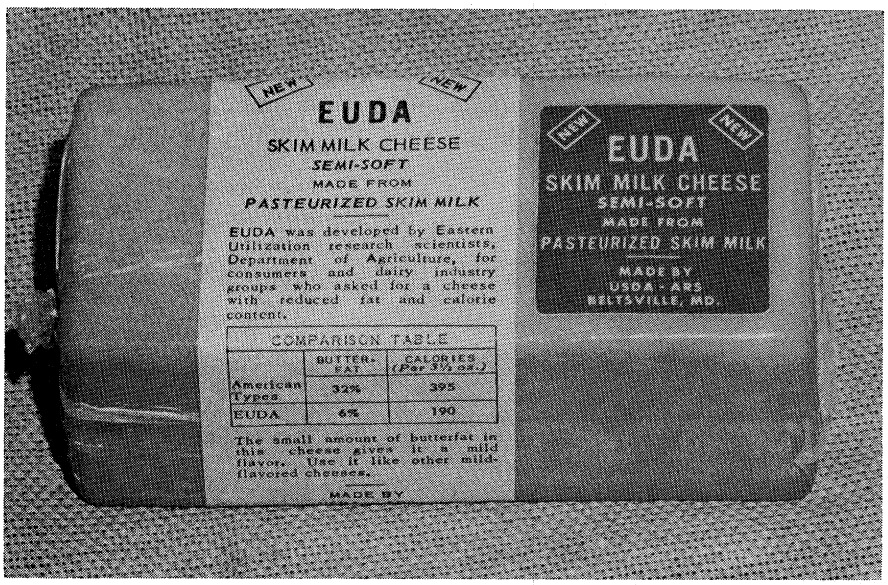


**New low-fat cheese developed by USDA is undergoing market testing in suburban Washington, D. C. So far, however, EUDA cheese, which resembles cheddar, is not generally available. Cheese has about half the calories and only 20 per cent of the fat content of typical American cheese varieties.**

**3080**

## increased dairy research is needed—

# to keep the cow out of the zoo


## Byron H. Webb/Chief, Dairy Products Laboratory/Eastern Utilization Research and Development Division/ARS/USDA/Washington, D. C.


THE DAIRY industry has not distinguished itself as a leader in new product development. The auto industry creates dozens of new models every year. To develop these new models it spends about 1.3 billion dollars on research and development. In contrast, the whole food industry spends about 186 million dollars on research and development. Accurate figures are not available, but it is estimated that only 6 or 8 million dollars are spent on dairy product research and development. In this respect the dairy industry expenditures lag far behind expenditures for the food industry as a whole and this, in turn, lags far behind expenditures for most of our larger industries.

Spending money for research and development will not, of itself, solve our problems. As in industry we must devise a sound research and development program. We must develop new, attractive and profitable products that will compete with the hundreds of newly developed foods that annually appear in our food markets. We must develop new dairy foods with attractive flavor and physical properties. They must be of unquestioned nutritional value. They must be sold at a low enough price so that the consumer will buy them in preference to the thousands of other items readily available to her.

We have made excellent progress in improving the quality of our standard products. We have improved production, manufacturing and marketing conditions that have made dairy products famous for cleanliness and freedom from undesirable bacteria. But, other than our very important contribution toward improved sanitary aspects of food manufacture, our basic products have changed little in 50 years. Butter has remained much the same during this period. Market milk is clean, sanitary and dressed up in new packages. We have removed feed and off flavors, but we have not intensified the good and attractive flavor of milk. In fact, as we have lowered fat content in some of our fluid milks we have markedly decreased flavor appeal. Ice cream remains much as it was 50 years ago although our manufacturing practices have improved greatly. We have improved body and texture but flavor is essentially unchanged. We have brought engineering to the cheese factory to lower production costs; there is more high grade cheese on our markets now, but one cannot buy a better cheddar cheese today than he could 50 years ago. It is true there has been some effort at new cheese product development with the production of spreads and dips, and various kinds of processed cheese and cheese foods. Finally, evaporated milk in the eyes of the consumer has remained unchanged except that it has a slightly thinner body, but the decrease in cooked flavor is scarcely


Adapted from a presentation before the 1969 annual meeting, National Dairy Council, Cleveland, Ohio, January 28, 1969.

**Table I. Consumption of Dairy Products, Margarine, and Mellorine, 1937 vs. 1967, in the U.S.A.**

| Product | Total, Annual, Civilian Per Capita Consumption lb. 1937 | lb. 1967 | % Change |
|---|---|---|---|
| Fluid Milk and Cream | 331 | 286 | −13.6 |
| Butter | 16.8 | 5.5 | −67.3 |
| Margarine | 3.1 | 10.5 | +239 |
| Condensed and Evaporated Milk | 16.7 | 9.1 | −45.5 |
| Cheese | 5.6 | 10.0 | +78.6 |
| Ice Cream | 10.6 | 18.1 | +70.8 |
| Mellorine | — | 1.2 | — |
| Dry Whole Milk | 0.1 | 0.3 | +200 |
| Nonfat Dry Milk | 1.9 | 5.6 | +195 |

**Table II. Fresh Fluid Dairy Products and Some Potential Fluid and Refrigerated Dairy Products**

| Old | New |
|---|---|
| Market Milk | Increased Flavor in Skim and Low Fat Milk |
| Buttermilk | Fruit Flavored Milk |
| Skim Milk | Carbonated Fermented Milk |
| Diet Milk | Alcoholic Lactic Milk |
| Chocolate Milk | Kefir Milk |
| Yogurt | Koumis |
| Acidophilus Milk | Low Fat Cultured Dressing |
| | High Protein, Soft Curd Flavor Rich Milk |
| | Milk Pudding |
| | Frozen Milks |

perceptible. We must conclude that our efforts at innovation have been designed primarily for decreasing manufacturing and marketing costs and increasing our profits rather than in the development of new, *consumer oriented* products.

Has the slow development of new dairy products affected consumption? Let us compare per capita consumption today with that of 30 years ago as shown in Table I. There has been a drop in the consumption of fluid milk, butter, condensed and evaporated milk. Dry milk consumption is small but it has increased, especially nonfat dry milk. People are eating more cheese and ice cream because they like them, there are as yet no successful imitations, and prices are reasonable.

We should hasten to say that some new product development work has been done. Many improvements have been made in our standard products. Yogurt was unheard of a few years ago, but now we can produce an excellent product and sales are increasing. We are making many low calorie diet drinks, and milk-based instant breakfasts have become popular. Milk is at least holding its place in confections, bakery goods and in other manufactured foods. A line of aseptically canned sauces is under development and butter sauce is being used in some canned vegetables and other prepared, aseptically packed or frozen dishes.

We are entering a struggle with imitation products where we have already lost the battle to retain the butter market. Why did we lose it? Because (1) margarine is a third the price of butter, (2) most people cannot taste a difference between margarine and butter, and (3) we have been unable to show that there is a nutritional advantage to eating butter. Mellorine sales on the other hand have not rapidly increased because ice cream contains only about 10 per cent fat and there is a limited profit in replacing milk fat in ice cream when it is present at less than one-third of the solids of the products. There have been large increases during the last decade in sales of ice milk, a product that can effectively compete with mellorine.

Let us examine by classes the dairy products we are now making and a few new products. We have tabulated the old or standard products with some suggestions for new or modified products. Table II lists these fresh fluid milk or refrigerated products in the old category and includes many of the well known stable products of the market milk industry.

## The Role of Flavor

One improvement we need to make is in the flavor of our skim milk products. The great attraction of market milk is its excellent flavor, both mild and satisfying. We should discover a way of intensifying the flavor of skim milk and increasing its smoothness and palatability. There is no better source of protein than skim milk, but we must make it taste better.

Forms of the new fresh milk products listed in Table II are known to many of you, but they have not attained any significant volume in the marketplace. Perhaps they need improvement in flavor, in convenience of handling, serving, or in length of storage life. Would a fresh milk pudding packaged as we now package yogurt have consumer appeal?

Much more could be done to promote yogurt by improving the quality of the product as it reaches the consumer. From personal experience I would estimate that one-third of the yogurt as purchased is of poor quality. I believe at least 10 per cent of it is so old, moldy or fermented that it must be discarded. I know of no better way to discourage sales.

## Using Milk Fat

How to sell milk fat is the industry's biggest problem. The standard high fat products no longer can be counted upon as an adequate outlet. Some new possibilities are suggested in Table III. There must be more

**Table III. Some Possible Milk Fat Containing Products**

| Old | New |
|---|---|
| Butter | Milk Fat Spreads (40%) |
| Whipping Cream | High and Low Melting Fractions |
| Coffee Cream | Stable Anhydrous Milk Fat |
| Ice Cream | Special Purpose Milk Fats for Confections, Baking, Food Uses |
| | Whippable Milk Fat Topping |
| | Milk Fat Based Salad Dressing |
| | Milk Fat-Vegetable Fat Blends |

**Table IV. Some Prospective Cheese or Cheese-like Products**

| Old | New |
|---|---|
| 400 Cheese Varieties | Semi-Soft Skim Milk Cheese |
| | Stable Cottage Cheese |
| | Fresh Curd High Flavor Cheese |
| | Spreads, Dips |
| | High Flavor Syrupy Concentrate |
| | Stable Cheese Solids and Protein-Fat Blends for Food Manufacture |

Table V. Analyses of Cheddar, Cottage, and Euda Cheese

| | Cheddar | Cottage (Creamed) | Euda |
|---|---|---|---|
| Fat, % | 33 | 4.2 | 6 |
| Moisture, % | 38 | 78.3 | 56 |
| Protein, % | 24 | 13.6 | 30 |
| Salt, % | 1.7 | 1.0 | 2.4 |
| Calories Per 100 g | 398 | 106. | 185. |

Table VI. Prospective Aseptic and Preserved Dairy Products

| Old | New Sterile Products |
|---|---|
| Sweetened Condensed Milk | Milk-Cola High Protein Beverage |
| Evaporated Milk | 3:1 UHT Concentrate |
| | Canned Desserts (Puddings) |
| | Butter, Hollandaise and Cheese Sauces |
| | Diet Milks |
| | Coffee Creams |
| | Aseptic Packaged Fluid Milks |

research to discover the nutritional role of milk fat. Perhaps there is a fear that research will not uncover a clear, nutritional function for butterfat, but if this is the case, the situation should at least be clarified. We need evidence to show that the fat of milk has a specific function that is not met by other fats. We should determine whether there are important interactions between milk fat, milk protein and lactose. All this will require an expensive program of nutritional research but until we have answers we are vulnerable in a very tender spot.

There must be clarification of our definitions and standards for high fat products so that there will not be legal obstacles to our development of new and unusual blends of fat, protein and lactose. We can modify the structure of butter so that it becomes as spreadable as margarine, but our current laws prevent us from doing this.

Today there are 3,779 different brands of salad dressings on the market. Thirty years ago consumption of salad dressing was 2.6 pints per person. In 1966 it was 7.4 pints and the oil used was 80 per cent soy. Can you think of a more tasty salad dressing than one made to contain some of the liquid fraction of butter oil? Annual U. S. soy oil production is 6 billion lb. It would take 200 million lb. of anhydrous milk fat to flavor 1 billion lb. of this soy oil at a 20 per cent level. But the flavor of the milk fat would not be stable, and the cost would be high. Clearly, a research and development job should be done.

There are more than 400 varieties of cheese products. As we indicate in Table IV, a number of approaches to new cheese products can be made. I should like to describe a process for making a new low-fat cheese developed in the USDA Dairy Products Laboratory. We knew that the source of flavor in our finest cheeses was the fat and the products derived from fat by the bacteria that develop cheese flavor. Extra flavor then must be developed quickly in the smaller quantity of fat that might be used. Fat and water contribute to the soft, pliable body of cheese. In the absence of a considerable quantity of fat, water must be introduced as a readily available softening agent, but high water content permits undesirable bacterial activity. The problem of producing a low-fat cheese is essentially one of substituting water and protein for the fat. Bacterial breakdown must be encouraged to produce flavor and softness, but it must not be allowed to reduce keeping quality. Scores of batches of experimental cheese were made and when the small scale equipment yielded a suitable product, the process was taken to the pilot plant at Beltsville, Md. Finally, with additional processing changes, a semisoft skim milk cheese was produced using milk of 0.4 to 0.7 per cent fat, mildly hydrolyzing this fat with a lipase enzyme and curing the cheese for not more than 60 days. The resulting product is compared to Cheddar and Cottage cheese in Table V. The new cheese is called *Euda* for Eastern Utilization, Department of Agriculture. It contains much less fat than Cheddar cheese and only half the calories. Euda cheese has been store tested in the Washington, D.C. area with encouraging results. We believe it will be a new outlet for skim milk, and that it will not affect the sale of standard cheeses.

Table VI lists suggestions for new sterile products. A new high protein, cola-type beverage that would even mildly compete with soft drinks might greatly increase milk consumption. Cola-milk might be made with a skim milk base so that it contained, perhaps, 3 per cent milk solids. If casein is physically incompatible because of pH limitations, perhaps a specially designed whey fraction could be used.

Already there is commercial production of butter and cheese sauces which give promise of being important new products. We know how to produce a 3:1 high temperature, sterilized, aseptically packaged whole milk. The product has some cooked flavor but this is not objectionable to many people. We must find a way to slow up the chemical reaction that produces the stale storage flavor which develops rapidly as the product is held at room temperature. It would be desirable to restore and accentuate the fine flavor of fresh homogenized milk. Basic flavor research is needed to resolve these problems not only in sterile products but in almost all dairy products subjected to storage.

Coffee cream has been replaced in most refrigerators by coffee whiteners. If these contain a milk component, it usually is sodium caseinate and this is largely derived from imported casein. Surely we can muster enough ingenuity to produce a flavorful and attractive coffee creamer made with milk fat, which if sterilized would keep well at room temperature. But again we are confronted with the development of stale and even oxidized flavors. Additional basic research would seem to be the answer.

Table VII identifies some traditional dried products and some new possibilities. We have still not really resolved the problem of instant dispersibility in powders containing milk fat. This matter should receive continued study. We need dried dairy products that will disperse rapidly and dissolve as well as sugar. We do a good job with nonfat dried milk, but not with the other dried milk products unless we add sugar to them. We should develop new, tasty, attractive dried forms of milk protein; this is still of unquestioned nutritional value and when fresh, of excellent bland flavor. We should use milk protein in our new products at every opportunity. We have seen our coffee cream market almost vanish, yet we can still not produce coffee whiteners containing flavorful milk fat that will keep well in storage. Here again is the problem of stabilizing the fresh flavor of fat.

The Dairy Products Laboratory has

**Table VII. Potential Dried Dairy Products**

| Old | New |
|---|---|
| Whole Milk | Instant, Flavor Stabilized, High Protein Powders for Beverages and Food Preparation |
| Nonfat Milk | Milk Fat Coffee Whiteners |
| Flavored Novelty Powders | High Protein Whey-Soy Powders For Foreign Feeding |
| Buttermilk | Stable Dried Whole Milk |
| Whey | |

**Table VIII. Volume and Utilization of Whey Products**

| Old (Whey) | New (Whey for Food) |
|---|---|
| 22 Billion Lb. Produced | Concentration/Fractionation |
| 11 Billion Lb. to Sewers and Streams | (a) Reverse Osmosis |
| 11 Billion Lb. to Food and Feed | (b) Gel Filtration |
| | (c) Electrodialysis |
| | Whey Protein Concentrates |
| | New Uses for Whey in Foods |
| | New Uses for Lactose |

prepared mixtures of whey and soy for foreign feeding programs. The corn-soy-milk (CSM) of the Northern Regional Laboratory is well known. These seem to have some potential. If soy flour is added to fluid whey and the mixture concentrated under vacuum much of the soy flavor is removed. This approach might provide a method of stretching our food supplies by using whey or milk solids and soy flour to make a product which is nutritionally equal or superior to either of the raw materials separately.

A glimpse of the whey problem is shown in Table VIII. Eleven billion pounds of whey is still being discarded in this country each year. Processes are now being developed for fractionating and/or concentrating surplus whey. Of the three procedures listed, I will comment only on reverse osmosis, a process on which we have been working in the Dairy Products Laboratory. It should be said in passing that there is a great potential for whey solids in foods and increasing amounts are being used in confections, bakery goods and in certain other dairy products.

Table IX shows results obtained by fractionation and concentration of Cottage cheese whey by reverse osmosis. Using one type of membrane about a quarter of the salts of the whey are lost in the permeate. We believe it would be practical to concentrate whey to 20 to 30 per cent solids by reverse osmosis in small cheese factories where drying equipment is not available. The concentrate could be shipped to a drying plant for further processing. The cost of concentrating whey to a ratio of 2:1, 3:1, and 4:1 is shown in Table X. Considering that some of the salts are also removed, the remaining concentrate should be a valuable and economical source of milk solids for food use. In the removal or fractionation of whey salts by one of the available methods we should consider what salts it might be desirable to remove and which should remain. Much of the calcium of milk remains soluble in Cottage cheese whey. It may be nutritionally important to retain the calcium and phosphates in this whey during any fractionation procedure.

**Table IX.**
**Fractionation and Concentration of Cottage Cheese Whey by Reverse Osmosis**

| Analysis | Original Whey, % | Solids Content of Fractions Concentrate, % | Permeate, % | Loss in Permeate, % |
|---|---|---|---|---|
| Total Solids | 6.53 | 32.6 | 0.30 | 3.7 |
| Ash | 0.61 | 2.5 | 0.18 | 23.7 |
| Lactose | 4.39 | 22.2 | 0.07 | 1.3 |
| Nitrogen | 0.13 | 0.6 | 0.014 | 7.3 |
| as Protein x 6.38 | 0.86 | 4.0 | 0.089 | — |

Membrane Type: 75% NaCl Rejection

We are beginning to make products such as diet milks to suit the needs of special groups. This should be encouraged and we should study group requirements to produce the kind of products that will function best for each group. There are the aged, the school lunch group, the obese, those with sedentary jobs and those with very active jobs. The nutritional requirements of each group should be met with flavorful products balanced by a judicious combination of protein, carbohydrate and fat, preferably but not necessarily derived entirely from milk. We should use our raw materials wisely and encourage the production of what we require to fulfill our national food needs.

The food service business has expanded into a $30 billion market or nearly one-third of the whole food industry. There are predictions that the away-from-home eating market will equal retail food store volume within a decade. Institutional food emphasis will be on high quality with greater variety, built-in convenience and portion control. Here is a rapidly expanding new market which includes hospitals, schools, industrial plants, restaurants and other institutions feeding increasing numbers of people where new products will find ready markets.

There will always be a horse to contribute to our riding and racing pleasure, but the day of the work horse is over; except for their use for riding and racing, horses would be found only in the zoo. There will always be a cow to contribute to our eating pleasure, but the day when the cow is the foster mother of mankind could end when dairy substitutes become tasty, nutritionally acceptable and low in cost. To keep the cow out of the zoo we must redouble our new product development effort. In the final analysis the best and cheapest product will survive. In the past the dairy industry has enjoyed many years of great prosperity, superb nutritional service to our people and a top place in providing eating pleasure. Although we may seem less prosperous today we must maintain our position by increasing product and nutrition research and expanding market development to provide consumers with products they want and need at prices that will encourage volume sales. ō

**Table X. Reverse Osmosis - Estimate of Costs and Capacities**

| Whey Concentration Ratio | Processing Costs 900 Sq. Ft. Unit | | Unit Size | |
|---|---|---|---|---|
| | 1000 lb. Whey, Cents | lb. Water Removed, Cents | 300 Sq. Ft. Membrane $8000 lb/hr. | 900 Sq. Ft. Membrane $19,000 lb./hr. |
| 2:1 | 43 | 0.09 | 2060 | 6200 |
| 3:1 | 76 | 0.12 | 1190 | 3610 |
| 4:1 | 114 | 0.16 | 670 | 2013 |