# Milk and Dairy Products

The chief contributions of the Eastern laboratory to milk research have been to improve and safeguard processed dairy products, to modify them to expand consumer use, and to increase our fundamental knowledge of milk's chemical and physical properties. The use of milk in the United States today continues to be almost entirely for nutritional purposes. Nearly three-fifths of the milk produced in this country each year goes into processed foods, including cheese, butter, ice cream, and

other dairy products. Milk-derived nonfood products developed by ERRC scientists and others have generally not proved competitive in price with comparable products made from other raw materials.

One of the first ERRC invitations to be widely applied by the dairy industry was an improvement in canned evaporated milk. As far as the industry was concerned, the preferred method for sterilizing concentrated milk was the high-temperature, short-time (HTST) process, which did the job in from 3 to 15 seconds. But there was a problem: Evaporated milk made the HTST way tended to gel in the can if stored too long at room temperature. While the thickening was harmless, consumers were understandably disturbed when the milk wouldn't pour from the can. Processors reluctantly abandoned the HTST method.

Then, in the 1960's, an ERRC dairy products team found that gelling could be prevented for a much longer time in HTST-sterilized milk by adding polyphosphates to stabilize the milk before canning. The stabilizers, which were already used in processed cheese, extended the gel-free shelf life of evaporated milk by from two to six times. The practice was soon adopted throughout the industry and is still in use today.

Wyndmoor scientists also developed an economical way to remove off-flavors from milk without overheating it. (The objectionable flavors came from the plants the cows grazed in certain seasons, such as wild onions.) The ERRC method brought milk to the required pasteurization temperature by steam injection; it was then deodorized by flash cooling in a vacuum chamber. Any volatile flavors in the milk were removed in the vacuum chamber, along with the water added as steam during pasteurization. In conventional deodorizers, milk had to be heated to 195°F or higher to eliminate off-flavors.

The ERRC deodorizing process was adopted by cheesemakers as well as by processors of market milk. The method permitted cheese milk to be pasteurized, deodorized, and increased in concentration by 8 percent in one continuous procedure. This allowed the capacity of a cheese plant to be increased without installing more vats. The research, which was relatively inexpensive, resulted in savings of millions of dollars for processors within 2 or 3 years.

Before 1960, many of the bacterial starters used in making cheese were attacked by viruses known as bacteriophages, which either slowed the growth of starters or killed them. ERRC researchers developed a phosphate-and-heat treatment for the milk used for preparing starters. It effectively prevented bacteriophage activity. Within 5 years, half the cheddar cheesemakers in the United States were using the process.

An improved dry whole milk with 3 percent butterfat was also developed in the 1960's, using a new vacuum foam process. ERRC engineers first introduced fluid milk into a vacuum at low temperatures to concentrate it. Nitrogen gas was injected to transform the fluid milk into a foam. The foam was then spray-dried. Because the milk was dried gently, at low heat, the flavor was altered so slightly that many people were unable to tell the whole milk reconstituted from powder from fresh milk. Market tests in the Philadelphia area indicated favorable consumer response to the product, and the product may yet be marketed.

Another innovation of the 1960's was lowfat ripened skim milk cheese. At the time of its development, there were no reduced-fat, semihard cheeses on the retail market, despite considerable consumer demand for such products. The outcome of many experiments by an ERRC team was a low-fat, high-moisture, semisoft cheese that resembled cheddar in texture and flavor. Its fat content, however, was only 6 percent, compared to 33 percent for Cheddar; its protein was higher—30 percent versus only 24 percent for Cheddar. The process was commercialized.


*Thanks to lab research at the Eastern center, a wide range of dairy products is available today for the many consumers unable to digest milk sugar, or lactose.*

*Peoria food technologist George N. Bookwalter pours a cup of low-cholesterol milk made from frozen concentrate.*

Research at the Western laboratory during the 1980's led to a new chemical test that cheesemakers can use to make sure their cheeses are properly aged and ready to sell. Commercial dairies could automate the procedure and use it to check such products as Cheddar, feta, and Monterey Jack.

For several decades, research to unravel the mysteries of milk proteins has been conducted at the Eastern center. As part of this fundamental research, caseins, the major protein in milk, were separated by a simple method into three individual proteins, designated alpha, beta, and gamma. Relative amounts of each protein in milk were later found to vary genetically with the individual cow and the breed. The genetic variations could be related to a cow's yield of milk, the milk's total protein, and the total yield of cheese, and the data could be used in breeding cows with higher, more nutritious milk production.

The proteins in casein are so complete nutritionally that they are a standard by which other food proteins are evaluated. Nevertheless, proteins other than casein, found in the whey portion of the milk, contain even more of the essential amino acids. They include alpha-lactalbumin and beta-lactoglobulin. Research on these proteins revealed that they also vary genetically. The laboratory's findings on the chemistry of milk proteins has led to important new insights into their use as highly nutritious food ingredients. Several scientists involved in basic and applied research have been recognized with Borden Awards for milk chemistry and dairy manufacture and with other prizes.

One piece of ERRC research in the early 1980's created a whole new group of consumers for milk and milk products. Throughout the world, countless people suffer from a deficiency of the enzyme lactase in their digestive tracts. As a result, they are unable to digest lactose, or milk sugar, which is fermented to undesirable compounds and gas by intestinal bacteria. The condition is much more common among black people, Asians, and native Americans than it is among Caucasians, and it is more common among adults than children.

Wyndmoor researchers used lactase from nonhuman sources to break down about 70 percent of milk sugar into the simpler sugars, glucose and galactose. Most lactose-intolerant people could drink this modified milk and digest it without discomfort. Scientists then demonstrated that treated milk could be used to make milk products, such as ice cream, cheese, and yogurt, that were equal to or superior to untreated products. The results of the research were first made available to the public by a firm in New Jersey. The company's president reported that more than 100 million servings of lactase-treated milk and dairy foods were consumed in 1985 by enthusiastic new customers of the dairy industry.

## New ARS Dairy Drinks

New milk drinks have been concocted at three regional labs. One of these, Orange Velvet, combines milk and orange juice and was blended cooperatively by ERRC and a dairy products firm. It has scored well in market tests in the Washington, D.C., area. The Wyndmoor lab has also come up with tasty vanilla and chocolate shakes that contain only half the sugar of conventional shakes. They were designed as an alternative to the fluid milk requirement for a Type A school lunch.

In New Orleans, an ARS food technologist combined water, nonfat dry milk, and juice or fruit flavoring, and then bubbled carbon dioxide through the mixture. The carbonated milk combines the nutritional values of nonfat milk with the flavor and fizz of a soda.

In Peoria, two NRRC researchers have invented a frozen milk concentrate with no more cholesterol than skim milk. They combined nonfat dry milk with a little water and vegetable oil (cholesterol-free) before freezing. The milk is said to reconstitute well, and taste panels liked it. It also makes a tasty whipped topping that stays foamy for 24 hours.