Appendix E Dairy Processing Primer

There are many textbooks and online resources available to food service operators wanting to learn more about dairy chemistry, microbiology, and the manufacturing and processing of dairy products. This appendix (Appendix E, Dairy Processing Primer) provides basic information on some of the significant aspects of dairy processing that will assist the food service operator prepare safe products that meet their quality requirements for use within their operation. The topics have been chosen to complement the process-based food safety plans available on the website as well as spark the interest of the operator to continue their learning of dairy manufacturing as applied to their food service operations.

The following topics are included in this appendix.

- Milk Composition and Standardization
- Post Pasteurization Contamination
- Time and Temperature Relationships in Dairy Processing
- Calibration of pH meter
- Digital Thermometers and Calibration

Milk Composition and Standardization

Milk is composed of water, butterfat (milkfat), and MSNF (Milk Solids Not Fat). The TS (Total Solids) content of milk includes all the constituents of milk except water. The MSNF constituents are those found in skim milk and include lactose, protein, and ash (minerals). See Figure 1, Components of Milk.

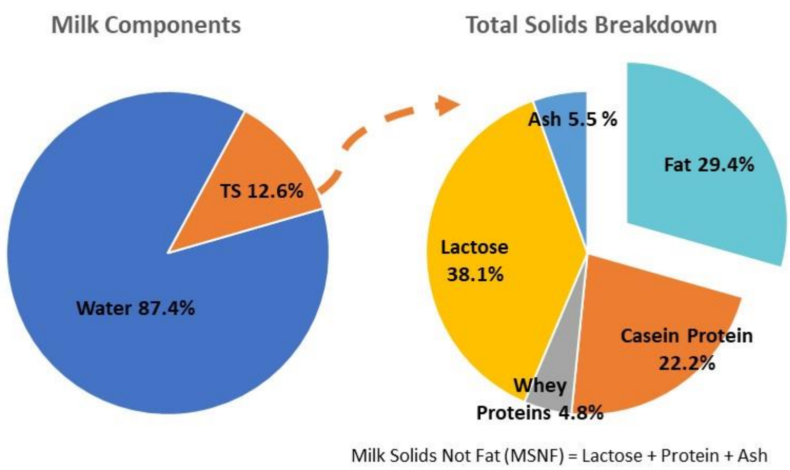


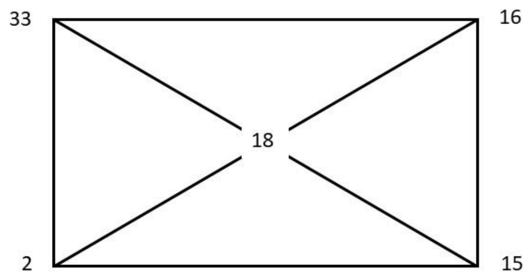
Figure 1 Components of Milk

The flavour and texture of dairy products is determined by the composition of the milk ingredients used. Some of the recipes included on this website, particularly the cultured dairy products and frozen desserts use a combination of dairy ingredients so that the resulting dairy product has a desired level of butterfat and total milk solids. These two components of milk are key to the resulting product texture and flavour.

Adjusting the butterfat and total milk solids of a dairy mix can be done in a number of ways. For example, in the recipe for Khoya, water is evaporated to increase the total solids of the product. Other recipes suggest the addition of skim milk powder or using a higher fat cream product as a method to increase the total solids of the dairy product.

Standardization is a method used by dairy processors to adjust (raise or lower) the fat (BF) and milk solids not fat content of milk (MSNF). Milk is **standardized** to provide a variety of milk products with different composition. There are many online sources that can perform the algebra used for the standardization of milk ingredients. Traditionally, this calculation has been done in dairy processing plants using a simple technique called the Pearson Square. An example calculation is shown in Figure 2, Standardizing Milk using Pearson Square Method.

Problem: Standardize 10 Kg of 33% BF cream to 18% BF using a 2% BF milk.



The number in the lower right-hand corner is the difference of the number in the upper-left hand corner and the number in the center. The number in the upper right-hand corner is the difference of the number in the lower left-hand corner and the number in the center.

Solution: The difference between the BF test of the cream and the desired BF is 33 – 18 = 15. The difference between the desired %BF and the milk used for the standardization is 18 – 2 = 16. Using these figures, we have 10 X (15 / 16) = 9.4 Kg of 2% BF milk required to standardize the cream to 18% BF.

The amount of BF in the 10 Kg of 33 % cream = 3.3 Kg
The amount of BF in the 9.4 Kg of 2 % milk = .19 KG

Therefore, there is 3.49 Kg fat in the total blend of 19.4 kg which is equal to 3.49/19.4 = 18% BF.

There are many variations of the Pearson Square method. For example, the recipe may require preparation of a specific amount of a dairy ingredient at a desired butterfat. See a standard dairy processing textbook or online calculator.

Figure 2 Standardizing Milk using Pearson Square Method.

Preventing cross contamination of dairy products (or post pasteurization contamination)

In FoodSafe, cross contamination is defined as the process by which a substance that is harmful or dirty spreads from one area to another. When making dairy products in a food service establishment attention to cross contamination risks must be given strict attention. (See Figure 3)

Causes of Cross Contamination

- food storage practices
- water
- ingredients with allergens
- reworked product: *using one product to make something else*
- Improper food handling practices
- chemicals
- poor cleaning
- poor hand washing
- traffic paths

Figure 3 Causes of Cross Contamination in Food Service Establishments

Contamination of milk ingredients due to improper handling and poor sanitation can have a detrimental affect on product quality and safety. Bacterial cultures may not grow and produce the desired flavour and/or acidity. Texture of cheeses may be soft or have difficulty with curd formation.

A common defect descriptor that is used in the dairy industry is “dirty dairy ingredient”. It is an off flavour that can develop in dairy products when sanitation practices are poor and dairy ingredients are old.

The dairy products made in food service establishments may have a cook step followed by a cooling step. The handling of dairy products after a heat step is very critical to the food safety, quality, and shelf life. The sugars and proteins of milk ingredients provide the FOOD (see FATTOM) for bacterial growth and the heat treatment has eliminated other bacteria creating a suitable substrate for bacterial growth. Great effort must be given to prevent any introduction of undesirable microorganisms after milk has received a heat treatment. Ingredients such as fruit preparations, flavourings and fresh herbs must be of sound quality and techniques used to add these ingredients must be hygienic.

Time and Temperature relationships for dairy products

All milk ingredients used in food service establishments must be commercially pasteurized ingredients. Pasteurization is a heat treatment applied to milk to avoid public health hazards arising from pathogenic microorganisms associated with milk. The process also increases the shelf life of the product. Legal pasteurization time and temperature relationships are stated in the BC Milk Industry Standards Regulations

The temperatures at which bacteria will survive, multiply and die are a key element of the FoodSafe course. The time food products remain in the temperature Danger Zone will affect the rate of growth of pathogens. Restricting the amount of time that foods are left in the danger zone will help reduce the risk of food borne illness. This food safety knowledge must also be applied when making dairy products.

The dairy products made in this manual may require temperature adjustments for successful manufacture. Examples of heat treatments used in dairy product manufacture includes:

- warming milk to inoculation temperature before addition of bacterial culture
- holding at fermentation temperature to allow bacterial culture to grow
- heating to promote protein coagulation (direct acidification)
- heating to denature milk proteins. (done to improve texture of cultured product)
- heating to aid incorporation of ingredients.
- after incubation – cooling to below temperature danger zone.

Temperature adjustments must be done quickly, and process steps must be designed to ensure the dairy products are returned to cold temperatures as soon as possible.

Calibration of pH meter

Operators must have a pH meter to monitor how quickly the bacteria are growing and producing acid. **Important**: The normal fermentation time is specific to your process and must be established during your product development.

All pH meters require regular calibration to remain accurate. This is a simple technique that food service establishment operators can perform before using the pH meter. It must be done before measuring the pH of the product.

The method described here is a two-point calibration method using pH buffers 7 and 4. These buffers of known pH can be purchased from a laboratory supply company. A supply of distilled water and delicate task wipes (e.g., Kimwipes) are needed for wiping the electrode. Do not use paper towels.

In a 2-point calibration, the calibration process is repeated twice. Rinse and dry the electrode then dip it in the pH 7 buffer (in a small container; don't dip the pH meter in the buffer bottle). Press calibrate and check the display. If the display shows a pH of 7 accept the reading. Rinse and dry the electrode probe again then dip it in the pH 4 buffer solution. Press calibrate and check the display. If the display shows a pH of 4 then accept the reading. The pH meter is now ready for use. Rinse the electrode on the pH meter with distilled water and wipe dry with a soft delicate task wipe.

The electrode is a very delicate part of this instrument. Handle with care. **Consult the manual** that comes with the pH meter for more detailed instructions specific to the model of pH meter in use in the facility. Always store the electrode in a storage solution when not in use. The pH 4.0 buffer is often used for this purpose.

Digital Thermometers and Calibration

One of the critical factors in controlling pathogens in food is controlling temperatures. Disease-causing microbes such as bacteria grow very slowly at low temperatures, multiply rapidly in mid-range temperatures, and are killed at high temperatures. For safety, perishable foods must be held at proper cold temperatures to inhibit bacterial growth or cooked to temperatures high enough to kill harmful microbes.

It is essential to use a digital food thermometer and record times and temperatures on the batch reports as required to ensure that the dairy products you create are safe for consumption and foodborne illness is prevented.

The types of digital thermometers that can be used for dairy are Thermocople or Thermistor.

Type	Speed	Placement	Usage considerations
Thermocople 	2-5 seconds	1 cm (¼") or deeper in the food, as needed	• gives fastest reading • good for measuring temperatures of thick or thin foods • Not designed to stay in the food while cooking • Can be calibrated • More costly and may be difficult to find in stores
Thermistor 	10 seconds	At least 1.5 cm (1/2") deep in the food	• Gives fast reading • Can measure temperature in thin and thick foods • Not designed to stay in the food while cooking • Some models can be calibrated – check manufacturer's instructions • Available in "kitchen stores"

Source: USDA Food Safety and Inspection Services

Digital thermometers are pre-calibrated at the time of purchase and should come with a certificate of verification for a one-year period. It is important that you verify the accuracy of your thermometer frequently. There are two ways to check a thermometer, depending on whether it is being used for cold or hot temperatures.

The Ice-Water Method.
Use the ice-water method to check a thermometer used for cold temperatures..

- Fill a container with equal parts ice and clean tap water. Stir well.
- Insert the thermometer stem a minimum of 5 cm (2 inches) into the ice water, being sure not to touch the sides or bottom of the container.
- Wait 30 seconds. If the thermometer read 0°C (32°F), then it is accurate and safe to use. If the thermometer does not read (32°F), then it is inaccurate. It needs to be recalibrated or replaced.

The Boiling-Water Method

Use the boiling-water method to check a thermometer used for hot temperatures.

- Bring a pot of clean tap water to a full rolling boil.
- Insert the thermometer stem a minimum of 5 cm (2 inches) into the ice water, being careful not to touch the sides or bottom of the pot. (Some thermometers come with clips that can make this process easier. Alternatively, use tongs.)
- Wait 30 seconds. If the thermometer read 100°C (212°F), then it is accurate and safe to use. If the thermometer does not read 100°C (212°F) then it is inaccurate. It needs to be recalibrated or replaced.