

## Milk Processing

Milk fresh from the cow is virtually a sterile product. All post-milking handling must maintain the milk's nutritional value and prevent deterioration caused by numerous physical and biological factors. In addition, equipment on the farm must be maintained to government and industry standards. Most cows are milked twice a day, although some farms milk three or four times per day. The milk is immediately cooled from body temperature to below 40°F (5°C), then stored at the farm under refrigeration until picked up by insulated tanker trucks at least every other day. The milk tanker driver records the amount of milk and notes the temperature and the presence of any off-odors. If the milk is too warm or has an off-odor, it will not be picked up, and the farmer will have to feed it to his animals or dump it. When the milk is pumped into the tanker, a sample is collected for later lab analysis.

When the milk arrives at the milk plant, it is checked to make sure it meets the standards for temperature, total acidity, flavor, odor, tanker cleanliness, and the absence of antibiotics. The butterfat and solids-not-fat content of this **raw milk** is also analyzed. The amounts of butterfat (BF) and solids-not-fat (SNF) in the milk will vary according to time of year, breed of cow, and feed supply. Butterfat content, solids-not-fat content, and volume are used to determine the amount of money paid the farmer.

Once the load passes these receiving tests, it is then pumped into large refrigerated storage silos (nearly half-million pounds capacity) at the processing plant.

All raw milk must be processed within 72 hours of receipt at the plant. Milk is such a nutritious food that numerous naturally occurring bacteria are always present. The milk is pasteurized, which is a process of heating the raw milk to kill all "pathogenic" bacteria that may be present. A pathogen is a bacteria that could, if allowed to grow and multiply, make humans sick. It should be noted that pasteurization is not sterilization (sterilization eliminates all viable life forms, while pasteurization does not). After pasteurization, some harmless bacteria may survive the heating process. It is these bacteria that will cause milk to "go sour." Keeping milk refrigerated is the best way to slow the growth of these bacteria. Some bacteria do not cause spoilage, but are actually added to milk or cream after pasteurization to make "cultured" products such as cheese, cottage cheese, yogurt, buttermilk, acidophilus milk and sour cream.

There are different ways to pasteurize milk. The "batch" method heats the milk to at least 145° and holds it at that temperature for at least 30 minutes.

Since this method may cause a "cooked" flavor, it is not used by some milk plants for fluid milk products.

**High Temperature/Short Time (HTST) pasteurization** heats the milk to at least 161° for at least 15 seconds. The milk is immediately cooled to below 40° and packaged into plastic jugs or plastic-coated cartons. Most milk plants have at least one HTST processor. This piece of equipment is considered the "heart" of the plant.

Butterfat content accounts for several different types of products. Whole milk, 2%, 1%, Nonfat, and Half & Half are some examples. A machine called a separator separates the cream and skim portions of the milk. A separator is really a large centrifuge that spins about 2,000 rotations per minute. The different types of milk products are then "standardized" by blending the components (skim milk, raw milk, cream) in the correct proportions to yield the desired end-products. Water is never added to lower the butterfat content of fluid milk. Excess cream is used to make ice cream and butter.

Milk is homogenized to prevent the cream portion from rising to the top of the package. The expression "cream rises to the top," is accurate because cream is lighter in weight than milk. The cream portion of un-homogenized milk would form a cream layer at the top of the carton. A "homogenizer" forces the milk under high pressure through a valve that breaks up the butterfat globules to such small sizes they will not "coalesce" (stick together). Homogenization does not affect the nutrition or quality of the product; it is done entirely for aesthetic purposes.

Vitamin quantities may be reduced by the heating process and removal of the butterfat. Therefore, to replace the natural nutrition of nature's perfect food, liquid vitamins are added to fortify most fluid milk products. Many states have milk standards that require the addition of **milk solids**. These solids represent the natural mineral (i.e. calcium, iron), protein (casein), and sugar (lactose) portion of nonfat dry milk. You will see this shown as an ingredient on those products needing fortification.

Quality Control personnel conduct numerous tests on the raw and pasteurized products to insure optimum quality and nutrition. A sample is analyzed for the presence of microbiological organisms with a **standard plate count** (SPC) and **ropey milk** test. The equipment used to analyze butterfat and solids-not-fat is calibrated on a regular basis to insure a consistent, quality product that meets or exceeds government requirements.

All milk products have a **sell-by** date printed on the package. This is the last day the item should be offered for sale. However, most companies guaranty the quality and freshness of the product for at least 7 days past the date printed on the package. Samples of each product packaged each day are saved to confirm that they maintain their freshness 7 days after the sell-by date.

Once the milk has been separated, standardized, homogenized and pasteurized, it is held below 40°F in insulated storage tanks, then packaged into gallon, half-gallon, quart, pint, and half-pint containers. The **packaging machines** are maintained under strict sanitation specifications to prevent bacteria from being introduced into the pasteurized product. All equipment that comes into contact with product (raw or pasteurized) is washed daily. Sophisticated automatic **Clean-in-Place** (CIP) systems guarantee consistent sanitation with a minimum of manual handling, reducing the risk of contamination.

Once packaged, the products are quickly conveyed to a cold storage warehouse. They are stored there for a short time and shipped to the supermarket on refrigerated trailers. Once at the store, the milk is immediately placed into a cold storage room or refrigerated display case.

## **Food Safety**

Food safety is a very broad topic. Pesticides, herbicides, chemical additives, and spoilage are all of concern, but food scientists, food processors, and consumers focus most on microbiological quality. [Microorganisms](#) pose a challenge to the food industry and most food processes are designed with microbial quality in mind. Microorganisms are often too small to be seen with the unaided eye and have the ability to reproduce rapidly. Many of them produce toxins and can cause infections. For all of these reasons, the microbiological quality of the food we eat is scrutinized closely.

Centuries ago, Genghis Khan was able to rule vast stretches of land through the mobility of his army. With very little food, he was able to engage in swift attacks over long periods of time. As the story goes, each horseman carried two leather bags. The larger one held dry milk produced by drying fluid milk in the sun during periods of rest. The smaller bag was used to rehydrate some of the milk powder with water, which was consumed during an offensive. The lightly equipped army of Khan thus could cover long distances in weeks, and eventually controlled most of the Asian continent. Yet, one has to wonder how many people suffered food-borne illness in those days.

Today, [food-borne illness](#) is of serious concern. Its frequency is not known because a great majority of the cases go unreported. Reporting [food-borne diseases](#) to public health authorities is not required in the United States. Estimates claim as many as 200 million cases in the U.S. per year. Only a small percentage of these are hospitalized. Most are passed off as traveler's diarrhea, 24 hour flu, or upset stomach. [Salmonellosis](#), one of the more serious food-borne diseases, is said to be reported only about 1% of the time. About 42,000 cases of salmonellosis are reported in the U.S. annually, with about 150 deaths. So, there are potentially 4.2 million cases of [Salmonella](#) food poisoning annually despite the fact that the U.S. food supply is considered very safe and processed under the best conditions available.

Testing the foods we consume for the presence of pathogenic microorganisms is very important. Although 100% of the food cannot be tested, it can be deemed "safe" through proper audit of the food supply. In many instances, the pathogenic microorganisms are present in very small numbers, but for many of these pathogens, small numbers are all that are necessary to transmit disease or illness. For that reason, the presence of other microorganisms is monitored. These microorganisms provide an index of the sanitary quality of the product and may serve as an indicator of potential for the presence of pathogenic species. [Escherichia coli](#) (E. coli) is commonly employed as an indicator microorganism. Because E. coli is a coliform bacteria common to the intestinal tract of humans and animals, its relationship to intestinal food-borne pathogens is high.

Total counts of microorganisms are also an indication of the sanitary quality of a food. Referred to as the **Standard Plate Count** (SPC), this total count of viable microbes reflects the handling history, state of decomposition or degree of freshness of the food. Total counts may be taken to indicate the type of sanitary control exercised in the production, transport, and storage of the food. Most foods have standards or limits for total counts. This is especially true for milk.

It must be remembered that a low SPC does not always represent a safe product. It is possible to have low-count foods in which toxin-producing organisms have grown. These organisms

produce toxins that remain stable under conditions that may not favor the survival of the microbial cell.

In adopting microbiological standards to milk, the first concern is product safety, followed by shelf-life. The following bacterial counts are standards for milk as recommended by the U.S. Public Health Service:

**Grade A raw milk for pasteurization** Not to exceed 100,000 bacteria per milliliter (ml) prior to commingling with other produced milk; and not exceeding 300,000 per ml as commingled milk prior to pasteurization.

**Grade A pasteurized milk** Not over 20,000 bacteria per ml, and not over 10 coliforms per ml.

The objective of pasteurization is to reduce the total microbial load, or SPC. In addition, pasteurization must destroy all pathogens that may be carried in the milk from the cow, particularly undulant fever, tuberculosis, Q-fever, and other diseases transmittable to humans. This is accomplished by setting the time and temperature of the heat treatment so that certain heat-resistant pathogens, specifically **Mycobacterium tuberculosis** and **Coxiella burnetii** (causative agents of Q-fever and tuberculosis, respectively) would be destroyed if present. Milk pasteurization temperatures are sufficient to destroy all yeasts, mold, and many of the spoilage bacteria.

## **Quality Assurance**

Of all functions in the food industry, Quality Assurance (QA) requires many diverse technical and analytical skills. QA personnel continually monitor incoming raw milk and finished milk products to insure compliance with compositional standards, microbiological standards, and various government regulations. A QA manager can halt production, refuse acceptance of raw material, or stop the shipment if specifications for a product or process are not met. This department does not usually have control over the product unless something has gone wrong.

The major functions of the QA Department are:

**Compliance with specifications** Legal requirements, industry standards, internal company standards, shelf-life tests, customers' specifications.

**Test procedures** Testing of raw materials, finished products, and in-process tests.

**Sampling schedules** Utilize a suitable sampling schedule to maximize the probability of detection while minimizing workload.

**Records and reporting** Maintain all QA records so that customer complaints and legal problems can be dealt with.

**Trouble shooting** Solve various problems caused by poor quality raw materials, erratic supplies and malfunctioning process equipment; and investigate reasons for poor quality product to avoid repetition.

**Special problems** Customer complaints, production problems, personnel training, short courses, etc.

A typical QA Department may have a chemistry lab, a raw materials inspection lab, a sensory lab and a microbiology lab. All of these disciplines work together to assure that the food we consume is of the highest quality. After all, it is quality which will bring a customer back again and again.