

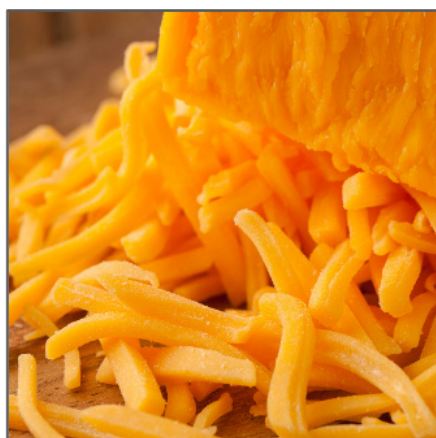
Cheddar Cheese: The Manufacturing Basics

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Cheddar cheeses (or cheddars) are closed-textured, cured or ripened, semi-hard to hard cheeses. Cheddars are typically held at 50 to 55 F and ~70 percent relative humidity for at least 2 months to allow for chemical and physical changes that contribute to their flavor and texture. They are categorized by aging time as:

- mild (2 to 3 months)
- medium (4 to 7 months)
- sharp (8 to 12 months)
- extra sharp (> 1 year)

Most cheddars sold are younger than 18 months, but many value-added producers sell cheddars aged 2 to 5 years or longer. Cheddars can be broken down further into many forms including sticks, cubes and slices, and varieties such as yellow, white and flavored.



What makes a cheddar cheese?

- Approximately 10 pounds of whole milk are required to make 1 pound of cheddar cheese.
- Nearly half of whole milk total solids remain in the cheese curd, including approximately 75 percent of the milk proteins.
- Cheddars must have a maximum moisture content of 39 percent and a minimum milkfat content of 50 percent by weight of solids (FDA, 2021).
- Most water-insoluble components are retained in the curd.
- Cheddars may have protein (casein), fat, calcium, phosphorous and vitamin A concentrated 8 to 10 times more than that of fluid milk.
- Most water-soluble components, including whey proteins, water-soluble salts and lactose,¹ are dispersed in whey, which is drained off.

How to produce cheddar cheeses from raw milk

Step 1: Pre-Treatment (Optional)

The two most common pasteurization methods are vat and high temperature short time (HTST). Vat pasteurization requires milk to be heated to 145 F for a minimum of 30 minutes in a large drum (also known as a vat), while HTST pasteurization requires milk to be heated to 161 F in a series of pipes, called an in-line pasteurization system, for a minimum of 15 seconds.² Large scale processors may use one or more of the following pre-treatment methods alone or in combination to reduce bacteria loads or standardize fat content of milk prior to pasteurization and cheesemaking: 1) bactofugation, 2) microfiltration, 3) thermization or 4) separation and standardization.

Small enterprises may not do any of these pre-treatments due to the additional cost of equipment. Many cheeses made in small processing facilities, such as those sold at farm stores and farm stands, are made with raw “full-fat” milk; in other words, the milk used has not been pasteurized, separated or standardized, and has whatever fat content came from the cows (may be 4 to 4.5 percent fat).

Bactofugation	Microfiltration	Thermization	Separation and Standardization
<ul style="list-style-type: none"> • Mechanical reduction of bacteria count within the milk via centrifuge • Separated bacteria and spores may be heated to higher temperatures to inactivate them while the remaining milk is treated at a lower temperature 	<ul style="list-style-type: none"> • Filters out bacteria from the skim milk and is often used in conjunction with bactofugation or thermization • Skim milk is run through a 0.2-micron filter • Milk must be separated otherwise the filter will capture proteins and fats in cream 	<ul style="list-style-type: none"> • Sub-pasteurization heat treatment that kills most pathogenic bacterias • Heat milk to between 144 and 149 F for 10-20 seconds • Cheese must still be aged at least 60 days at 35 F • This is not the same as pasteurization and will not replace pasteurization 	<ul style="list-style-type: none"> • Cream and skim are separated from each other using a centrifuge • Appropriate amounts of cream are added back to skim to return milk to a specific fat percentage (< 0.25, 1.25, 2.25, 3.25 percent) • Most commercially manufactured cheddars are made from standardized milk

Step 2: Additives and Ripening of Milk

After milk is added to a cheese vat (Figure 1), the temperature is adjusted to between 86 and 88 F. Once at temperature, the appropriate lactic acid starter culture is added. Lactic acid starter cultures produce lactic acid to lower the pH, help expel whey and denature proteins. Additionally, the starter cultures help release salt, calcium and phosphorous, creating firmer curds and suppressing other bacterial growth. Starter cultures for cheddars are typically a single strain of lactic acid-producing bacteria such as *Lactococcus cremoris* or *L. lactis*, which are non-gas-producing mesophilic

¹Thus, lactose-intolerant people are more likely to digest cheddar cheese.

²Raw milk is not required to be pasteurized if cheese is aged for at least 60 days at a minimum temperature of 35 F.

bacteria, meaning they prefer to grow at temperatures between 86 and 100 F. Adjunct cultures may be added if accelerated ripening or unique flavors are intended. A colorant, such as annatto bean extract, may be added to give the cheddar its distinctive yellow color. Additionally, CaCl₂ (calcium chloride) may be added to improve poor quality milk (i.e., low starting calcium content or poor coagulation). Once all cultures have been added, milk is left to ripen in the vat for 30 to 60 minutes.

Step 3: Curd Manufacturing and Whey Drainage

Once the milk has ripened with the cultures, curd manufacturing and whey drainage can begin. Rennet is added to promote coagulation of milk and left to rest for another 25 to 35 minutes. After this time, the coagulum must pass the curd test to ensure it can be cut. This is done by taking a knife and plunging it into the milk before slowly pulling it out horizontally. The coagulum is ready to be cut when there is a clean break where the knife exits, and little coagulum is left on the knife (Figure 2; Wallace, 2018). If a shattering effect is seen on the surface (resembling glass shattering), the coagulum needs more time to rest because the proteins within the milk have not had enough time to solidify (FAO, 1998; IFST, 2017). The coagulum may be cut into curds once this test has been successfully completed. The size of curds depends on how much moisture the final product requires. Cheddars are usually cut to 0.2-inch curds and left to “heal” for 10 to 15 minutes. (Hill and Ferrer, 2020). The process of whey expulsion (syneresis) is accomplished through mechanical stirring and heat treatment. Syneresis begins with gentle stirring before being raised to a scalding temperature of 100 to 104 F. The heat source for syneresis of a typical mild or sharp cheddar comes from water being pumped through an outer jacket around the cheese vat, so hot water never touches the curds and whey. This process should take approximately 20 minutes with between 1 and 3 stirring sessions.

Step 4: Cheddaring

After the whey is drained, the curd is left for 2 to 2.5 hours to give the lactic acid bacteria time to drop the pH of the curd to between 5.20 and 5.25 and allow it to mat together. Cheddaring is essential for controlling the final moisture content of the cheese.

Step 5: Milling

Once the pH of the curds has reached 5.20 to 5.25, the curds are milled into chips of approximately ¾ x ¾ x 3 inches using a cheese miller (Figure 3).

Step 6: Salting

There are a few ways to add salt to the curds, but the most common way with cheddar cheese is dry salting. Granulated salt is added to the cheese and mixed thoroughly. This results in controlled moisture content and further developed flavor, body and texture.

Step 7: Hooping

Once the salt has been mixed in, the chips are placed in molds of the maker’s choosing. Traditionally, this step was called hooping because the molds used resembled hoops (Figure 4).

Step 8: Final Pressing

Next, the cheese is pressed in one of two ways: 1) use the weight of cheeses stacked as the source of pressure and rotated occasionally, or 2) use a continuous pressing system (Figure 5). Curds are usually pressed for ~18 hours, but this time can be shortened by using a continuous pressing system.



Figure 1. Cheese vat and drain table (Anco Equipment, 2021b)



Figure 2. Proper curd test results (Wallace, 2018)



Figure 3. Cheese miller (Anco Equipment, 2021a)

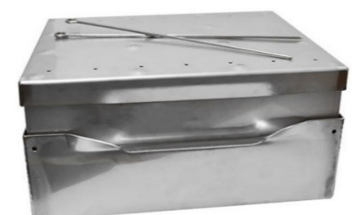


Figure 4. Square cheese mold or hoop (Koss Industrial, 2021)

Step 9: Aging/Ripening

The final step is curing. After cheese is removed from the molds, a covering, or rind, of the maker's choosing (i.e., wax, cloth, leaves [not poisonous], plastic, etc.) surrounds the cheese to prevent oxygen and water from entering and contaminating the cheese. This eliminates the growth of mold and prevents drying. Cheddars are placed in an aging facility, typically on pallets, to develop flavor, body and texture. Whether mild or extra sharp, the ripening of cheddars is done in a room with a closely monitored and controlled temperature of 39.2 to 46.4 F and relative humidity of < 80 percent (Bylund and Tetra Pak Processing Systems, 2015). For cheese made with raw milk, it must be aged for at least 60 days at 35 F or higher.

Flavor Development and Testing of Cheddars:

“‘Ideal’ cheese should have:

1. a clean, delicate, pleasing aroma, and when cured, a nutty flavor;
2. a firm and springy body, showing smoothness and waxiness (if cured) when worked between the thumb and fingers, and slight curdiness if fresh;
3. a texture that reveals a smoothbore (few or no openings);
4. uniform, translucent color, whether colored or uncolored when fresh, it may be slightly seamy; and
5. a smooth finish that is clean, well-shaped, uniform in dimensions and overall size, with a complete, airtight package, and mold free” (Partridge, 2009).

High-quality cheddars should taste clean, moderately aromatic, nutty and pleasantly acidic—the prominence of these tastes increases as the cheese ages. The preferred texture is firm, waxy and silky smooth, and it should feel solid and resist applied pressure. High-quality cheddars will tear apart slowly upon bending rather than breaking suddenly. A waxy-body cheese is pliable and spreads like clay or cold butter when pressed between fingers. Silky- or smooth-bodied cheeses feel silky smooth when passed between your fingers under pressure. These texture preferences indicate whether the cheese has developed the proper flavor, mouthfeel and slicing properties.

For more information about dairy processing and steps, please contact your [local Extension agent](#) or Dr. Eckelkamp at 865-974-8167 or eeckelka@utk.edu. More resources are also available on the [UT Value-Added Dairy website](#). If you are considering a value-added dairy enterprise, be sure to reach out to the [Tennessee Department of Agriculture](#) about permitting and licensure.



Figure 5. Vertical a-frame cheese press 10 head (Koss Industrial, 2021)

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