

INTRODUCTION

Cheesemaking techniques vary depending upon the intended final use or consumption of the cheese. Cheese can have widely varying characteristics.

Italian mozzarella-type cheese, used in pasta dishes, must have good melting quality and mild flavor. Hard cheese such as Romano and Parmesan must be dry with distinct flavor. Mexican cheese, often used in fried foods, must be stable at high temperatures. The variety among cheeses has arisen from differences in milk quality, diversity among native microflora (microorganisms naturally occurring in a given region) and differences in handling during processing. In North America cheese is usually made from the milk of cows (*Bos taurus*) or goats (*Capra aegagrus*). In India cheese is often made of milk from water buffalo (*Bubalus arnee*). Yak (*Bos grunniens*) cheese is made in the interior of Asia.

Cow's milk consists of 88% water with 3.7% fat, 3.4% protein, 4.8% sugar (lactose), and 0.7% minerals and vitamins (USDA, 2005). The process of making cheese involves forming a curd from milk solids such as fats, protein and minerals that are separated and concentrated (Hill, 2006). The discharged liquid, whey, contains most of the lactose, water, simple proteins, minerals and vitamins (Hill, 2006). About 10 pounds (1.25 gallons) of milk are required to make one pound of cheese.

Making cheese is a dynamic process, affected by time, temperature and the bacterial culture (lactic acid bacteria) and coagulating enzyme (rennet) that are used to concentrate and separate the casein (milk protein) and fat from the whey. Exceptions to this include cheeses such as Queso Fresco or Queso Blanco (traditionally eaten in Latin American countries) and Paneer (traditionally eaten in India), which are made without bacterial cultures or rennet. These cheeses are made by curdling hot milk by adding an acid such as vinegar or fruit juice.

This type of fresh cheese is simple to make and has higher yield because all the whey proteins normally lost are included in the cheese.

The enzyme rennet causes casein to form chains and to develop a mesh-like network or gel, trapping water and fat. This semisolid gel is the curd. When the gel is firm enough, it is cut into small pieces and, after cooking, the whey is removed. The whey may be partially drained from the curd and the curd washed with water to increase its moisture content. The temperature during cooking and handling of the curd affects the texture of the curd and the type of final product. When the curd has reached the desired moisture and acidity, salt can be added. Salting may be achieved through brine, as with Gouda; surface salt, as with Feta; or dry salt, as with Cheddar. After salting, the curd may be partially drained and again washed with water to increase the moisture content. When the curds have reached the desired moisture and acidity (pH), the whey is separated from the curd.

The cheese curd formed is a result of bacterial action on lactose converted to lactic acid. The acid acts as a preservative, removes water from the cheese curd, and develops cheese texture (Hill, 2006). Initially the enzymes from native microflora produce the flavor components, which change during aging.

Commercial cultures have been developed to produce a particular cheese type. Yogurt and buttermilk contain live bacteria that can be used as a culture to make cheese.

Once the whey is removed, the curd is allowed to stick together, forming a mat. The mat is transferred to a hoop or mold lined with cheesecloth, which contributes to the final shape. The mold can be pressed to form a dense cheese (Cheddar) or can be left to settle under its own weight to have an open texture (Feta).

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Soft cheese can be made at home without specialized equipment. Because soft cheese contains over 45% water, it is highly perishable and has a refrigerated life of only five to seven days.

FOOD SAFETY CONCERNS

There are four major pathogens associated with fresh cheese. These can cause foodborne illness. They are: *Salmonella* spp., *Escherichia coli*, *Listeria monocytogenes*, and *Staphylococcus aureus*. These pathogenic bacteria are controlled by good sanitation of equipment and food contact surfaces, proper cooking, cooling and handling of cheese curds during processing, and proper hand washing.

Sanitation

1. Wash hands* and all equipment with soapy detergent before and after use.
2. Rinse all equipment with clean potable water, removing all soapy residue.
3. Boil all cheese-making equipment between uses.
4. Soak all cheese-making equipment in a bleach-water solution for 2 minutes, before and after use. Maintain active chlorine in bleach water (see below).
5. For best-quality cheese, use new cheesecloth each time you make cheese. (Sterilize cheesecloth by first washing, then boiling or soaking 2 minutes in bleach-water.)
6. Squeaky clean is clean. If you can feel a residue on the equipment, it is not clean.

* **Wash hands** whenever hands touch dirty or soiled surfaces, after a sneeze or cough, after bathroom use, after eating, or after handling raw milk. Hands should be dried completely with a clean disposable paper towel.

Bleach-water

- Add one tablespoon of standard household bleach to one gallon of water.
- Make a new bleach-water solution each time you make cheese.
- Test chlorine activity of bleach-water on a regular basis using litmus test paper (available at hardware stores).
- Remake bleach-water if it becomes cloudy with food particles.
- Bleach-water recipe can be doubled if necessary.

Pasteurization of Raw Milk

The pasteurization of raw milk is a delicate procedure dependant on temperature and time. It is recommended that the raw milk be pasteurized by heating at 60–62.5°C (140–145°F) for 30 minutes. This heat treatment will destroy pathogenic bacteria that could cause foodborne illness. After pasteurization the milk is cooled to 32–37°C (89.6–98.6°F). Then the cheese making process may begin.

- Use a cooking thermometer in the milk to measure temperature. Temperature control is very important.
- Do not heat milk over 145°F. It may change the texture and flavor of the cheese. Temperatures under 140°F will not kill harmful bacteria.

Note: *Pasteurized milk available at the grocery store has been heat processed and homogenized for a ready-to-drink milk product. This affects milk protein and fat texture. Although homogenized milk can be used, resulting cheese will have a different texture than the traditional cheese.*

Table 1. Fat content of common milk products (USDA Nutrient Database, 2005)

Dairy Product	Fat g/cup (g/240 g)
Whole milk	8
2% milk	5
1% milk	2.5
Skim milk	0.5
Condensed milk	27
Buttermilk	2.2
Half 'n' half	28
Heavy cream	88
Light cream	40
Yogurt, plain, nonfat	0.4
Yogurt, plain, lowfat	3.5
Yogurt, plain, whole	7.4

Selecting Milk and Cultured Products

The quality of the cheese depends highly on the quality of the raw milk and cultures used to make the cheese. Quality is affected by freshness, or age and microbial status of the raw milk, and by the health of the dairy cow. Cultures, as already mentioned, can be obtained directly from a supplier or indirectly from yogurt or buttermilk. Regardless of the source of milk and cultures, care must be taken to handle the cultures properly to prevent microbial contamination that may affect the actions of the culturing agent.

The texture and flavor of cheese are determined initially by the culturing agents, by the fat content of the milk product used, and by the amount of moisture left in the product. The milk products used in cheese-making contribute both fat and moisture. Therefore, when the goal is to make a low-fat cheese, it is important to consider that the flavor, texture and moisture content of a cheese made from low-fat milk will be much different than those of a cheese product with a higher fat content. Table 1 provides information on the fat content of various milk products that may be used in making cheese.

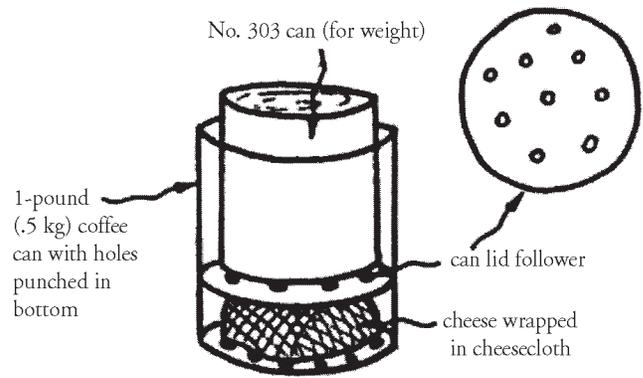


Figure 1. Coffee can cheese press. (Taken from C. McDaniel and P. Kendall, 2004)

EQUIPMENT FOR MAKING SOFT CHEESE

- Thermometer with a temperature range of 40 to 165°F.
- Large double boiler with about a 5-quart capacity for 1 gallon of milk. (Two large cooking pots of different sizes can be substituted for a double boiler.)
- Spatula long enough to reach the bottom of the double boiler.
- Long-handled spoon.
- Long-bladed knife.
- Digital timer or easy-to-read clock.
- Measuring cups, teaspoons.
- Cheesecloth or muslin, tea towel.
- Quart strainer to support draining cloth.
- Forms or molds for shaping the cheese.
- A homemade press can be made from pan-shaped colander and a salad plate or a “follower.” (Figure 1) A 1-pound coffee can (smooth sided) can also be used. Punch holes in the bottom of the can from the inside out so a cloth liner will not catch on the metal edges. Make a follower out of the can lid in the same way.
- A press or device to put pressure on the cheese. Cans or glass jars that fit snugly in the coffee can may be used for this purpose.
- Brining container made of glass or heavy plastic.
- Plastic bucket (2-gallon capacity) for whey discharge.

RECIPES

No-rennet Queso Blanco (Latin American White Cheese)

Recipe adapted from Hill, A.R. (2006)

Heat-acid or no-rennet Queso Blanco is a white, semi-hard cheese made without culture or rennet. It is eaten fresh and may be flavored with peppers, herbs and spices. It is considered a “frying cheese” meaning it does not melt and may be deep fried or grilled. Queso Blanco can also be made by renneting whole milk with little or no bacterial culture.

Ingredients:

- 4.6 fl. oz. (137 ml) vinegar (5% acetic acid)
- 9.2 fl oz. (274 ml) distilled water
- 1.0 gallon (3.76 L; 8 lb; 3.63 kg) heat-treated or pasteurized milk
- 1 teaspoon (4.6 g) salt
- Spices to taste

Procedure:

1. Heat milk to 176°F (80°C) for 20 minutes.
2. Add vinegar (5% acetic acid) to water and then add slowly to the hot milk until the whey is semi-clear and the curd particles begin to mat together and become slightly stretchy. You should be able to stretch a piece of curd about 0.39 inches (1 cm) before it breaks. It may not be necessary to add all of the vinegar.
3. Separate the curd by filtering through a cloth bag until free whey is removed.
4. Work in salt and spices to taste.
5. Press the curd (high pressure is not required).
6. Package curd in boilable bags (vacuum package if possible) and place in boiling water for 5 minutes to sterilize the surface and prevent mould growth.
7. Queso Blanco may keep for several weeks if properly packed and stored in a refrigerator, but should be eaten in as fresh a state as possible.

Ricotta Cheese

Recipe adapted from Hill, A.R. (2006)

Ricotta cheese is also made by heat-acid precipitation of proteins from blends of milk and whey. It is used in lasagna or eaten as a side dish along with the main course.

Ingredients:

- 1 quart (940 ml) vinegar (5% acetic acid)
- 25 gallons (94 L; 200 lb; 90.72 kg) heat-treated or pasteurized whey
- 2.5 gallons (9.4 L; 20 lb; 9.07 kg) pasteurized whole milk

Procedure:

1. Add whole milk to fresh whey, then heat to 185°F (85°C). Heating must begin immediately after the whey is removed from the curd to prevent further acidification by the lactic acid bacteria. Some small curd particles will form.
2. Slowly add about 2 teaspoons of vinegar per quart of whey with gentle agitation. You will see more curd particles forming and the whey will become less “milky.”
3. Pour into a cloth to separate the curds. After the curd is dripped dry it is ready to eat.

Note: *More vinegar may be added depending on the amount of milk used. Continue adding vinegar until the whey is quite clear. By adding the vinegar slowly over a time period of about 5 minutes you will obtain better quality curd and it will be easier to know when to stop.*

Cheese Made with Rennet

Rennet is available as a tablet or liquid. One teaspoon liquid rennet is equivalent to one tablet. Either form must be completely dissolved in cold tap water. Hard water must be neutralized by adding 1/4 cup milk to water before the addition of rennet.

SAFE Queso Fresco (Fresh Cheese)

Recipe adapted from "Abuela project," Washington State University (2002).

This recipe was designed to replace Queso Fresco made with raw milk after an increase in Salmonella outbreaks in Yakima County, Washington. Queso Fresco has a grainy, soft crumbly texture and a mild, fresh flavor. This cheese can be eaten in crumbly pieces in salads but holds up well to heating, both baking and broiling.

Ingredients:

- One tablet rennet or 1 tsp liquid rennet dissolved in 1/2 cup tap water
- One quart (0.95 L; 2.15 lb; 911 g) cultured buttermilk for culture
- Two quarts (1.89 L; 4.3 lb; 1.9 kg) heat-treated or pasteurized milk
- Seven teaspoons (35 ml) white vinegar (5% acidity)
- 2 teaspoons (9.3 g) salt

Procedure:

1. Mix one quart cultured buttermilk with two quarts heat-treated or pasteurized milk.
2. Add 7 teaspoons white vinegar to the milk mixture.
3. Mix well.
4. Heat milk to 90°F (32.22°C). Remove pan from the heat.
5. Add rennet mixture and mix for about 2 minutes.
6. Let stand for 30–40 minutes until curd is firm.
7. Cut curd into 1-inch cubes and let stand for about 5 minutes.
8. Heat curds and whey to 115°F (46.11°C) without stirring. Remove pan from heat, then let stand for 5 minutes.
9. Pour mix through cheesecloth and allow whey to drain for 5 minutes.
10. Form curd into a ball and twist the cheesecloth gently to squeeze out the whey.
11. Break up curds into a bowl and add 2 teaspoons of salt.
12. Mix in salt and let stand for 5 minutes, then squeeze again as before.
13. Place curd in mold to form the cheese overnight in the refrigerator.
14. Remove cheese from mold and package in an air-tight container.
15. Keep cheese refrigerated during storage.

Neufchatel

Recipe adapted from C. McDaniel and P. Kendall (2004)

Neufchatel (New-sha-TEL) is a milky-white cheese with a soft, smooth texture and is low in fat if made with reduced-fat or fat-free milk.

Ingredients:

- 1 gallon (3.79 L; 8.6 lb; 3.9 kg) pasteurized milk (any level of fat)
- One tablet rennet or 1 tsp liquid rennet dissolved in 1/2 cup tap water
- 1/2 cup (4 fl oz; 114 g) fresh cultured unsalted buttermilk or 1/4 cup (2 fl oz; 57 g) fresh plain yogurt for culture
- 3 teaspoons (14 g) salt (optional)

Procedure:

1. Put 1 gallon of milk into the upper part of a double boiler. Add enough water in the bottom of double boiler to prevent milk from scorching. Stir in buttermilk or yogurt and warm slowly to 92 to 94°F (33.33 to 34.4°C). Maintain this temperature range through Steps 2 and 3.
2. Add rennet mixture and stir into milk for 2 to 3 minutes. Allow milk to set undisturbed for about 30 minutes or until a firm gel forms. To test for curd formation, cut a slit in the curd with a metal spatula, slip under the curd and lift slightly. If the cut in the curd breaks clean, it is ready for Step 3.
3. Cut the curd into approximately 1-inch cubes. Stir gently and continuously for 20 to 30 minutes to help firm curds. Keep the temperature range 90 to 94°F (32.22 to 34.4°C).
4. Pour off whey (yellow liquid). Allow the curds to settle, and dip out the remaining whey.

5. Add 1 teaspoon salt, mix gently. Wait 5 minutes and mix in the second teaspoon salt. Wait 5 more minutes and mix in the last teaspoon salt.
 6. Divide the curds into two batches and proceed as follows for each batch.
 7. Line two coffee cans with clean cheesecloth or muslin. Place half of the cheese curd inside each lined can. Fold the cloth over the top and add the follower.
 8. Apply pressure by pressing with a weight, such as a number 303 can of food, until the surface is smooth (2 to 4 hours). Do this in the sink to allow the whey to drain out of the cans.
 9. Remove the formed cheese and the cloth. Wrap the cheese tightly in plastic or in waxed paper and store in refrigerator. It will keep for seven to ten days under refrigeration. It can be frozen for four to six months. However, freezing lowers the quality of the cheese.
3. Cover the milk and let stand for 1 hour or until the whey covers the curd and breaks clean from the side of the pan. Maintain a temperature of 85°F (29.4°C).
 4. Cut curd into 1-inch cubes and allow to stand undisturbed for 5 minutes.
 5. Pour mixture into a muslin bag or cheesecloth-lined colander. Drain overnight in the refrigerator.
 6. With a wooden spoon, work in 1 1/2 teaspoons salt. Package and store cream cheese in the refrigerator.

Cream Cheese

Recipe adapted from C. McDaniel and P. Kendall (2004)

Cream cheese has a mild, smooth texture and a slight citrus flavor balanced with buttery cream. Cream cheese can be blended with fruit and seasonings, used as a dip or spread, or used in desserts such as cheesecake.

Ingredients:

- 3 1/2 quarts (3.3 L; 6.45 lb; 2.92 kg) pasteurized whole milk
- 1 pint (473.2 ml) pasteurized whipping cream
- 3/4 to 1 cup (6-8 fl oz; 177 ml; 242 g) fresh buttermilk for culture
- 1 1/2 teaspoons (7.12 g) salt (optional)
- One tablet rennet or 1 tsp liquid rennet dissolved in 1/2 cup tap water

Procedure:

1. Place milk, cream and starter in double boiler. Warm to 85°F (29.4°C).
2. Add rennet mixture, then stir gently for 4 minutes.

Pizza Cheese

Recipe adapted from C. McDaniel and P. Kendall (2004)

Also known as mozzarella, this fresh cheese is very mild in flavor and adds texture to cooked dishes. Fresh cheese can be stored in water but must be eaten within two days.

Ingredients:

- 1 gallon (3.79 L; 8.63 lb; 3.91 kg) 2% milk
- **OR** 2 quarts (1.9 L; 4.3lb; 1.95 kg) whole milk plus 2 quarts skim milk
- 1/4 cup (2 fl oz; 57 g) fresh, plain yogurt
- One tablet rennet or 1 tsp liquid rennet dissolved in 1/2 cup tap water
- Brine: use 2 pounds (907 g) of salt per gallon (3.78 l) of water

Procedure:

1. Heat milk to 90°F (32.22°C) and add yogurt. Stir slowly for 15 minutes while maintaining this constant temperature.
2. Add rennet mixture and stir for 3 to 5 minutes.
3. Cover, maintaining temperature at 90°F (32.22°C). Allow to stand until coagulated, about 30 minutes.
4. Cut curd into 1/2-inch (1.27cm) cubes. Allow to stand for 15 minutes with occasional stirring.

5. Slowly increase temperature to 118°F (47.77°C) over a period of 45 minutes. Hold this temperature for an additional 15 minutes. (Total time for this step is 1 hour.)
6. Allow curd to settle under whey. Remove whey and transfer the mat of curd to a flat pan that can be kept warm. Do not cut mat, but turn it over every 15 minutes for a 2-hour period. Mat should be tight when finished.
7. Cut the mat into long strips 1 to 2 inches (2.5–5 cm) wide. Put curd in hot water (180°F; 82°C). Using wooden spoons, tumble and stretch it under water until it becomes elastic, about 15 minutes.
8. Remove curd from hot water and shape it by hand into a ball or a loaf. Place cheese in cold water (40°F; 4.4°C) for approximately 1 hour.
9. Remove cheese from cold water and put it into a saturated salt solution. To prepare salt brine, keep the brine cold (40 to 50°F; 4.4 to 9.9°C) while the cheese is in it. Excess salt will remain on the bottom, which is normal. Because a brine solution is corrosive, place in a heavy plastic, glass or pottery container. Cover any exposed areas of cheese with dry salt. Leave cheese in the brine for 24 hours.
10. Remove cheese from brine and let it dry for several hours. Wrap in plastic wrap and refrigerate. This cheese may be used immediately or stored under refrigeration for one week.

RESOURCES AVAILABLE ONLINE

Dairy Connection Incorporated

<http://www.dairyconnection.com/>

This site sells products helpful for making and customizing cheese: coloring, cheese wax, cheese ladles, cheese cloths, draining mats, and thermometers.

Danlac.com

<http://www.danlac.com/>

Here you can find rennet and other enzymes, equipment, starter cultures and information on cultures.

Glengarry Cheesemaking and Dairy Supply

<http://glengarrycheesemaking.on.ca/>

Here you can find cheese presses, molds, rennet, ripening racks, drying racks, cheese vats, pasteurizers (both commercial and non-commercial), curd cutters, coatings, waxes, kits, videos, etc.

Junket

<http://www.junketdesserts.com/>

This site provides information on rennet products as well as recipes for soft cheese and custard desserts.

Moorlands Cheesemakers

<http://www.cheesemaking.co.uk/>

Here you can buy cheese making kits of all sorts, as well as molds, rennet etc., Although this site is based in the United Kingdom, shipments can be accepted in the U.S..

New England Cheesemaking Supply Company

<http://www.cheesemaking.com/>

This site is for non-commercial cheese makers. They offer many complete kits for cheese making.

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