project (Figure 1) these recent changes to the year 1985, we observe it is likely that a two-fold increase in the price of manufacturing grade milk could occur.

Comparing the last eight years (Table V), we observe that nonfat dry milk solids have increased from 26cents/pound to a high of 67cents/pound, butter has remained stable at a price of 69cents/pound until the last three years and then increased to 98cents/pound, and cheese has increased from 55cents/pound to a high of 97cents/pound. There are many factors which are causing the price of milk and the products manufactured from it to increase. Let's examine some of the historical milk production patterns in the U.S. and other factors affecting supply and demand.

During the past 27 years (Table VI), milk cows on farms have decreased from ca. 22 million to less than 11 million (405,926 cows/year). During the same period, annual milk production per cow has increased from 5,134 pounds to 11,194 pounds/cow. This large increase in productivity per cow has nearly maintained milk production but with a slight overall downward trend. Since 1965, overall milk production has decreased by 1%, while total U.S. food consumers have increased by 11.5%. Traditionally, total milk production has kept pace with population growth.

If we compare population growth and the demand for protein products against the decreasing trend of total milk

TABLE V

Market Prices of NFDM, Butter and Cheese - $/CWT - U.S.

	1970	1971	1972	1973	1974	1975	1976	1977
NFDM	$26.31	30.74	33.06	46.38	58.62	63.32	63.50	67.00
Butter	69.43	68.35	68.60	69.75	65.72	79.38	92.03	98.42
American cheese	54.95	56.48	59.82	72.63	79.89	86.61	96.30	96.83

TABLE VI

Milk Production in U.S. - 1950-1977

	Milk cows on farms average during year (000)	Milk production lbs per cow	Milk production Total (mm lbs)
1950	21,944	5,314	116,602
1955	21,044	5,842	122,947
1960	17,515	7,029	123,109
1965	14,953	8,305	124,180
1970	12,000	9,747	116,962
1975	11,140	10,352	115,326
1976	11,049	10,893	120,356
1977	10,984	11,194	122,957

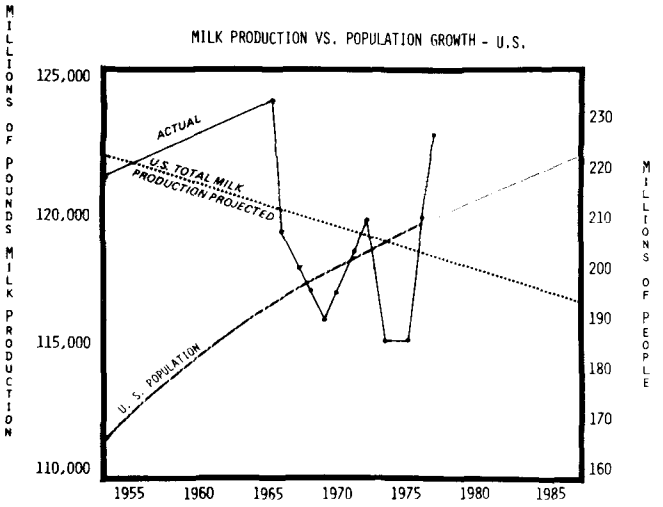

FIG. 2.

TABLE VIII

Sensory Evaluation of Experimental Soy Isolate in Ice cream

Samples	No. Correct/ Total No. Judgments
Control (NFDM) vs. experimental A	18/36
Control vs. experimental B	17/36
Control vs. experimental C	21/36
Control vs. experimental D	14/30

production (Figure 2), the widening gap becomes very significant after 1980, providing current trends are not reversed by other factors. The erratic fluctuations occurring in the actual production values are caused by many factors, such as the demand for milk, price and availability of feed, weather, foreign markets, etc. The heavy rigors of dairy farming have become less attractive to the younger generation vs. an 8 to 4 factory job. Once a decision to get out of the dairy business has been made, it is difficult to get back into the business because of the large financial commitment involved.

During the past 27 years (Table VII), the population growth in the U.S. slowed somewhat compared to per capita disposable income. This four-fold increase in disposable income has allowed the consumer to purchase higher priced dairy products. Thus, the purchasing patterns have shifted from a decreased milk fat and nonfat dry milk solids to a doubling of cheese consumption.

Relating all these factors, the following dairy trends appear likely in the U.S. over the next 10 years: (a) there is some indication of a decline in milk production; (b) the U.S. population is estimated to increase by about 10-15 million people; (c) the average person will have higher per capita disposable income; and (d) the per capita consumption of milk fat and nonfat milk solids will decrease only slightly.

For the future we see some shifting of milk utilization to beverage use. If this occurs we see a greater need for alternate protein sources to extend manufactured milk in the utilization of cheese and other dairy products.

SOY ISOLATE USE IN ICE CREAM

One of these other dairy products is ice cream. It is one of the more sensitive test systems in which to evaluate the flavor and functional properties of vegetable protein for use in dairy products. We have been able to differentiate between various soy protein isolates when incorporated into ice cream mixes. One-half of the protein from the milk solids are replaced by the soy isolate when mixed with cheese whey to simulate the composition of nonfat dry milk.

A number of these soy protein samples was submitted for sensory evaluation tests at our research center. To give you a bit of background information on these tests, let me briefly outline some of the general test procedures that are used in the laboratory. All tests are conducted under care-

TABLE VII

Population, Disposable Income and Milk Utilization Trends (Milk Equivalent)

	Total population (millions)	Per capita disposable income (dollars)	Per capita consumption milkfat (lbs)	NFDM (lbs)	Cheese (lbs)
1950	151.7	1,364	29.3	43.6	65.4
1955	165.3	1,666	27.2	44.5	67.1
1960	180.7	1,937	24.5	43.4	70.5
1965	194.3	2,436	22.9	42.9	77.4
1975	213.6	5,062	20.1	38.1	123.7
1976	215.1	5,493	20.1	39.1	136.5
1977	216.8	6,008	20.1	38.6	159
1978		6,480[a]			

[a]Preliminary.

fully controlled conditions to minimize nontest variables.

The panel members are selected from among the 250 employees participating in the total sensory evaluation program - about 30 to 40 are used for each test. Their selections for specific evaluations are based on individual tasting ability - for discrimination tests - or their degree of liking of the product under test for preference/acceptance evaluations.

The primary objective of these ice cream studies was to determine if the experimental samples containing soy isolate matched the control sample containing nonfat dry milk. Discrimination tests were chosen as the most appropriate test design. Discrimination or difference tests are frequently used to establish if the sample is not different and, therefore, is as good as the control (i.e., equal acceptability).

A duo trio test design was utilized. This test design is a three-sample evaluation technique where one sample is identified as the reference sample. The remaining two samples are a control and an experimental sample. Samples were presented in a balanced, simultaneus order of presentation. The panel member was asked to identify which of the two unidentified samples is the same as the reference sample When ice cream made with nonfat dry milk was used as the control, and ice cream made with a typical commercial soy isolate, the panel judged correctly 33 out of 36 times. The number of correct judgments was statistically significant, indicating that the samples were discernibly different. Thus, this sample representing the state of the art in the food industry did not meet the product matching objective.

Table VIII shows the sensory evaluation results of soy isolates used in ice cream samples representing some improved processing techniques and produced on commercial scale equipment by our own research scientists. In all cases the number of correct judgments was not statistically significant, indicating that the control and the new experimental samples were perceived as the same.

Though this was a limited exploratory test series, we view the results as very encouraging in that they suggest these soy isolates, properly processed, show considerable potential as an acceptable ingredient for a partial extension of dairy protein. We have experienced similar acceptability in other dairy products with vegetable protein processed in such a way to meet the critical functional needs of a given food product type. It is our conviction that when the need for alternate protein sources is required by the world supply as an ingredient in dairy products, the current scientific thrust in developing new technologies will allow these new protein sources to be used: to help control spiraling food costs; to use indigenous raw materials for dairy products in countries not now consuming significant quantities of dairy foods; and to develop and use new product types not currently being marketed.

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