ERRC engineers Edward Schoppet (left) and Howard Sinnamon evaluate macaroni enriched with high-protein whey for dough consistency, uniformity, and appearance.

Whey

Nine pounds of whey, a watery byproduct of cheesemaking that contains about half of the nutrients of milk, are produced for every pound of cheese. It is to the credit of the scientists of the Eastern center and to other researchers that new uses for whey have been discovered during the last 50 years to accompany sharp increases in U.S. cheese production. While whey continues to be a surplus product, more than 40 percent of it is now marketed each year, and research continues to find new and profitable markets for the product. Were it not for research, the industry would have to get rid of hundreds of millions more pounds of unused, surplus whey annually, a financial loss as well as a serious waste disposal problem.

In general, there are two kinds of whey: sweet rennet whey, produced in making Cheddar and other sweet-type cured cheeses, and sour or acid whey, from cottage cheese, farmer cheese, and similar products. Even before 1940, USDA researchers had begun working with the dairy industry to find

Kevin Hicks, ERRC chemist, led research team that developed an inexpensive way to obtain lactulose, used to treat a liver disorder, from whey, a surplus commodity.

uses for sweet whey. They were successful in helping create markets for a large part of it in sweet bakery items and in fudge and other candies.

Sour whey is more of a problem. Years ago, it was often dumped in streams, where its high oxygen demand made it a serious water pollutant. In 1961, ERRC scientists invented a better way to spray-dry dairy products. Selected gases were injected under pressure into the high-pressure feed line of a conventional spray dryer. The resultant foam dried quickly into a fine powder that could be reconstituted easily with water. The process worked well with cottage cheese whey, which had been difficult to dry with the unmodified equipment. The dried acid-type whey is used to a limited extent in several dairy, bakery, and pharmaceutical products.

In the same year, an ERRC team led by a biochemist found a way to use whey to produce a yeast. With a generous supply of oxygen to keep the process going, half a pound of yeast was produced every 5 hours from each pound of whey sugar. The yeast contained 50 percent protein and was similar in its content of amino acids and vitamins to other yeasts used in foods and animal feeds. Wheast, as it was called in the Wyndmoor lab, was produced for a number of years by a California company.

Pioneering research at ERRC in 1968 resulted in a new way to reduce pollution and produce nutritious food ingredients from whey. Millions of pounds of whey were still being fed to pigs or were dumped into streams and lakes, and the dairy industry needed better ways to handle it to comply with new antipollution legislation. ERRC research, both in Wyndmoor and through contracts, demonstrated the economic feasibility of removing water from whey with a process called reverse osmosis. It was already being used (and still is, in the Middle East, among other locations) to make fresh water from sea water.

Application of another process called ultrafiltration led to production of high-protein concentrates with the nutritive value of egg white, the highest quality protein. Whey protein concentrates are produced routinely today on a commercial scale by ultrafiltration. In addition, reverse osmosis units are gradually replacing thermal evaporators in plants as an economical means of removing water from whey.

In the early 1970's, a nutritious blend of dried whey and soybean flour replaced nonfat dried milk in the Food for Peace Program. It was developed at a time when dried milk was scarce and priced out of reach for the Title II food donation program. The whey product was designed as a dietary supplement for preschool children in developing countries. ERRC scientists and industry engineers worked together to move the product into commercial production, and millions of pounds of the whey-soy blend were shipped to feed malnourished children before dried milk again became available for the food program.

ERRC scientists in the 1970's boosted the nutritive value of pasta by enriching it with protein fractions derived from whey. The protein in unenriched wheat flour is nutritionally deficient in lysine, an essential amino acid that is a constituent of whey. Adding whey to spaghetti and macaroni enhanced their amino acid balance and increased their total protein content. Engineers found that as long as at least 60 percent of the added protein was denatured, or made insoluble, through heat coagulation, conventional equipment for processing pasta could be used without modification.

In the early 1980's, ERRC chemists found an inexpensive way to make a hitherto expensive noncaloric sugar—lactulose—from whey. Lactulose is used to treat a serious liver disorder.

Thanks to continuing research, about 1.5 billion pounds of whey are sold each year. A large portion goes into human food, including dairy products, prepared dry mixes, soft drinks, infant foods, candies, and bakery goods. It is also used in pharmaceuticals, often in the form of lactose. An even larger share of whey goes into feeds for cattle, swine, and household pets. And industry experts believe an expanding market exists today for whey protein concentrates, not only in pasta but in other foods as well.