



Furthering Families

Milk pasteurization *Guarding against disease*

Milk, a natural liquid food, is one of our most nutritionally complete foods, adding high-quality protein, fat, milk sugar, essential minerals, and vitamins to our diet. However, milk contains bacteria that—when improperly handled—may create conditions where bacteria can multiply. Most of the bacteria in fresh milk from a healthy animal are either harmless or beneficial. But, rapid changes in the health of an animal, or the milk handler, or contaminants from polluted water, dirt, manure, vermin, air, cuts, and wounds can make raw milk potentially dangerous.

How do microorganisms enter the milk supply?

Our environment contains an abundance of microorganisms that find their way to the hair, udder, and teats of dairy cows and can move up the teat canal. Some of these germs cause an inflammatory disease of the udder known as mastitis while others enter the milk without causing any disease symptoms in the animal. In addition, organisms can enter the milk supply during the milking process when equipment used in milking, transporting, and storing the raw milk is not properly cleaned and sanitized.

All milk and milk products have the potential to transmit pathogenic (disease-causing) organisms to humans. The nutritional components that make milk and milk products an important part of the human diet also support the growth of the organisms. Drinking raw milk causes foodborne illness, and dairy producers selling or giving raw milk to friends and relatives are putting them at risk.

What are common pathogens in milk?

Illnesses from contaminated milk and milk products have occurred worldwide since cows have been milked. In the 1900s it was discovered that milk can transmit tuberculosis, brucellosis, diphtheria, scarlet fever, and Q-fever (a mild disease characterized by high fever, chills, and muscular pains) to humans. Fortunately, the threat of these diseases and the incidence of outbreaks involving milk and milk products has been greatly reduced over the decades due to improved sanitary milk production practices and pasteurization.

- **Salmonella.** Salmonellosis is the most common disease transmitted in raw milk. This organism is shed in the feces of cattle and picked up on the animals' hair or teats. Many strains of *Salmonella* can cause foodborne illness in humans, and all strains exhibit the same symptoms such as gastroenteritis (vomiting and diarrhea). Pasteurization destroys the *Salmonella* organism, and although pasteurized milk,

powdered milk, and cheese have been implicated in salmonellosis outbreaks, in these cases, the pasteurized milk was contaminated during further processing.

- **Listeria monocytogenes.** This widespread organism is found principally in soil. Listeriosis in humans may cause serious illness, and is especially dangerous to pregnant women, causing stillbirths or infant death soon after birth. Pasteurization inactivates *Listeria monocytogenes*.
- **Yersinia enterocolitica.** This common organism has been found in many foods of animal origin including milk, cheese, and red. *Yersinia*, found in streams, lakes, and wells, spreads from the water to warm-blooded animals. The most common symptom of yersinosis is gastroenteritis and mimics the symptoms of appendicitis. *Yersinia enterocolitica* is destroyed by pasteurization.
- **Campylobacter jejuni.** This organism, isolated in raw milk and meat, can cause mastitis in dairy cattle. It has also been isolated in the feces of many species including dogs, cats, rodents, cattle, sheep, swine, and poultry. Symptoms include vomiting, cramps, bloody diarrhea, mild enteritis, or severe enterocolitis. Individuals who have recovered from the disease may suffer a relapse. *Campylobacter jejuni* is destroyed by pasteurization.
- **Staphylococcus aureus** is a common cause of mastitis in dairy cattle and can enter the milk supply from sores on the teats of cows or from

the hands and nasal discharges of dairy farmers and workers. The *Staphylococcus* organism produces an enterotoxin (toxins causing vomiting and diarrhea) in raw milk when it is held at temperatures above 50 degrees Fahrenheit. Sufficient amounts of enterotoxin in foods can cause illness. The incidence of staphylococcal intoxication has been greatly reduced by pasteurization.

- **Escherichia coli O157: H7.** Recent studies show that young dairy cattle are host to *E-coli* and fecal contamination is a likely source of *E-coli* in raw milk. It can cause hemorrhagic colitis and hemolytic uremic syndrome in humans. Milk should be stored at temperatures below 40 degrees Fahrenheit to inhibit the growth of *Escherichia coli O157: H7*. Temperature abuse during holding and shipping can cause significant growth of the organism. Pasteurization destroys this organism.



Reference: U.S. Department of Agriculture, (1981), USDA Fact Sheet Number 57.

Compiled by **Cindy Brock**, Extension Educator, Food Safety Area of Expertise Team, Cheboygan, Montmorency, and Presque Isle Counties, Michigan State University Extension

Reviewed by **John Partridge**, Ph.D., Professor, Food Science and Human Nutrition, Michigan State University



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Pasteurization and handling requirements

Pasteurization, named for Louis Pasteur who developed the process for other foods, is a moderate but exact heat treatment of milk. Pasteurization kills bacteria that produce disease and retards spoilage in milk.

What is pasteurization?

Pasteurization destroys most disease producing organisms and limits fermentation in milk, beer, and other liquids by partial or complete sterilization. The pasteurization process heats milk to 161 degrees Fahrenheit (63 degrees centigrade) for 15 seconds, inactivating or killing organisms that grow rapidly in milk. Pasteurization does not destroy organisms that grow slowly or produce spores.

While pasteurization destroys many microorganisms in milk, improper handling after pasteurization can recontaminate milk. Many dairy farms use a home-pasteurizing machine to pasteurize small amounts of milk for personal use. Raw milk can also be pasteurized on the stovetop. Microwaving raw milk is not an effective means of pasteurization because of uneven heat distribution. For more information on purchasing and caring for home pasteurization machines, contact your county Extension agent.

Ultra-high temperature (UHT) processing destroys organisms more effectively and the milk is essentially sterilized and can be stored at room temperature for up to 8 weeks without any change in flavor.

What are the requirements for safe handling of milk?

The requirements for proper pasteurization and handling of milk are:

- **A potable water supply and proper dispensing system must be available to avoid contamination.** A pure hot and cold water supply for the animals' health, and for proper cleaning of the animals, milk handlers and utensils. Regular inspection and maintenance of the system is necessary.
- **Clean and healthy animals, clean hands, and clean utensils are essential.** The animals' hair should be clipped regularly around the flanks and udder to keep it from collecting dirt. Milkers should walk their hands and the udder with clean water or use an approved germicidal solution before milking. *Milk from diseased animals or those under antibiotic treatment may not be used.* All

equipment and utensils should be cleaned immediately after use. Stainless steel utensils are preferred since they are durable and easy to clean.

- **Rapid cooling, cold storage, proper pasteurization, and clean cold storage of pasteurized are necessary for the prevention of foodborne illness.** Milk must be promptly cooled to 40°F (4°C) or less and stored in a closed container before and after pasteurization to maintain the quality and flavor of the milk.

Care should be taken not to transfer barnyard dirt from the bottom or sides of the storage container to the countertop or to utensils in the pasteurization and storage areas.

Do not mix fresh milk with previously cooked milk unless you plan to pasteurize the entire batch immediately.

How do I pasteurize milk?

Milk must be heated, with agitation, in such a way that every particle of the milk, including the foam, receives a minimum heat treatment of 150°F (66°C) continuously for 30 minutes or 161°F (72°C) for 15 seconds. The temperature should be monitored with an accurate metal or protected glass thermometer. Commercial operations commonly use a high-

temperature, short-time process in which the milk is heated to 170°F (77°C) for 15 seconds and then cooled immediately to below 40°F (4°C) to increase storage life without any noticeable flavor change in the milk.

Pasteurization of fluid milk has very specific requirements for time and temperature as listed in the chart.

Temperature-Time Pasteurization Requirements for Fluid Milk	
Temperature	Time
• 150°F (66°C) (vat pasteurization)	30 minutes
• 161°F (72°C) (high temperature, short-time pasteurization)	15 seconds
• 191°F (89°C)	1 second
• 212°F (100°C)	0.01 second



References

Namminga, Kelly, (1999), "Health Risks of Drinking Raw (Unpasteurized) Milk," <http://www.abs.sdstate.edu/flcs/ecoli/milk.htm>, South Dakota State University, Brookings, SD (reviewed by E. Kim Cassel, SDSU Extension Dairy Specialist).
Smith, P. W., (August 1981), "Milk Pasteurization" *Fact Sheet Number 57*, U.S. Department of Agriculture Research Service, Washington, D.C.

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How to pasteurize milk at home

While pasteurization destroys many microorganisms in milk supplies, improper handling after pasteurization can recontaminate milk.

How can I pasteurize milk at home?

Many dairy farms have a home-pasteurizing machine to pasteurize small amounts of milk for personal use. When they are operated according to manufacturers' directions, proper pasteurization will require little attention.

A good compromise for home pasteurization is to heat the milk to 165°F (74°C) in a double boiler and to hold it at this temperature for 15 seconds while stirring constantly. Then, cool it immediately while stirring to 145°F (63°C) by setting the top of the double boiler in cold water. Add ice to the cooling water to cool the milk further, stirring occasionally until the temperature of the milk falls below 40°F (4°C). Store the cooled milk in clean, covered containers and keep it at a temperature below 40°F (4°C) until used. This is the preferred method over the 30-minute/150°F (63°C) method because if at any time during the 30-minute period the temperature drops below 150°F (63°C), the milk must be reheated for 30 consecutive minutes. Another method is using jars for 30 minutes in a waterbath canner, again, provided care is taken to maintain the temperature at 150°F (63°C), and the milk is promptly cooled to 40°F (4°C) or less. All stirring devices, thermometers, or any other utensil that comes in contact with the milk must remain in the milk for the entire process—do not remove them at any time during the process—to prevent contamination.

Many dairy farms have a home-pasteurizing machine to pasteurize small amounts of milk for personal use. When they are operated according to manufacturers' directions, proper pasteurization will require little attention. Microwaving raw milk is not an effective means of pasteurization because of the oven's uneven heat.

Proper pasteurization and handling will greatly increase the storage life of milk and will inactivate certain enzymes responsible for spoilage. However, pasteurized milk has not received sufficient heat treatment to improve baking qualities in recipes calling for scalded milk.

Reference

Smith, P. W., (August 1981), "Milk Pasteurization" *Fact Sheet Number 57*, U.S. Department of Agriculture Research Service, Washington, D.C.

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