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Dairy Foods Science Notes

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Raw Milk Quality Tests

In order to make dairy products of high quality, high quality raw milk is required. Once raw milk is defective, it cannot be improved through processing or other means; defects often become more pronounced. Therefore, it is important that raw milk be produced and handled from farm to plant under conditions that do not reduce its quality or, consequently, the quality of the product. There are many factors that can influence the quality of raw milk. Following is a summary of raw milk quality parameters, testing procedures and required or desirable standards:

Herd Health & Somatic Cells: Unhealthy dairy cows have the potential to give milk that is lower in quality and wholesomeness. Mastitis, an inflammation of the udder, is one of the most common herd health concerns. Mastitis in dairy cows is most often the result of a bacterial infection (contagious or environmental). The infection causes an increase in milk somatic cell levels (blood cells that fight infections). While the limit for Grade "A" milk is 750,000 cells per milliliter (ml), somatic cell counts (SCC) exceeding 2-300,000 generally indicate some level of mastitis in the herd. High SCCs can result in quality defects in raw milk and processed dairy products due to increased enzyme activity associated with the infection and somatic cells. These enzymes break down proteins, fats and other components resulting in reduced yields in cheese and flavor defects (e.g., bitterness, rancidity) in cheese and possibly pasteurized fluid milk and other products, if counts are sufficiently high. SCCs are determined by approved automated counting systems (e.g., flow cytometry) and by the Direct Microscopic Somatic Cell Count (DMSCC).

Bacterial Contamination: Milk secreted from the udder of a healthy cow contains relatively low numbers of bacteria. Bacteria counts increase in raw milk due to contamination of and/or growth in the milk. Causes of high bacteria counts include poor pre-milking hygiene methods, inadequate cleaning and sanitization of milk equipment, poor cooling and in some cases, mastitis. Good production and herd management practices help ensure low bacteria counts and reduce the risk of pathogens contaminating raw milk. While the legal limit for total bacteria in farm Grade "A" raw milk is 100,000/ml, counts of 10,000 or less is considered desirable and achievable by most farms. Like somatic cells, bacteria produce enzymes that degrade proteins, fats and other components, resulting in reduced product quality when counts are high. Although pasteurization and more severe heat treatments (Ultra-High Temperature) kill a majority of bacteria in milk, some strains produce enzymes that survive the heat treatment. Heat-stable enzymes have the potential of further degrading the processed product, especially long-life, shelf-stable products (UHT milk). Certain types of bacteria can survive pasteurization and among these, certain strains grow under refrigeration, limiting the shelf-life of pasteurized fluid milk products. Following are methods commonly used to evaluate raw milk bacteriological quality, including the required Standard Plate Count and auxiliary tests sometimes used (for more information see the handout *Raw Milk Bacteria Tests & Review*):

Standard Plate Count (SPC): The SPC determines the total number of bacteria in a milk sample that can grow and form countable colonies on *Standard Methods Agar* when incubated aerobically at 32°C (90°F) for 48 hours. It serves as an overall microbial quality index. While the legal maximum for producer milk is 100,000/ml, ideally SPC values should be less than 10,000/ml. Extremely high counts in raw milk (e.g., due to poor cooling) can cause defects in raw milk that result in its rejection, due to off-odors and flavors such as sour, malty or rancid. These and other microbial defects can carry over into products. The SPC is the reference method for other official testing procedures. The Plate Loop Count (PLC), which plates a 1:1000 dilution, is a modification of the SPC.

BactoScan™ FC: The BactoScan FC is an automated system based on flow cytometry (FC) technology that determines total bacteria counts in approximately 9-10 minutes. This is considered equivalent to the SPC and is currently used for official testing for a majority of producer samples in NY State and the northeast.

Direct Microscopic Clump Count (DMCC): The DMCC is a rapid method that uses the microscope to estimate bacteria in a stained smear of a milk sample (0.01 ml). Although the method is not considered "official" in the national program, technicians are licensed in NY State where it can be used to reinstate producers after high count

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penalties (count must be confirmed by SPC) and is used to screen incoming loads of milk at dairy plants. The procedures is also used and considered an official method for counting somatic cells in raw milk (DMSCC).

Preliminary Incubation Count (PIC): The PIC is performed by holding milk samples at 12.8°C (55°F) for 18 hrs prior to performing the SPC. This incubation temperature selects for bacterial contaminants in a sample that can grow at cooler temperatures, some of which may have the potential for further growth during raw milk storage. The PIC should always be compared to the unincubated SPC. There is no legal limit for the PIC, but the goal is for no significant increase over the fresh SPC. PIC limits of 3-4 times the SPC, or less than a specific count, such as 50,000 or 100,000/ml have been used. The test is most often used as a tool to detect possible deficiencies in farm cleaning, sanitizing & milk handling procedures that may not influence and/or be detected by the SPC procedure. There is no scientific evidence that the PIC has any direct correlation to milk shelf-life.

Laboratory Pasteurization Count (LPC): The LPC is performed by heating the milk sample to 62.8°C (145°F) for 30 minutes (simulates batch pasteurization) followed by an SPC. This procedure counts bacteria that survive pasteurization (thermoduric bacteria). LPCs of less than 200-300 should be the goal. The legal maximum SPC for pasteurized milk is 20,000/ml. This test is also used as an indicator of possible deficiencies in farm procedures.

Coliform Bacteria Count: The coliform count is performed by plating a sample on *Violet Red Bile Agar,* a media that selects for coliform bacteria. Coliforms are associated with fecal and environmental contamination. Counts of less than 50/ml should be the goal; <25 is achievable. There are no legal limits for raw milk, unless coliform cause the SPC to exceed 100,000/ml. Coliforms are associated with filth contamination (e.g., dirty cows) and dirty equipment. Cows with coliform mastitis can sometimes shed these organisms, influencing the SPC.

Antibiotics and Drug Residues: Antibiotics and other drugs are often used to treat cows with mastitis or other infections or ailments. When a cow is treated, its milk is generally withheld from the bulk tank until treatment stops and milk is free of drug residues. The most commonly used drugs are the beta-lactam antibiotics (i.e., the penicillin family). Occasionally treated cows are overlooked and antibiotic contaminated milk enters the bulk tank. However, all raw milk tank trucks are screened for the presence of beta-lactam drugs at dairy plants before they are unloaded, therefore minimizing the potential for drug contaminants in processed dairy products. Individual farm samples are also tested routinely or for producer trace-back if a truck tests positive. Other antibiotics (e.g., sulfa-drugs) are tested for on a random basis or routinely in some plants. Antibiotics in milk are a concern due to the risk of allergic reactions and the development of antibiotic resistant pathogens. During the manufacture of cheese and cultured dairy products, antibiotics can inhibit dairy starter cultures used to develop acid (e.g., lactic acid bacteria), which can result in the loss of significant amounts of product and milk.

Added Water & Freezing Point of Milk: Added water can occur in milk due to unintentional (e.g., poor system drainage) and intentional addition. Added water can be detected in milk by measuring its freezing point (FP). The FP of milk is slightly less than that of pure water and relatively constant. Raw milk generally has an FP below minus 0.542 degrees Hortvett (°H); °H, a derivative of degrees Celsius, is a scale used almost exclusively for milk freezing point. When water is added to milk, the FP increases approximately 0.005°H for every 1% of water added. NY State uses a cut-off of minus 0.530°H or higher (less negative) as cause for investigation. Added water reduces the value of the milk by diluting the protein and other milk components and will influence product yields. Added water in fluid milk can also dilute the sweetness, potentially resulting in a "flat" taste.

Sediment: Sediment in milk is generally due to poor pre-milking hygiene procedures that allow soil and other materials to enter the milking stream. Proper environmental conditions for cow cleanliness are important to reduce soil on animals so that pre-milking hygiene procedures can be effective. Sediment in milk is measured by filtering the milk through a fine filter and visually examining it and comparing to a standard. High sediment levels in milk are associated with filth and the potential for bacterial contaminants that can influence quality.

Farm Related Off-Flavors: Off-flavors and odors can be present in raw milk due to practices on the farm. Some are minor and difficult to avoid, while others are due to poor practices and can be reason for rejecting a milk load. Most flavor/odor defects will be carried over into the finished product, although some of the volatile defects can be partially removed. Defects in milk can be classified as Absorbed - odors breathed in by cows transmitted to the milk through their blood stream (e.g., barny/cowy, feed) or odors directly absorbed by the milk during storage; Bacterial - growth of spoilage microorganisms (e.g., malty/acid due to poor cooling); or Chemical - related to enzymes and spontaneous chemical reactions (e.g., rancid due to excessive agitation; oxidized due to high fat feeds), health of the cow (e.g., ketosis), and/or direct chemical contamination (e.g., cleaning chemicals, ointments). For more information on milk flavors see the handout *Sensory Evaluation of Milk & Dairy Products*.

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