Report of the Chief of the Bureau of Dairy Industry, Agricultural Research Administration, 1945

Dried Milk

The Bureau last year reported that the keeping quality of dried whole milk packaged in air could be at least doubled by evacuating the container sufficiently and filling with inert gas to reduce the oxygen content of the free space in the container to 3 percent. Further studies this year indicate that only slight reductions below 3 percent are necessary to increase the keeping quality even more markedly.

Some of the oxygen-containing gases in dried milk are occluded or adsorbed, however, and it is difficult to remove them sufficiently to obtain a final oxygen concentration of less than 3 percent. A study of the factors that may be concerned has shown that the fineness of the powder particles, the degree of vacuum used, the length of time the vacuum is applied, and the temperature of the product at the time of evacuation are involved. Of these, the degree of evacuation is of predominant importance. Aside from the fact that low pressures must be used for efficient gas removal, it has been found that a double evacuation between operations to allow for diffusion of occluded or adsorbed gases, greatly facilitates the attainment of a low final oxygen content.

Results with average commercial products indicate that to obtain a final oxygen content of 3 percent or less in the container, a vacuum of 3 to 5 millimeters or less for at least 3 minutes must be used. The use of a double evacuation under these conditions, with an intervening period of 4 to 7 days between evacuations and subsequent gas filling, will result in a final oxygen content of approximately 1.5 to 2.0 percent in the container.

With the use of approximately 23 millimeters of pressure for 3 minutes and a double evacuation as described, the final oxygen content of the containers will be approximately 2.5 to 3.0 percent.

Cheddar Cheese

During the past year the Bureau of Dairy Industry obtained sufficient evidence to show conclusively that it is possible to speed up the ripening of Cheddar cheese by curing it at 60° F. instead of at 50°, provided the milk is of good quality and is pasteurized. Experimental cheeses held at 60° were as fully ripened in from 3 to 4 months as those held at 50° for 6 months, and generally the flavor of those held at 60° was better.

The results of additional analytical experiments during the year confirm the Bureau's previous findings that pasteurization of high-quality milk has little or practically no significant effect on the rate of ripening of the cheese. When the raw milk has a high bacterial content, however, the rate of ripening of the cheese is retarded by pasteurization of the milk. But if such milk is not pasteurized, the resulting cheese is very inferior in flavor and quality and is abnormal in composition.

A Phosphatase Test for Cheddar Cheese

A practical method for testing Cheddar cheese to determine whether or not the milk used in making the cheese was pasteurized has recently been developed by the Bureau of Dairy Industry. The method is a modification of the phosphatase test commonly used in testing milk to determine the adequacy of pasteurization.

More than 350 samples of Cheddar

cheese, for which records of the milk treatment were available, were tested by the new method. All samples of cheese made from raw milk gave very strongly positive tests; some of these were more than 1 year old, and one was more than 5 years old. All samples made from underpasteurized milk gave results that were positive in varying degree. None of the cheeses made from milk that was pasteurized at 143° F. for 30 minutes, or at 160° or higher for about 15 seconds, gave positive tests regardless of the age of the cheese. A decrease of 2 degrees in the pasteurizing temperature or the addition of as little as 0.1 percent of raw milk to pasteurized milk, could be detected by testing the cheese.

CHEESE WHEY

About 4 pounds of whey-protein curd can be recovered from 100 pounds of separated whey and, when pressed, the curd contains about 77 percent moisture, 16.5 percent protein, and 2.5 percent milk fat.

Preliminary results indicate the feasibility of converting the whey-protein curd into a Roquefort-type of cheese and continued experiments have yielded some cheese of good quality. Preliminary results also indicate the possibility of converting whey-protein curd into a cottage-type cheese or into a suitable base for cheese spreads.

SPOILAGE IN EVAPORATED MILK

Fat separation in evaporated milk depends not only on the efficiency of homogenization, viscosity, and conditions of storage, but also on the physical state of the protein which was associated with the fat in the cream layer. Easily dispersed fat layers are less objectionable than layers which are held tightly together by adsorbed partially denatured protein. Such protein seems to exert a cementing effect on the fat globules. Undesirable changes in the protein took place in those milks which had received less than the normal amount of heat during processing.

ADDITION OF SUGAR TO POWDERED ICE CREAM MIX

Experiments by the Bureau of Dairy Industry to improve the manufacture of powdered ice cream mixes have shown the possibility, as well as the economy, of adding most of the sugar after the mix has been dried rather than before it is dried. As much as 90 percent of the required sugar can be added after the mix is dried, thus avoiding the necessity of dissolving it in water and removing the water later during the drying process. The freezing and whipping properties of ice cream mixes made from powders prepared in this way are entirely normal.

Some manufacturers are not homogenizing the mixes before drying them, but are relying instead on the nozzle of the sprayer to homogenize the mix. Experiments with unhomogenized mixes show that some homogenizing effect on the butterfat occurs in the vacuum pan and at the nozzle, but usually this is not enough to stabilize the butterfat sufficiently to the action of the beaters. Homogenization of the mix is recommended without reservation.

HOMOGENIZATION OF ICE CREAM MIX

Small commercial manufacturers of ice cream mixes, who ordinarily do not have homogenizers, can make a good product without homogenizing the entire mix if they buy and use cream that has been properly homogenized, according to experiments by the Bureau of Dairy Industry.

At the time homogenizers first came into use in ice cream plants, about 1910 to 1915, it was customary to homogenize the cream only. Later the manufacturers found it more convenient and also productive of better results to homogenize the entire mix, and this is the common practice today. But the homogenizer is a much better machine than it was some years ago and cream properly homogenized affords the smaller manufacturer a means of mak-

ing equally good mixes. Besides improving the quality of the ice cream, the principal purpose of homogenization is to prevent the churning of the butterfat in the freezer.

The Bureau's experiments indicate that creams of from 20 to 30 percent fat content are most convenient to handle and that mixes made from such homogenized creams whip very satisfactorily, there actually being no trouble in obtaining overruns considerably in excess of the legal 100 percent standard. From the standpoint of "eating properties" identically proportioned ice creams made from homogenized creams and homogenized mixes are usually of the same quality.

NEW TYPE OF CANNED MILK DEVISED FOR ARMED FORCES

A new type of canned milk which is high in "quick energy" value and suitable for drinking directly from the container was developed during the year by the Bureau of Dairy Industry, with the cooperation of evaporated milk manufacturers, in response to requests by the Army Quartermaster Corps. The milk was wanted for use on invasion beachheads where the landing forces frequently need a "pick-up" for sluggish appetites.

The milk, which is a sterile product in sealed containers, has excellent storage life and it is only slightly more concentrated than ordinary fluid milk. It contains approximately 16 percent total solids, whereas ordinary fluid milk contains about 13. The extra solids are largely sugars of different kinds, although a little more milk fat is also included in the formula.

Both chocolate and caramel gave a product of satisfactory flavor, but caramel seemed the most promising from a commercial manufacturing standpoint. Small batches of caramel flavored milk were made commercially by an interested manufacturer of evaporated milk, and the new product is now available for use by the Quartermaster Corps.

PENICILLIN MAY HAVE NONMEDICAL USES

Experiments by the Bureau of Dairy Industry during the year showed that penicillin, which is now used only in the medical field, has a destructive action against bacterial spores which may make it useful also in nonmedical fields, including food preservation.

Spores, which are a dormant form of germ life, occur widely in food materials and constitute one of the major problems of the canning industry. Their extraordinary ability to resist high temperatures and other destructive influences, combined with their inherent capacity to germinate and produce toxins and other forms of food spoilage, is responsible for the rigorous pressure sterilization now required in commercial practice.

In the medical field the use of penicillin is against the nonsporulating or vegetative bacteria, but even these forms of bacteria are not affected except when they are actively multiplying. Apparently, bacteriologists in general have assumed that penicillin would have no effect against spores because of their dormant nature. Earlier work in the Bureau of Dairy Industry, however, had shown that mild heating would stimulate spores to grow, and this knowledge led the dairy bacteriologists to believe that suitable growth conditions or prior stimulation of the spores might make them susceptible to penicillin.

Investigating their theory, the dairy bacteriologists found that penicillin causes a marked destruction of bacterial spores when the fluids in which they are suspended are suitably incubated with small amounts of the drug (5 Oxford units per milliliter). They found that after incipient germination occurs the spores assume some of the unstable characteristics of vegetative cells, at which time they are attacked by the penicillin present. This action arrests their further development before vegetation can occur. In the mean-

time degenerative changes take place in the cells as a result of the penicillin action, which leads ultimately to their death.

Ten different cultures representing five different species of the genus *Bacillus* were studied (*B. cereus, B. megathereum, B. stearothermophilus, B. brevis,* and *B. subtilis*). All but one species (*B. cereus*) were found to be susceptible to penicillin in varying degrees. Even in the susceptible species, however, a small fraction of the spores is relatively resistant to penicillin.

The remarkable effectiveness of penicillin in low concentration against spores of high heat resistance, together with its nontoxic nature and its rapidly decreasing cost, suggest its possible usefulness as a preserving agent. A suitable combination of penicillin and mild heating seems to offer the best prospect of success. The possible usefulness of penicillin in relation to the sterilization of evaporated milk and to the prolonged preservation of fresh milk is under investigation.

NUTRITION AND PHYSIOLOGY INVESTIGATIONS

VITAMIN A VALUE OF SUMMER BUTTER

Since 1941 the Bureau of Dairy Industry has been cooperating with some 20 State agricultural experiment station laboratories to determine (1) the average vitamin A potency of the creamery butter produced in the United States; (2) the effect of commercial methods of storage on the vitamin A potency; and (3) the vitamin A potency of the butter sold on the retail markets.

The results of the nation-wide survey, which were compiled by the Bureau during the year, show that about 64 percent of the creamery butter is produced in summer and about 36 percent in winter. The summer butter has averaged nearly 18,000 International Units of vitamin A per pound and the winter butter about 11,000, making the average potency of the total annual output approximately 15,000 International Units per pound.

The survey showed also there is practically no loss of potency during ordinary commercial storage and handling of the butter, and that butter sold on the retail markets also averaged about 15,000 International Units of vitamin A per pound. Butter of the average potency, when consumed at the prewar rate of 18 pounds per capita per year, furnishes about 15 percent of the daily vitamin A allowance for normal adults.

Butter containing as much as 23,000 International Units is frequently produced in summer, under very good pasture conditions, but there are large fluctuations in the vitamin A potency of the butter produced from month to month and from State to State. The difference in vitamin A potency is largely the result of differences in the carotene content of the roughage feeds available to the cows in different seasons and regions. Research by the Bureau of Dairy Industry and by other investigators has shown that it is possible, by proper feeding, to produce butter in winter with the same high vitamin A potency as the summer butter.

BETTER HAY-PRESERVING METHODS RESULT IN A HIGHER VITAMIN A CONTENT IN WINTER MILK

Dairy farmers can produce milk in winter which will be as high in vitamin A value as summer milk, if they include sufficient carotene in the winter ration.

Although increasing the amount of carotene does not in itself result in a greater yield of milk, it is possible to improve the ordinary methods of preserving the hay crops and thus not only bring about an increased milk yield but reduce the losses of carotene in such crops. The greater yield of milk should make it more profitable to improve hay preserving methods, and the increased

carotene content would incidentally improve the vitamin A value of the milk.

During the year comparisons were made of the feeding value of alfalfa hay preserved as silage and a field-cured hay. The silage contained 21 percent protein and the hay about 15 percent per unit of dry matter. Cows on the silage produced 7.3 percent more milk than those on the field-cured hay. At the beginning of the feeding trials the silage contained 9 times as much carotene as the hay, and as the trial proceeded the hay lost more carotene until at the end the silage contained nearly 14 times as much per unit of dry matter as the hay. Preserving alfalfa as silage avoids the loss of feeding value in field-cured hay that results from exposure to various weather conditions during curing and in storage. The higher carotene content of the silage resulted in a higher vitamin A potency in the milk.

No Nutritional Deficiency in Milk from Cows on Grain and Corn Silage

Since the diet of the cow may alter the composition of her milk, experiments were conducted by the Bureau of Dairy Industry to determine whether there is any nutritional deficiency in the milk from cows limited to a ration of grain and corn silage. Such rations are frequently used in farm practice.

The milk produced by cows on this ration was tested for the unidentified growth factor which Bureau experiments have shown occurs in cows' milk, and the milk produced on this ration was found to contain as much of this factor as was found in milk produced either by cows on pasture or by cows that were getting a good grade of alfalfa hay.

Better Cheese

The Bureau's cheese manufacturing specialists traveled from factory to factory, usually in automobile-trailer laboratories, to demonstrate the Bureau's method of making high-quality Cheddar cheese and thus assist the factory operator in increasing the percentage of U. S. No. 1 cheese, which was so urgently needed by the Government for overseas shipment. Many factories that had previously been turning out less than 35 percent No. 1 cheese were able to increase the proportion to 80 percent, and more, by following the procedures advocated.