Yogurt Production

YOGURT is one of the most popular dairy foods. Its production is among the fastest growing segments of the dairy industry. When yogurt was introduced to consumers, many people were hesitant to try a product that was created using bacteria. The sour, nutty flavor of plain yogurt was not appealing to a large number of consumers. This kept sales of yogurt low. In time, food processors developed new techniques for flavoring yogurt to increase the sweetness and increase consumer demand. Today, numerous flavors and styles of yogurt, including fruit-added and frozen yogurt, are available. These new offerings, along with the health benefits of eating yogurt, have made yogurt one of the most highly demanded dairy products.

Objective:

Explain how fermentation and anaerobic respiration are needed to produce a yogurt product.

Key Terms:

aerobic respiration
anaerobic respiration
end product
fermentation
food fermentation
lactic acid
lactose
viscosity
yogurt

How Yogurt Is Made

Yogurt, a fermented dairy product in which milk is inoculated with bacteria, is an example of mixed pure culture fermentation. In other words, a controlled mixture of known bacteria is used in the fermentation process to create yogurt.

Yogurt is created through the process of **fermentation**, a slow decomposition of organic substances by microorganisms or enzymes. **Food fermentation** is the study of microbial activity, usually in anaerobic environments, on food substances under controlled conditions. In the production of yogurt, **lactose**, a compound sugar found in milk, also known as milk sugar or lactin, is fermented by both *Streptococcus* and *Lactobacillus* bacteria.

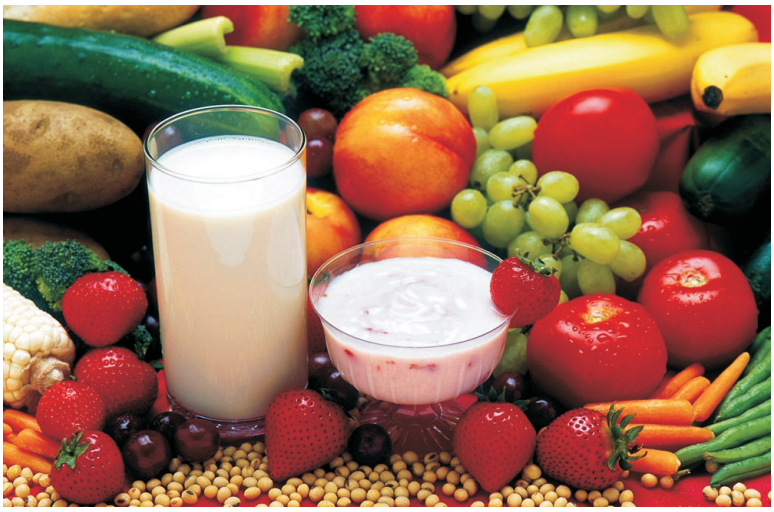

FIGURE 1. Yogurt has become one of the most popular fermented dairy products on the market. (Courtesy, Agricultural Research Service, USDA)

Yogurt is commercially produced using a mixture of milk and 2 to 4 percent nonfat dry milk powder. This mixture is then treated, or inoculated, with a 5 percent combination of *Streptococcus thermophilus* and *Lactobacillus bulgaricus* bacteria in a 1 to 1 ratio. Once treated, the milk product is incubated at 113°F (45°C) for three to six hours to encourage fermentation. After the completion of fermentation, the mixture is immediately chilled to stop the growth of the bacteria and any further fermentation.

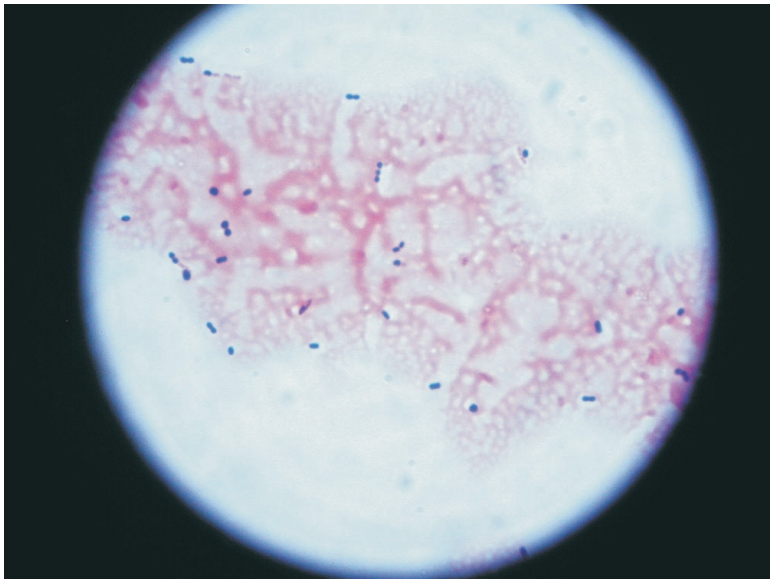

FIGURE 2. *Streptococcus* and *Lactobacillus* bacteria are used in the production of yogurt. (Courtesy, USDA)

Although the fat content of yogurt can vary from 0 to 3.5 percent, most yogurts are created low fat and contain only 1 to 1.5 percent fat. For this reason, yogurt has become a popular alternative for people desiring the nutrition of a dairy product without the fat content of regular milk products.

The distinct flavor of yogurt comes from the production of **lactic acid**, the end product of the anaerobic metabolism of glucose that happens during fermentation. Lactic acid will provide

UNDER INVESTIGATION...

LAB CONNECTION: Yogurt Production

Yogurt is quickly becoming one of the fastest growing and largest segments of the dairy industry. Millions of people are enjoying yogurt every day for its distinctive taste and health benefits. Producers and processors are constantly creating new flavors of yogurt to satisfy an ever-growing consumer demand.

Yogurt is created by inoculating milk with specific bacteria to begin the fermentation process. Although these bacteria would normally curdle and spoil milk, used properly they can create the semisolid texture and interesting flavor that yogurt provides. The large-scale production of yogurt is not without problems, however. Chemistry, genetic engineering of the bacteria, and general food science all play roles in yogurt production.

Yogurt can be made with a few ingredients and the right environmental conditions for bacterial growth.

Experiments with yogurt production can be conducted in your classroom with only a few supplies. Pasteurized milk, powdered milk, and a starter yogurt culture are the basic ingredients of any yogurt. In this exercise, powdered milk is added to milk. The mixture is heated, then cooled. Starter yogurt culture is added, and the container is placed in an incubator at 102.2°F (39°C) until the mixture coagulates (about six to eight hours). The yogurt is then refrigerated. Consider adding sugar or fresh fruit to your yogurt to enhance the flavor. Maybe you will develop the next big flavor in yogurt right in your classroom!

a tart, acidic flavor as well as create a gel structure that gives yogurt a semisolid texture and appearance. Most of the flavor of yogurt is derived from carbonyl compounds. One of these compounds, acetaldehyde, gives yogurt a green apple or nutty flavor. The quality of yogurt is based on the color, appearance, body, texture, and flavor of the product. Many yogurt producers will add additives and preservatives to increase the life and enhance the flavor of the product, drawing in more consumers.

Ropy, or slime-producing lactic acid bacteria, will produce polysaccharides that are released into the yogurt mixture. These polysaccharides will increase water retention and **viscosity**, or the resistance of a liquid to flow, in the yogurt. Processors wish to create yogurt with high moisture content yet somewhat solid in a gel-like structure. Most yogurts have a moisture content of 82 to 86 percent.

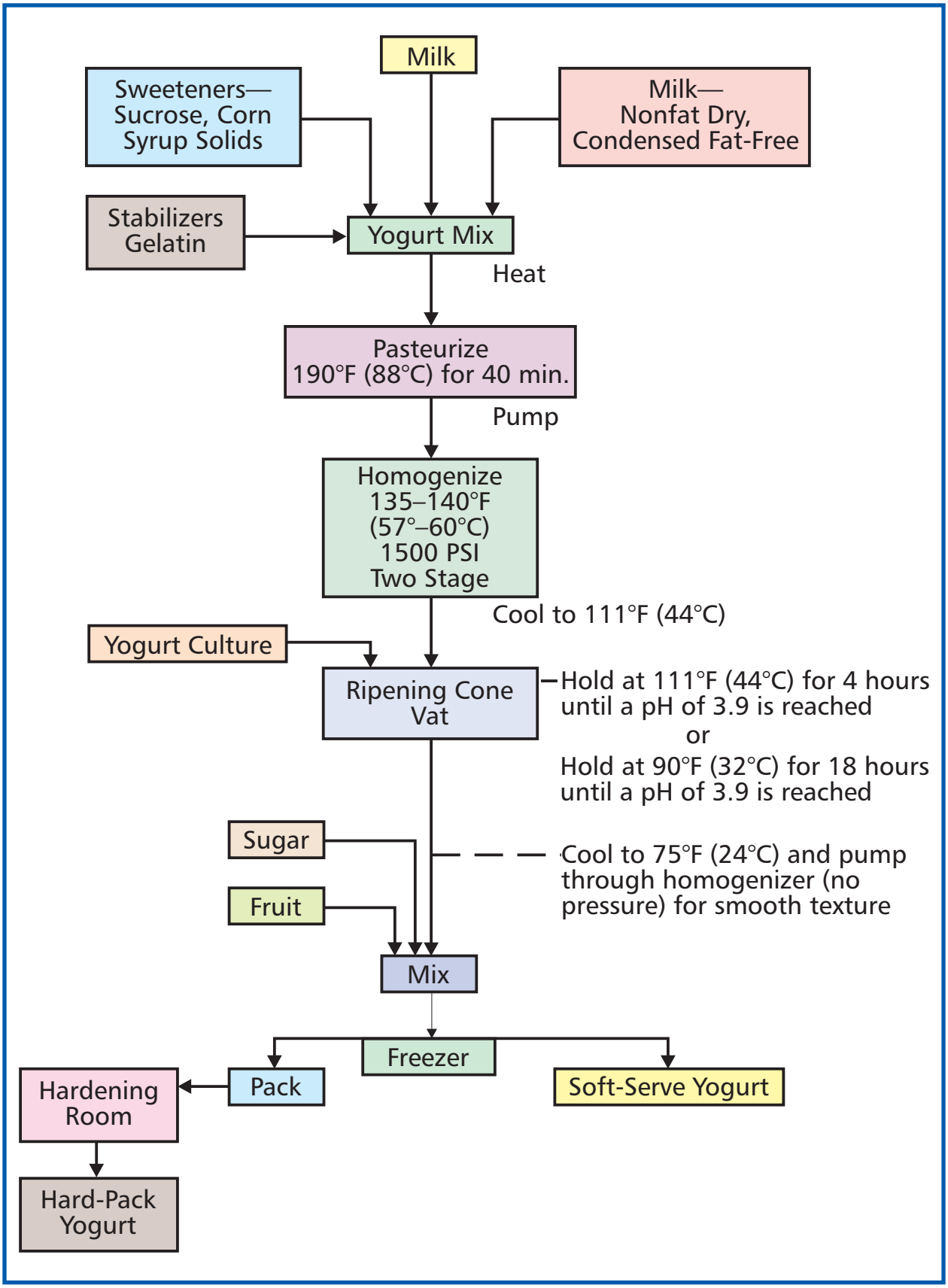

FIGURE 3. The frozen yogurt manufacturing process.

Milk SNF (solids-not-fat) content in yogurt will normally range from 9 to 16 percent. SNF levels in yogurt are increased by adding milk powder, which will increase protein levels in the mixture. Increased SNF levels will lead to an increase in viscosity and a thicker texture of the yogurt.

Frozen yogurt is a major part of the yogurt industry but is actually more than just "frozen yogurt." Ice milk, sweeteners, and stabilizers are all added to yogurt, and the mixture is then frozen to produce a frozen yogurt product.

FERMENTATION AND ANAEROBIC RESPIRATION

Even after the process of pasteurization, milk still contains bacteria that will ultimately ferment, or sour, the milk product. This fermentation process is critical to yogurt production but must be monitored closely to keep from spoiling the yogurt before it is completed. The bacteria present to create yogurt must complete a process known as respiration to create the energy they need to live and reproduce.

Aerobic respiration is the total oxidative breakdown of glucose in the presence of oxygen. Without oxygen, this type of respiration cannot take place, and the bacteria involved would not survive or grow. Fermentation, however, is an example of **anaerobic respiration**, a similar breakdown of glucose that happens only in the total absence of oxygen.

During anaerobic respiration, glucose is degraded into several end products, one of which is lactic acid. This lactic acid provides the sour taste that people enjoy in yogurt. The bacteria *Streptococcus* will create the lactic acid as they ferment the glucose and milk sugar present in the milk. The lower the pH value (or greater the acidity), the more the liquid milk will coagulate and become viscous.

Lactic acid bacteria are gram-positive, non-spore–forming bacteria that produce lactic acid as the product of fermentation. These bacteria are used not only in the production of yogurt but also in pickling, cheese making, and other dairy technologies.

Yogurt can be created because milk proteins have the ability to curdle, or form a gel. Curdling is begun by proteolytic enzymes, lactic acid, heat, and other means. The milk gel caused by curdling contains a protein matrix, or a netlike structure of proteins, that is able to trap and hold moisture in milk. As heat is applied to milk, the micelles in milk interconnect to form the gel matrix. As scientists work with this gel structure, they are able to modify it to create stable milk products with high moisture contents, such as yogurt.

Milk being used to make yogurt is normally heated first to increase the total solids content, resulting in a firmer end product. An **end product** is the final compound or substance resulting from a chemical reaction.

If dairy cows are currently receiving antibiotic treatments, their milk is normally discarded for a specific period. The antibodies present in their milk could disrupt or inhibit the growth of the beneficial bacteria needed for the production of fermented dairy products.

Summary:

Yogurt is one of the most popular dairy foods. Its production is among the fastest growing segments of the dairy industry. Bacteria that would normally spoil milk are used in an anaerobic fermentation process to curdle or thicken the liquid milk into a semisolid product. The byproducts of the fermentation process create the unique flavor of yogurt that many people desire.

Checking Your Knowledge:

1. Explain the fermentation process.
2. What causes yogurt to develop a distinct, sour flavor?
3. List three factors that affect curdling in milk.

Expanding Your Knowledge:

Visit the dairy department of a local supermarket. Note the varieties of yogurt available. Select six different kinds and examine the nutrition labels. List the total calories, the fat content, and the sugar content of each. Rank your six choices according to how healthful you believe them to be (1 = most healthful, 6 = least healthful).

Web Links:

Microbes in My Food!

http://www.uen.org/Lessonplan/preview.cgi?LPid=2232

Yogurt—A Milk Product with More!

http://www.medicinalfoodnews.com/vol02/issue5/yogurt.htm

Agricultural Career Profiles

http://www.mycaert.com/career-profiles