# CONCENTRATED MILKS

Concentrated milks are liquid milk preserves with a considerably reduced water content. Water is removed by evaporation. Preservation is achieved either by sterilization, leading to a product called *evaporated milk*, or by creating conditions that do not allow growth of microorganisms. The latter is generally realized by addition of a large quantity of sucrose and exclusion of oxygen. The resulting product is called *(sweetened) condensed milk*.

## EVAPORATED MILK

Evaporated milk is sterilized, concentrated, homogenized milk. The product can be kept without refrigeration and has a long shelf life; it is completely safe for the user. After dilution, flavor and nutritive value of the product are not greatly different from that of fresh milk. A major problem with sterilization is the heat stability; the higher the concentration of the milk, the lower its stability. That is why concentrating cannot be by more than about 2.6 times, which corresponds to a level of about 22% solids-not-fat in the evaporated milk.

Currently, bottled evaporated milk is often used in coffee in certain countries. It can be added while cold because a fairly small amount is involved as compared to nonevaporated milk. After the bottle has been opened, the milk can be kept in a refrigerator for up to 10 days because it initially contains no bacteria at all and because contaminating bacteria grow somewhat more slowly owing to the reduced water activity, which is about 0.98.

# MANUFACTURING (FLOW SHEET)

## UHT-STERILIZED AND IN-BOTTLE STERILIZED EVAPPRATED MILK

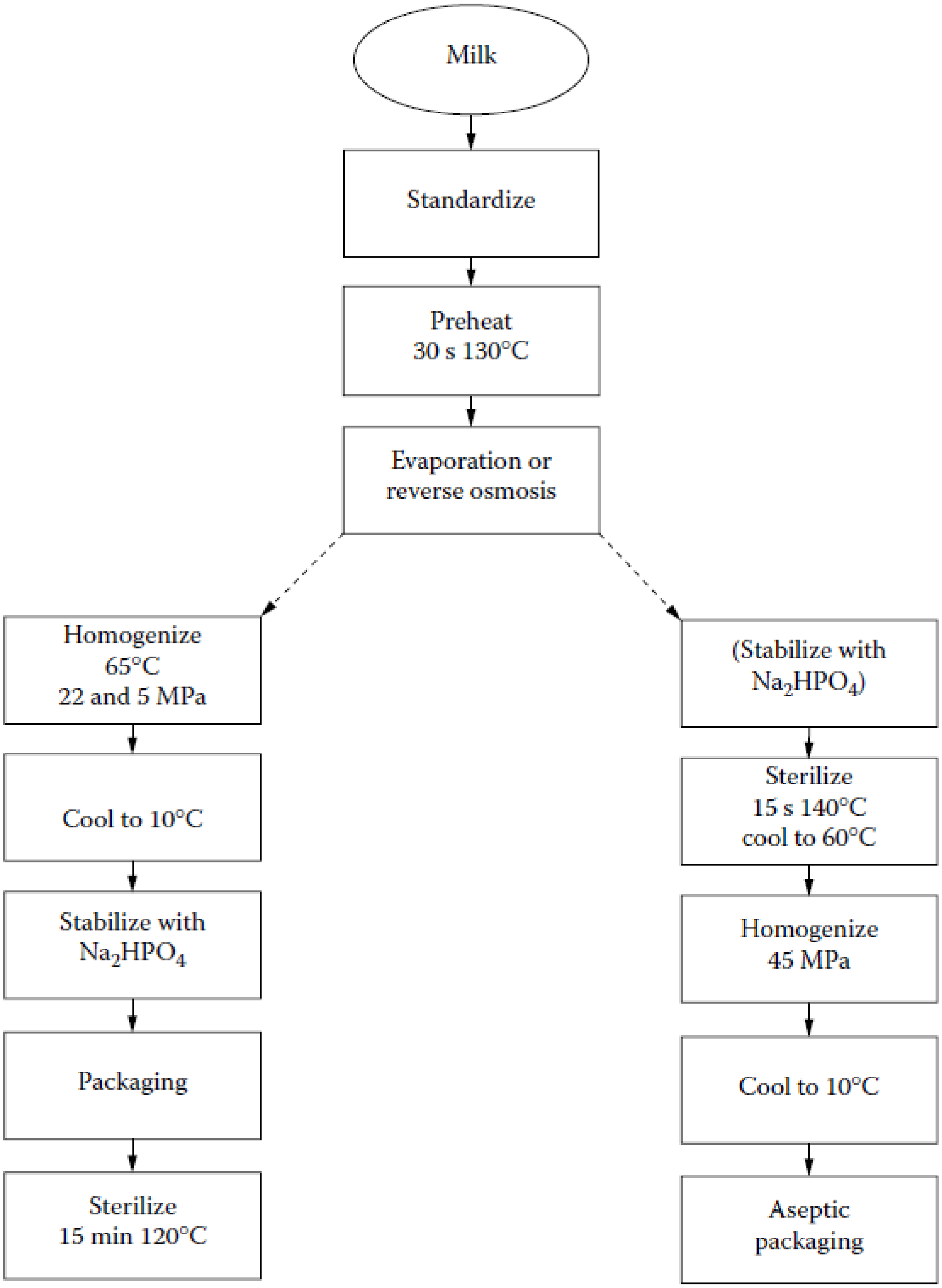


**FIGURE 19.1** Examples of the manufacture of in-bottle-sterilized (left) and UHT-sterilized (right) evaporated whole milk.

**Explanation of process:** This portion is for your understanding and explanation of above process.

*Preheating* serves to enhance the heat stability of the evaporated milk, inactivate enzymes, and kill microorganisms, including a significant proportion of the bacterial spores present. The heating temperature–time relationship is usually selected on the basis of heat stability. Formerly, a long heat treatment (e.g., 20 min) at a temperature below 100°C was often applied. Currently, UHT treatment is generally preferred. It reduces the number of spores in the milk considerably, and therefore a less intensive sterilization suffices.

*Concentrating.* The milk is usually concentrated by evaporation (see Section 10.2). Standardization to a desired dry-matter content is of much concern. A higher concentration causes a lower yield and a poorer heat stability. Continuous standardization is usually applied via determination of the mass density. Based on that parameter, either the raw milk supply or the steam supply is adjusted; it is obvious that density and dry-matter content of the raw milk must be known. Alternatively, standardization can be based on refractive index determination. The milk can also be concentrated by reverse osmosis, but this is rarely done.

After concentrating, the manufacturing processes for in-bottle-sterilized and UHT-sterilized evaporated milk differ. The former process is discussed first.

*Homogenization* serves to prevent creaming and coalescence. It should not be too intensive because the heat stability becomes too low.

*Stabilization.* To ensure that the evaporated, homogenized milk does not coagulate during sterilization and at the same time does acquire a desirable viscosity, a series of sterilization tests is often done on small quantities of the evaporated milk to which varying amounts of a stabilizing salt (for the most part, $Na_2HPO_4$) are added. The tests are needed because variation occurs among batches of milk. Essentially, the addition of the salt means adjusting the pH (see Subsection 19.1.3). Because further processing must be postponed until the test results are available, this necessitates cooling the evaporated milk after its homogenization and storing it for a while. However, long-term storage should be avoided to prevent bacterial growth; moreover, cold storage of the milk increases the tendency of age thickening (see Subsection 19.1.5). The stabilizing salt is added as an aqueous solution, which dilutes the evaporated milk slightly. Therefore, the milk is often concentrated somewhat too far and is restandardized to the correct dry-matter content during stabilization.

*Packaging* in cans is common. The tin plate of the cans is coated (provided with a protective layer of a suitable polymer) to prevent iron and tin from dissolving in the product. After filling, the cans may be closed by soldering, but mechanical sealing is currently preferred. Evaporated milk intended for use in coffee is usually packaged in bottles that are closed with a crown cork or a screw cap.

*Sterilization*. In-bottle or in-can sterilization can be applied batchwise (in an autoclave) or continuously. Machines that have rotary air locks (to maintain the pressure) may be applied for cans and hydrostatic sterilizers for bottles (see Figure 7.21).

The sterilization is primarily aimed at killing all bacterial spores — reduction to, say, $10^{-8}$ spores/ml — and inactivating plasmin. Lipases and proteinases from psychrotrophs should be absent from the raw milk because these enzymes would be insufficiently inactivated. The most heat-resistant spores are those from *Bacillus stearothermophilus*. This bacterium does not grow at moderate temperatures but may do so in the tropics. At 121°C, the $D$ value of the spores is some 4 to 7 min. The preheating as given in Figure 19.1 suffices for a sterilizing effect $S$ almost equal to 1, whereas the sterilization gives $S$ almost equal to 3 at most and, hence, added together giving $S$ less than or equal to 4. Contamination by these spores should therefore be slight, and growth of the organism occurring in the evaporator, possibly followed by sporulation (e.g., during intermediate cold storage), should rigorously be avoided (see also Section 20.3). If the sterilizing effect is adequate for *B. stearothermophilus*, then *B. subtilis*, *Clostridium botulinum*, and *C. perfringens* are also absent (see Table 7.4).

*UHT sterilization* kills bacterial spores more effectively than in-bottle sterilization. The combination of preheating and UHT treatment of the concentrate as shown in Figure 19.1 suffices to inactivate plasmin. Preheating is also required to prevent excessive heat coagulation in and fouling of the UHT sterilizer. Some heat coagulation nearly always occurs, and the subsequent homogenization also serves to reduce the size of the protein aggregates formed. Aseptic homogenization must be applied. Indirect UHT sterilization in a tubular heat exchanger allows the pump of the homogenizer to be fitted before the heater and the homogenizing valve behind it. Thereby, the risk of recontamination with bacteria is diminished. The addition of stabilizing salt can often be omitted if UHT sterilization is applied, or the amount to be added is not so critical that sterilization tests must be carried out. It implies that the whole process from preheating up to and including aseptic packaging can proceed without interruption. Aseptic packaging and suitable packaging materials are discussed in Chapter 15.