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SYMPOSIUM ON THE CHEMICAL AND NUTRITIONAL ASPECTS OF DAIRY WASTES

Introduction

While whey, for years, was considered "just a dairy waste", such a correlation is no longer valid. The Whey Products Institute was organized in 1971 as the national trade association for whey processors and at the expressed need of these processors for an active industry organization through which industry progress could be realized. Since organized, the Institute has developed industry-recommended nomenclature and standards for whey products and at the present time the Food and Drug Administration is finalizing a common or usual name regulation for these products, in conjunction with GRAS (generally recognized as safe) affirmation of modified whey products. U.S. Department of Agriculture programs continue to recognize industry processing guidelines and product standards, and a standard of identity has been published for lactose, the sugar of milk, commonly obtained from whey; all of these are examples of progress being realized by the industry. Obviously, standardized high-quality whey products are essential in developing markets and a demand for these products.

Therefore, whey and waste are no longer synonymous.

Food scientists rapidly have come to recognize the value of whey products in various food applications. Modified wheys, for example, are especially useful in producing infant formulas which closely resemble the composition of human milk. When compared with cow's milk, human milk (like whey) is characterized by lower casein and mineral, but higher whey protein and sugar contents. Another outstanding example of the human food use now being made of whey products is by nutritionists and the medical profession who specify whey products for specialized dietetic food needs of geriatric and convalescing patients whose digestive functions require special dietary management.

Table I. Estimated U.S. Fluid Whey and Whey Solids Production (by type) and Resulting Quantity of Whey Solids "Further Processed"

	millions of pounds				
	1972	1973	1974	1975	1976
sweet-type whey					
cheese production[a]	2605	2685	2937	2811	3337
calcd fluid whey[b]	23445	24165	26433	25299	30033
calcd whey solids[c]	1524	1571	1718	1645	1952
acid-type whey					
cottage cheese production[a]	784	763	690	701	711
calcd fluid whey[b]	4704	4578	4140	4206	4266
calcd whey solids[c]	306	297	269	273	277
total whey production	28149	28743	30573	29505	34299
total equivalent whey solids (sweet-type + acid-type)	1830	1868	1987	1918	2229
% of total whey solids further processed $\frac{\text{total whey solids manufacture} \times 100}{\text{total equivalent whey solids}}$	53.2%	55.0%	56.5%	60.0%	56.7%

[a] Crop Reporting Board, SRS, USDA, Da 2-1. [b] Whey production: approximately 9 lb/1 lb of cheese produced (except Cottage); approximately 6 lb/1 lb of Cottage cheese produced. [c] Average total solids content of whey is 6.5%.

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Typical food applications for whey include: bread and other baked goods, infant and dietetic foods, ice cream and other frozen desserts, cereals, soups, sauces, toppings and dressings, snack foods, confections, and beverages, to name a few. In addition, whey and modified whey have been utilized as food ingredients in P. L. 480 programs, where they play an important role in feeding malnourished peoples of developing countries. During the symposium, particular animal feed and industrial applications for whey will be discussed.

Table I summarizes U.S. fluid whey and whey solids production and the quantity of these whey solids currently estimated to be processed. Obviously, while considerable quantities of the whey solids presently available are being further processed and utilized, additional quantities are available for processing and use. During the course of this symposium, information will be given about potential processes that soon may lead to the processing/utilization of all available whey solids.

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Effect of Whey Applications on Chemical Properties of Soils and Crops

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Investigations were conducted to determine the effects of cheese whey application on agricultural cropland. One season whey additions of 4, 8, 16, and 32 in. to soil in Wisconsin showed significant yield and quality increases in corn grown over a 4-year period. In Michigan, annual applications of 3.3 in. of whey over 18-year period increased the surface soil phosphorus and potassium concentrations to abundant levels. Deeper soil profile samples showed limited downward movement of these nutrients. In Idaho, whey in irrigation waters had no significant measured impact on the quality of the ground water underlying the site. Unless excessive applications were made, no effect of nutrient buildup that would adversely influence soil productivity was noted. We conclude that land application of whey, either from truck spreading or through irrigation water, can be practiced with beneficial effects for the land and its productivity.

Public concern for pollution control has prompted the dairy industry to give greater attention to the water-pollution potential of disposable whey. The processing of whey into food and feed supplements is hampered today by increasing energy costs and is economical only at large cheese plants. The small, scattered cheese plants cannot individually or jointly afford the necessary condensing and drying facilities and therefore must dispose of the whey in some other manner.

Kraft, Inc., and similar industries, by necessity, are using the land to dispose of whey. In 1972, the Kraft firm began a project at the University of Wisconsin—Madison to evaluate this disposal method.

The results from the University of Wisconsin—Madison study were reported by Watson et al. (1977). Results showed that land spreading of whey can be practiced to the mutual benefits of the landowners and the cheese plant operators by increasing the fertility of land while providing a satisfactory method of whey disposal.

Test plots in the Wisconsin study were heavily dosed with whey. We report observable changes in the composition of the soil and the corn grown on these plots. In addition, land used for whey disposal by Kraft plants in Rupert, Idaho, and Clare, Michigan, are examined briefly as are crops grown on this land.

The plant food contained in 1 acre-inch of whey (27 300 gal, or 226 000 lb), as indicated in Morrison (1967), is about 320 lb of nitrogen, 100 lb of phosphorus, and 400 lb of potassium.

EARLIER WORK

The earliest known work was that of Berry (1923) in Scotland, where the only apparent effect of whey application on land was greater growth of the coarser grasses. Berry concluded that whey was beneficial to the soil but that high hauling costs would usually make it unprofitable. Cain (1956) studied the nutritive value of whey applied to plants grown in the greenhouse on a Miami silt loam soil. He found responses from whey application to both oats and blue-grass sod, although he felt that little nitrogen in the whey is released to plants during the early part of the growing season, following a late fall or early spring application. Sharrat et al. (1962) reported that whey was effective in increasing corn yields in the first and second growing season after application. He also found that, one-season application of whey at more than 4 acre-inches may supply sufficient salts to temporarily inhibit plant growth. He observed that the protein in whey was readily

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