

Lesson 4: Processing Dairy Products

Dairy products play an important role in the human diet. This lesson discusses the techniques used to process raw milk into a variety of products that can be found in the dairy case at the grocery store.

Processing Raw Milk

The milk jug in your refrigerator probably contains milk from several cows. That is a result of modern processing techniques. Quality control tests are the first techniques used in processing raw milk. These tests include determination of fat and solids contents, sediment content, bacterial counts, freezing point, and milk flavor. All raw milk received at a processing plant is tested for antibiotics before the milk is pumped from the delivery truck.

The second step is separation, the process of removing fat from milk in the form of cream. Separation with a continuous centrifuge produces about 10 pounds of cream testing about 36 percent fat and 90 pounds of skim milk from each 100 pounds of milk.

The third step is standardization. Batches of milk and skim milk or cream are blended in large tanks to reach a uniform fat content. Clarification is the fourth step. Here the milk is centrifuged to remove sediment, body cells, and some bacteria.

Pasteurization is the next step aimed specifically at eliminating any disease-producing microorganism. Heating milk to 161°F for 15 seconds meets minimum pasteurization criteria. Louis Pasteur is credited with designing this technique but he did so with wine. Pasteurization effectively destroys the tuberculosis bacterium.

Modern food science helped develop step six, which is homogenization. Fat globules in fluid milk naturally clump together and rise to the top. Homogenization subdivides the fat globules so they will no longer separate and rise to the top.

In the United States, fluid milk is generally fortified with vitamin D. This is step seven. Following fortification, the milk is cooled and finally packaged.

Why Pasteurization and Homogenization?

In 1871 Louis Pasteur proved that heating to a critical temperature destroyed the spoilage microbes in a liquid. Other scientists have shown what the temperature must be for different lengths of time in order to kill specific disease-producing (pathogenic) bacteria and viruses in milk and its products. The milk industry applies the concept to milk processing. Pasteurization is necessary to rid milk of any disease-producing microorganism and to reduce the total bacterial numbers for improved shelf life. Lipase and other natural enzymes are destroyed by this process which proved to be the breakthrough in preventing the spread of tuberculosis. The batch method is designed

Food Science and Technology-Unit II

to heat each milk particle to 145°F for 30 minutes. The high temperature, short-time method (HTST) heats every particle to at least 161°F for 15 seconds. The HTST method has largely replaced the batch method. Pasteurized milk is not sterile, so it must be refrigerated.

Homogenization is the reason why every glass of milk from a milk jug is consistent in flavor and texture. In the homogenization process, milk is pressure pumped to subdivide its fat globules. The fat globules are divided into very small globules and this prevents them from rising to the top and forming a cream layer. Milk that has undergone homogenization, which is not necessary for health reasons, is richer in taste and whiter in appearance than unhomogenized milk.

Processing Major Dairy Products

The milk processing industry stands as one of the largest segments in the food science area. A growing number of products result from research efforts in this field. Fifteen major products are discussed in this lesson.

Whole milk has a minimum milk fat level of 3.25 percent. It is pasteurized, homogenized, fortified with vitamin D, and packaged. Vitamin D is added because the diets of many children in the U.S. are deficient in Vitamin D.

Low-fat milk has its milk fat level standardized to 0.5 percent, 1 percent, 1.5 percent, or 2 percent, and is fortified with vitamins A & D, pasteurized, homogenized, and packaged. Vitamins A and D are fat-soluble vitamins. This means that as the milk fat is removed, so are these vitamins. Therefore, low fat milk must be fortified with them.

Non-fat milk (also called skim milk) has its milk fat level reduced to below 0.5 percent, is fortified with vitamins A & D, and is pasteurized, homogenized, and packaged.

Chocolate milk can be made from whole, low-fat, or nonfat milk that is mixed with chocolate syrup or cocoa powder and sugar.

Cultured buttermilk is skim, low-fat, or whole milk that is heated to 185°F for 30 minutes and then inoculated with lactic acid-producing bacteria and held at 72°F until the pH drops to about 4.5. Then it is cooled. This controlled environment allows the pH, flavor, and texture to be modified.

Yogurt is another product that can be made when appropriate microorganisms are allowed to ferment at about 110°F. *Streptococcus thermophilous*, and *Lactobacillus bulgaricus* are used to inoculate whole, low-fat or skim milk. The pH is lowered as lactose is converted to lactic acid, and casein (milk protein) coagulates and forms the thick texture of yogurt.

Acidophilus milk is fermented whole milk. Milk is fermented by adding *Lactobacillus acidophilus* bacteria. These bacteria digest the lactose in the milk, making it possible for lactose-intolerant people to drink this milk. Sweet acidophilus milk contains the same bacteria but is not fermented.

Cream (high in milk fat) is separated from the raw milk with a centrifuge. After it rises to the top, it is skimmed off (Quiescent method). It is then pasteurized and processed into a variety of fat-content creams, such as whipping cream, coffee cream, half-and-half, sour cream, or heavy whipping cream.

Sour cream, as previously mentioned, begins as cream that has been separated from raw milk. This cream is pasteurized and cultured with lactic acid-producing and flavor-producing bacteria. Sour cream is 18 percent fat whereas half-and-half is 10.5 percent fat.

Butter is produced by churning (agitating) sweet or sour cream. In the U.S., sweet cream is the preferred type. The cream must be churned sufficiently to break the oil-in-water emulsion of cream and form a water-in-oil emulsion. The butter is washed with cold water and then worked to reduce the water content to around 15 percent. Butter is at least 80 percent fat. Salt may be added to enhance the flavor and color may be added to reach the desired yellow color.

Canned milk has had 60 percent of the water evaporated before it is homogenized. The concentrated milk is at least 7.5 percent milk fat and 25 percent milk solids. This viscous milk is canned and sterilized at 240°F for 15 minutes. An additive, carrageenan gum, is used to give it a smooth texture. Sweetened, condensed milk is canned with sugar added.

Nonfat dried milk is skim milk that has been dehydrated so that it can be stored for long periods of time at room temperature. Growth of microbes is prevented due to the low moisture content. It may be reconstituted before use or used in the dried state. Instant nonfat dry milk has been wetted and redried to increase its ability to be dispersed and dissolved in water.

Ice cream is a frozen mixture of cream, milk solids, sugar, and flavorings into which air is stirred as the mixture is frozen. Ice cream is 10 percent milk fat which accounts for its smoothness of texture and richness of flavor. The milk is heated to 140°F and then sugar, an emulsifier, a stabilizer, and flavorings are added. This mixture is pasteurized, homogenized, and slightly aged. Then it is frozen to 20°F while air is whipped into the cream. It is now ready for packaging. Frozen custard differs in that egg yolks are added to the mixture. New labeling will replace ice milk with reduced fat, light, low-fat, and nonfat ice creams. Sherbet has 1-2 percent milk fat and only 2-5 percent total milk solids.

Food Science and Technology-Unit II

Natural cheese is made from pasteurized milk that has the added enzyme rennin, which helps clot the milk. Bacteria convert lactose to lactic acid and the pH drops from 6.7 to as low as 4.6. A soft curd develops. This curd is cut to release the whey, which is a watery liquid that contains lactose, serum proteins, minerals, and water-soluble B vitamins. The riboflavin in it gives it the yellow-green color. The curd is then heated, pressed down to 40 percent water, salted, shaped, and ripened. Ripening alters the texture, odor, and flavor. Two of several cheeses that are not ripened are cottage cheese and cream cheese.

Processed cheese is a mixture of different kinds of natural cheeses that have been mixed and ground together and then melted to a uniform product with the aid of emulsifiers. Processed cheeses contain about 1 percent more moisture than the natural cheese from which they are made, which forms an easier spreading product. Additional moisture is permitted in processed cheese food and even more in processed cheese spread.

Packaging

Milk and dairy products should be packaged for protection and convenience. A fundamental reason for packaging is that mold and bacterial contamination are prevented with proper packaging. Shelf-life and freshness increase with a sealed package. Riboflavin (vitamin B₂), thiamine, vitamin A, and vitamin C in fluid milk are light sensitive. Opaque or other appropriate packaging is useful in reducing the breakdown of these vitamins when containers are exposed to sunlight or ultraviolet light. Dried whole milk is packaged under nitrogen, so the packaging material must be impermeable to oxygen.

Industry Organization

Today's dairy industry is composed largely of individual producers who belong to milk cooperatives. The cooperative pools the milk and processes it or sells it to proprietary (private) processors. Separate processing plants for cheese and ice cream production are the norm. Coops generally belong to the National Milk Producers Federation whereas processing firms belong to the International Dairy Foods Association (IDFA). These organizations conduct research and do educational, promotional, regulatory, legislative, and training activities for their members as well as the general public. California, Wisconsin, New York, Pennsylvania, and Minnesota rank as the top five milk producing states.

Summary

Milk is nature's most complete food nutritionally. It is rich in calcium, phosphorus, water-soluble vitamins, protein, and carbohydrates. Before it arrives at the grocery store, milk is tested, standardized, clarified, pasteurized, homogenized, fortified, cooled, and packaged. Pasteurization rids milk of pathogens, and homogenization improves its drinking quality. Milk is processed into numerous products using multiple techniques. Milk products are fresher and store longer if they are properly packaged. The dairy industry is composed of individuals, cooperatives, and national organizations that work toward providing quality dairy products for American consumers.

Credits

Campbell and Marshall. *The Science of Providing Milk for Man*. 1st ed. New York: McGraw-Hill, 1975.

McWilliams, Margaret. *Foods Experimental Perspectives*. 1st ed. New York: Macmillan Publishing Co., 1989.

Milk Industry Foundation (M.I.F.). *Milk Facts*. Washington, DC: 1992.

Potter, Norman N. *Food Science*. 4th Ed. Westport, CT: AVI Publishing Co. Inc., 1986.