



ENSURING DAIRY FOOD QUALITY & SAFETY FROM FARM TO FRIDGE



SUMMARY

Milk and milk products are among the safest and highest quality foods in the U.S., in large part due to the strict food safety controls and vigilance at every stage of dairy production, processing, and distribution. Many stakeholders, including the government, dairy farmers, dairy processors, transporters, retailers, and consumers, share responsibility for protecting the quality and safety of milk and other dairy foods, both conventionally and organically produced.

Food safety controls, including the Pasteurized Milk Ordinance (PMO), Good Manufacturing Practices, and Hazard Analysis Critical Control Points are used by the dairy industry to provide consumers with safe, high quality milk and milk products. The PMO is the primary public health safeguard for the nation's milk supply.

Microbiological contamination is the major food safety concern. Because of the nutrient rich composition of milk and milk products, these foods can support the growth of a variety of pathogenic bacteria. However, due to milk pasteurization, as well as improved sanitation and dairy herd health, the incidence of milkborne illness in the U.S. is less than 1% of annually reported food and water outbreaks, down from approximately 25% of all reported outbreaks in 1938. The majority of milkborne illnesses are associated with the consumption of raw (unpasteurized) milk and milk products. For this reason, pasteurization of milk and restriction of raw milk sales is supported by many government agencies, health and scientific organizations, and the dairy industry. Risk of adverse health effects from chemical contaminants in milk and other dairy foods is minimal to non-existent because of strict regulations from the farm to the marketplace.

Ensuring milk's quality and safety requires proper attention to conditions from the farm to retail outlets. On the farm, dairy farmers adhere to strict food safety regulations and provide their animals with safe, comfortable housing, nutritious feed, regular veterinary care, and sanitary milking procedures. At the dairy processing plant, incoming milk is tested for quality and milk is pasteurized to assure its microbiological safety. Dairy processors take measures (e.g., refrigerated storage, adherence to sanitary procedures) to prevent post-pasteurization contamination of milk and other dairy products.

Retailers and consumers maintain the quality and safety of milk and milk products by keeping these perishable foods at proper temperatures and by following recommended handling practices. For example, consumers are advised to pick up milk and other perishable dairy products just before checking out of the store, especially in hot weather, and once home, immediately refrigerate milk at 40° F or below. Dairy foods are regularly monitored from farm to retail outlets to ensure compliance with government and industry food quality and safety regulations.

Consumers can be assured that the dairy industry, along with the U.S. government, continually places the utmost importance on the quality and safety of milk and other dairy products. By taking a proactive approach such as adopting new technologies and working with government agencies, the dairy industry can effectively meet new food safety challenges as they may arise. **D**

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INTRODUCTION

Recent well-publicized food recalls have heightened consumers' awareness of food safety issues (1,2). Although the U.S. has one of the safest, most plentiful food supplies and most comprehensive food safety regulations, food recalls are a reminder that a perfectly safe food supply cannot be taken for granted or guaranteed (3). A positive outcome of heightened food safety concerns has been the development of new technologies and research aimed at safeguarding the nation's food supply (4).

U.S. milk and milk products are among the safest and most regulated foods marketed nationwide despite the fact that they can support the growth of pathogenic (disease producing) organisms and are consumed on a daily basis (5). A complex system of strict food safety controls (e.g., pasteurization) required by government agencies, along with the dairy industry's commitment to food safety, helps to assure the safety and quality of milk and milk products (5,6a,7). According to the U.S. Food and Drug Administration (FDA), less than 1% of foodborne illness outbreaks in the U.S. involve pasteurized dairy products (5).

This *Digest* reviews who is responsible for milk quality and safety, regulatory and dairy industry control measures, and potential milk safety concerns. Also provided is an overview of steps taken on the farm to those taken by consumers to protect the quality and safety of milk and milk products.

The U.S. government, all sectors of the dairy industry (i.e., dairy farmers, dairy processors, transporters), retailers, and consumers share the responsibility for protecting the quality and safety of the nation's supply of milk and milk products.

RESPONSIBILITY FOR MILK QUALITY & SAFETY

Food safety, including dairy food safety, is a shared responsibility among many stakeholders (3,5). Government at federal, state, and local levels, all sectors of the dairy industry, retailers, and consumers share the responsibility for protecting the quality and safety of U.S. milk and milk products, both conventionally and organically produced (5,6a). FDA develops standards for dairy foods, conducts research to improve detection and prevention of possible contaminants, and inspects dairy processing facilities, imported products, and feed mills. The FDA's Center for Veterinary Medicine monitors feeds eaten by cows and animal health. One of FDA's major roles is to oversee the federal Grade "A" Pasteurized Milk Ordinance (PMO) (5,6b). FDA milk specialists in district and regional offices provide scientific, technical, and inspection assistance to state regulatory agencies (e.g., Dairy Division of state Departments of Agriculture or Health) to ensure that regulatory policies and procedures are followed. State regulatory agencies regularly test milk from the farm to the supermarket to make sure that it meets bacteriological, chemical, and temperature standards. If a product fails to meet safety and quality standards for human consumption, actions are taken to prevent it from reaching the consumer (6b).

The dairy industry, including dairy farmers and dairy food processors, protects the quality and safety of milk and other dairy foods by abiding to, under penalty of law, strict government food safety regulations related to the health and care of cows, and cleanliness and sanitation on dairy farms and in processing plants. In addition, the dairy industry adopts various voluntary practices to ensure milk safety. Dairy farmers work closely with government extension agents and land-grant universities to implement state-of-the-art production and safety practices on farming operations (6b). Dairy producers and processors work together to ensure that the highest quality milk possible is manufactured into dairy foods. Dairy retailers and consumers, by properly handling and storing dairy foods, also play an important role in safeguarding dairy food quality and safety.

DAIRY FOOD SAFETY CONTROLS

To provide consumers with a safe milk supply, the dairy industry has adopted various scientific and technical measures or controls such as the PMO (5), Good Manufacturing Practices (GMP) (3,6a,c,d), and Hazard Analysis Critical Control Points (HACCP) (5,6b,c,e).

The PMO is one of the most effective instruments for protecting the quality and safety of Grade “A” milk. It describes a comprehensive set of requirements for milk and dairy product safety, milk hauling, sanitation, equipment, and labeling. The extensive requirements cover milk from production at the farm to shipment from the processing facility to retail outlets (5). All Grade “A” raw milk for pasteurization and all Grade “A” pasteurized milk and milk products must be produced, processed, and pasteurized to meet specific quality standards and sanitation requirements. The PMO mandates parameters for temperature, somatic cell count (indicator of cow health), antibiotic residues, and bacterial limits. The National Conference on Interstate Milk Shippers (NCIMS), a cooperative effort of federal, state, and local regulatory agencies, industry, and academia, helps to set standards and regulations related to the PMO (6d). At its biennial conferences the NCIMS recommends changes and modifications to the Grade “A” PMO based on recent scientific and technological advancements (6b,f). The 2009 PMO (i.e., the 28th revision) incorporates the most recent knowledge into public health practice (5).

To ensure compliance with the PMO, dairy farms and dairy processing plants are regularly visited by representatives of government regulatory agencies who conduct quality and safety inspections (6f). These inspectors examine herd health, veterinary practices, sanitation of facilities and milking equipment, as well as

A complex system of stringent regulations by federal and local government agencies, along with the dairy industry's strong commitment to dairy food safety and quality, help maintain dairy's high safety record and consumer confidence in dairy food quality and safety.



temperature and storage conditions of milk on the farm and delivery to the processing plant (6f). At the processing plant, inspectors ensure that milk is processed in accordance with state and federal food laws. In some cases, the state standards differ from and may be more stringent than the federal standards. Milk and milk products transferred across state lines must meet PMO defined Grade “A” specifications and standards (5,6a). Public health agencies, the dairy industry, and many others recognize the PMO as the sanitary standard for milk and milk products (6b).

GMP, a set of operational conditions established by the dairy industry and FDA, is an indispensable part of protecting milk's quality and safety. The practices relate to methods and control procedures used in dairy plants for the processing, packaging, and storage of milk and milk products to protect dairy food quality and safety (6a,c). This regulation details various standards in dairy processing plants including cleaning and sanitizing food-contact surfaces, hygienic floors, walls, and ceilings, disposal of wastes, good air quality, appropriate employee hygiene, potable water, quality control of incoming ingredients and materials, and proper maintenance of equipment.

HACCP is a structured, scientific-based approach voluntarily implemented in many Grade “A” fluid milk and milk product processing facilities to help assure milk quality and safety (5,6b,c,e). Unlike traditional PMO- and GMP- driven programs in which procedures are carried out independently from one another, HACCP is a systematic approach that identifies potential hazards (e.g., harmful microorganisms or their toxins) or critical situations (e.g., post-processing contamination) before they occur and outlines appropriate measures at each step to prevent food safety hazards from occurring (5,6a,b).

POTENTIAL HAZARDS & CONCERNS

Microbiological Contaminants.

Contamination by bacteria is considered to be the most serious food safety issue (1,2,8). Because of the nutrient rich composition of milk and milk products, these foods are a good medium for the survival and growth of a variety of pathogenic bacteria (6e,7,9). However, as a result of improved animal health and management, plant sanitation, and widespread use of pasteurization, the incidence of milkborne illness in the U.S. has decreased from approximately 25% of all reported foodborne illness outbreaks in 1938 to less than 1% of reported outbreaks in 2009 (5).

Pasteurization is described as “the process of heating every particle of milk or milk product, in properly designed and operated equipment” to one of several temperatures for a corresponding specified time as defined in the PMO, most commonly to at least 161° F for at least 15 seconds followed by rapid cooling to 40° F (5). Alternatively, some milk and milk products can be ultra-pasteurized, which involves heating milk to 280° F for at least 2 seconds, or sterilized at an ultra-high temperature (i.e., 280° F to 302° F for at least 2 seconds) (5,6d,7). Ultra-pasteurized milk has an extended shelf-life under refrigerated conditions (5), whereas milk products heated to an ultra-high temperature and aseptically packaged may be stored at room temperature for at least six months (6d).

Proper pasteurization destroys pathogenic bacteria, yeast, and molds that may be associated with raw milk, as well as increases the product’s shelf life (5,7). Milk pasteurization is recommended for all milk consumed by humans by the Centers for Disease Control (10), the FDA (11), the 2005 Dietary Guidelines (8), and the 2010 Dietary Guidelines Advisory Committee (4), among other medical and scientific organizations identified in a recent review article (7).

HACCP systems are based on seven established principles, or steps, and supporting prerequisite programs (PPs) that include GMP and sanitary standard operating procedures (6a). The principles include: 1) performing a step-by-step hazard analysis (e.g., to determine potential milk or milk product hazards and identify control measures); 2) defining the Critical Control Points (CCPs) at which hazards can be controlled (e.g., pasteurization, homogenization, cooling, filling, and storage of packaged milk); 3) establishing critical limits that must be met at each CCP; 4) determining monitoring procedures (e.g., visual inspection, chemical, physical, microbiological, and organoleptic tests) for each CCP; 5) establishing corrective actions if needed; 6) developing verification procedures; and 7) maintaining all appropriate records and documentation procedures.

Before implementing a HACCP plan, dairy processing plants, receiving stations, and transfer stations need to develop, document, and implement written PPs, which in many cases are based on regulatory requirements and guidelines such as those in the GMP and PMO. PPs are basic sanitation programs that reduce the potential occurrence of a milk or milk product safety hazard. Complete, up-to-date process flow diagrams are required for all milk and milk products manufactured. The HACCP, when properly implemented, can be an alternative to the traditional inspection program in Grade “A” dairy plants to provide assurance of milk and milk product safety (5,6b).

In recent years, major advances and innovations, including increased mechanization, automation, computerization, sanitation, ultra-pasteurization, and aseptic packaging, have resulted in improvements in dairy food quality and safety (6a,e). These advances are the result of research and development work by universities, government, and private industry.



Pasteurization of raw milk is recognized worldwide as an essential public health measure to reduce the risk of illnesses from pathogenic bacteria and increase the shelf life of milk and milk products.

Although some people believe that raw milk, either conventionally or organically produced, is a healthier alternative to pasteurized milk, there is little or no impact of pasteurization on the nutritional quality of milk or on milk's natural, antimicrobial properties (7,11-13). The majority of milkborne illnesses are associated with the consumption of raw (unpasteurized) milk and milk products (6e). Between 1998 and 2008, 85 outbreaks of human infections resulting from consumption of raw milk were reported to the Centers for Disease Control (9,14). These outbreaks included more than 1,600 illnesses, 187 hospitalizations, and two deaths. The actual number of illnesses associated with raw milk likely exceeds this number given that not all foodborne illnesses are recognized and reported. Several pathogenic microorganisms may be found in raw milk including *Campylobacter jejuni*, *Salmonella* spp., *Listeria monocytogenes*, *Yersinia enterocolitica*, *Escherichia coli*, and *Staphylococcus aureus* (4,6e,7,10). Milkborne pathogens can affect the health of anyone who drinks raw milk; however, they are especially dangerous for high-risk consumers such as pregnant women, children, the elderly, and people with weakened immune systems (6e,8,15).

Pasteurization is required by law for all Grade "A" fluid milk and milk products moved in interstate commerce for retail sale (5). Also, U.S. Standards of Identity for cheese products require pasteurization for certain natural cheeses (i.e., fresh or soft-ripened cheeses) (16). Most cheese made in the U.S. is manufactured using pasteurized milk (6g). However, some hard and semi-hard cheeses can be made with raw milk (6e). To ensure their safety, cheeses made from raw milk must be aged for at least 60 days at not less than 35° F (6e). While the majority of states currently allow raw milk sales within their borders with certain limitations (6e), a number of regulatory, medical, educational, and public health authorities identified in a recent review article have published position statements supporting restriction of raw milk and milk products (7).

U.S. pasteurized milk and milk products are among the safest foods marketed nationwide. This success is attributed in large part to compliance with strict food safety regulations and adoption of proactive measures from farm to fridge.

Chemical Contaminants. Risk of adverse health effects from chemical contaminants such as antibiotics and pesticide residues in milk and other dairy foods is minimal, or non-existent, because of stringent regulations and programs from the farm to the marketplace. Antibiotics, primarily penicillin and tetracycline, may be given to dairy cows in therapeutic doses to treat temporary bacterial infections such as mastitis (5). Before approved for use, these antibiotics must meet extensive pre-clearance requirements (5,17). Federal law requires dairy farmers to wait a specified withdrawal time, usually 72 to 96 hours, after administering antibiotics to dairy cows to ensure that the antibiotics have cleared the cow's system and that the milk is safe to consume. In establishing withdrawal times, the FDA applies wide margins of safety to ensure food safety (17).

The PMO requires that milk (both conventionally and organically produced) in all bulk milk tankers arriving at a dairy plant be sampled and analyzed for animal drug residues before milk is unloaded and processed (5). State regulatory agencies monitor the industry's surveillance activities by routinely making unannounced on-site inspections to collect milk samples for antibiotic residues and review industry records (5). According to FDA's most recent (2008) National Milk Drug Residue Data Base, which is a voluntary industry reporting program, only 0.028% of over three million tanker loads of raw milk from dairy farms and only 0.007% of 43,940 pasteurized fluid milk and milk products analyzed were positive for any animal drug residue (i.e., antibiotics) (18). In those rare cases when a tanker load of milk tests positive, the entire load of milk is rejected and the milk does not reach the consumer.

Pesticide residues are not a health concern in any U.S. milk products as a result of industry preventive programs and federal regulations which limit exposure to these contaminants (19,20). All pesticides sold in the U.S. must be approved for safety by the Environmental Protection Agency before being used (19). Regulatory agencies have also set tolerance or threshold levels for allowable pesticide residues in foods such as milk (20). Because pesticides are found in

water and soil, extremely low levels can be found in all foods, conventional and organic. The FDA, under its pesticide monitoring program, collects and samples food nationwide for pesticide and other chemical contaminants (21). This surveillance has shown that pesticide contamination of foods in the U.S. is extremely low. For example, no samples of domestic dairy products tested in Fiscal Year 2008 contained levels of pesticide residues above well-established thresholds (21). Foods shown to contain levels of chemical residues above the maximum allowable levels are removed from the marketplace (21).

Hormones. Some people perceive hormones as a food safety concern (2). All cows have the natural protein hormone bovine somatotropin (bst) that helps them produce milk. Some dairy farmers may use the FDA-approved synthetic hormone, recombinant bovine somatotropin (rbST), in lactating cows to increase milk yield, improve the milk-to-feed ratio, and decrease waste (22). This synthetic hormone is not added to milk and the composition of milk from treated and untreated cows is the same (23). Based on a recent review of the scientific evidence, the FDA states that milk from cows treated with rbST is safe for human consumption (24).

DAIRY FOOD SAFETY FROM FARM TO FRIDGE: AN OVERVIEW

Ensuring the quality and safety of milk and milk products requires proper attention to conditions at every step in the process, from farm to fridge.

On the Farm. To produce an abundant safe supply of high quality milk, dairy cows must be healthy (5). Dairy farmers producing conventional or organic milk make sure that each animal receives safe, comfortable housing by providing specialized bedding and individual resting spaces, a nutritious diet several times a day, and medical care to ensure good herd



health and prevent disease. Organic dairy farms must meet additional requirements of USDA's National Organic Program (e.g., use of only organic feed, no growth hormones) (20,25). Organically produced foods, including milk and milk products, have been shown to be no more nutritious or safer than conventionally produced products (23,26).

Dairy farmers adhere to strict food safety regulations, maintaining clean, safe facilities (6b). Milking equipment is thoroughly cleaned after and sanitized before each use to preserve a sanitary environment. Milking machines deliver milk directly from the cow to a refrigerated holding tank, where milk is cooled rapidly to 45° F or below within two hours after the completion of milking and maintained at no higher than this temperature until processing at the dairy plant (5,6b). Milk goes directly from the refrigerated holding tank to an insulated bulk tank truck for transport to the processing plant. The tanker driver obtains samples of milk from each farm for testing (6b). Bulk milk tank trucks must obtain a permit and are inspected annually by the state regulatory agency (6b). Modern equipment such as automated milking systems has increased the speed of cleaning, sanitizing, cooling, and delivery of good quality raw milk to processing plants (6f). Government officials regularly inspect dairy farms to assure compliance with strict sanitation regulations and transportation practices from the farm to the processing plant.

At the Dairy Processing Plant.

Delivering high quality, safe dairy products is critical to successful dairy processing operations (6a,b). Before unloading raw milk at the dairy processing plant, dairy cooperatives and processors test the milk in milk tankers arriving at the processing facility for a variety of quality and safety parameters (e.g., sediments, antibiotic residues, somatic cell counts, bacteria counts, odor, etc.) (5,6a,b). If safety standards are not met, the tanker load of milk is rejected.

If all tests meet standards specified by the Grade “A” PMO or state regulatory agencies, the milk is transferred from the milk tanker to refrigerated or insulated bulk storage tanks or silos and held for a maximum period of 72 hours (usually less than 24 hours) at a temperature of 45° F or below before processing (6a,b).

Heat treatment is a critical part of all processes used in dairy manufacturing plants (5,6a,d). Raw milk is pasteurized or heated in properly designed and operated equipment according to specific time and temperature requirements to ensure milk safety (5). Proper pasteurization is the only practical, commercial measure that will destroy all milk-borne disease organisms (5,6b). Pasteurized fluid milk products are rapidly cooled, packaged in plastic, paper, or glass containers, and stored in cold refrigerated rooms for delivery to grocery stores or warehouses for distribution (6a).

Once the dairy product has been pasteurized, it must be protected from post-pasteurization contamination. Dairy processors rely on refrigerated storage and safe processing and handling procedures to prevent post-pasteurization contamination of milk and other dairy products (6a). The dairy industry and government officials regularly inspect dairy processing plants at least four times per year to make sure that the strict sanitation requirements are being met (5,6a,d). Also, dairy processors keep detailed information on the sources of all ingredients and packaging coming into their facilities and all dairy products shipped to customers.

Dairy processors manufacture and use only safe, high-quality ingredients (e.g., whey products, milk powders, milk protein concentrates, etc.) in various dairy products including some types of cheese, yogurt, ice cream, and frozen yogurt (6h). Dairy ingredients must be stored at suitable temperatures in a sanitary environment to ensure their quality and safety (6h).

At Retail Outlets and Consumer Handling. Keeping pasteurized dairy foods cold at all stages of the distribution chain is critical to dairy food quality and safety. Dairy case temperatures are carefully



monitored at retail outlets such as grocery stores. Public health officials regularly inspect foodservice facilities (e.g., restaurants, institutional food service operations in nursing homes, schools, hospitals) to ensure that strict government sanitation, food storage, and food handling requirements are being met and that the dairy products offered for sale are safe.

Consumers can help maintain the quality and safety of pasteurized milk by taking the following steps (4,27):

- Pick up milk and other perishable dairy foods immediately before checking out of the store, especially in hot weather.
- Refrigerate milk at 40° F or below (preferably at the back of the refrigerator where it is cooler), as soon as possible after purchase and store in the original container.
- Return milk to the refrigerator immediately after use. Unused milk poured out of its container should never be returned to its original container.
- Choose versions of milk, cream, yogurt, pudding, ice cream and frozen yogurt, cottage, cream and ricotta cheeses, processed cheeses, and soft cheeses (e.g., Brie, Camembert, blue-veined cheeses, and Mexican-style soft cheeses such as *Queso Fresco*, *Panela*, *Asadero*, and *Queso Blanco*) that are made only with pasteurized milk (4,11). Read food labels on milk and milk products to make sure that the word “pasteurized” is shown (4).
- Keep milk containers closed to prevent the absorption of other flavors. Although this could change the taste, the milk is still safe.
- Check the “sell-by,” “best if used by (or before),” or “use-by” dates on product containers. The “sell by” date refers to how long the grocery store can offer the product for sale in the dairy case. When handled properly and kept at 40° F or below (without freezing), milk generally stays fresh for 2 to 3 days after this date. The “best if used by” date is recommended for best flavor and quality. The “use by” date is the last date recommended for use of the product at its peak quality (28).

CONCLUSION

The high quality and safety of milk and milk products in the U.S. result from stringent government regulations and dairy industry programs, along with continued vigilance at every stage of production, processing, pasteurization, and distribution. The dairy industry, by taking a proactive approach such as adopting new technologies and working with government agencies, can effectively meet new food safety challenges as they may arise and continue to provide consumers with safe, high quality dairy products. **D**

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