AS-1131

Mastitis Control Programs

Milk Quality Evaluation Tools for Dairy Farmers

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Producers have a variety of informational tools available to monitor both the mastitis in their herds and the quality of milk being shipped to processors (Table 1). Somatic cell counts (SCC) are a measure of mastitis in a dairy herd. The SCC will increase in a quarter as a result of an infection. The increase represents white blood cells entering the quarter to fight the infection. The bulk tank somatic cell count (BTSCC) reflects the total number of infected mammary quarters in the herd that are actually being milked into the tank.

Table 1. Mastitis and milk quality tests.

Test	Abbrev.	Measurement	Tests Conducted By
Somatic Cell Count	SCC	White blood cells in milk	Regulatory, Coop/Plant, DHI, Vets, Independent/University
Individual Cow Somatic Cell Counting Program	Cow-SCC	SCC in individual cows at monthly intervals	DHI, Independent
Bulk Tank Somatic Count	BTSCC	SCC of bulk tank milk	Regulatory, Coop/Plant, Vets, Cell Independent/University
Direct Microscopic Somatic Cell Count	DMSCC	Standard method for determining SCC of a milk sample	Regulatory, Coop/Plant, Independent/University
Wisconsin Mastitis Test	WMT	Indirect measure of SCC in a milk sample (antiquated)	Coop/Plant, Vets, Independent/University
California Mastitis Test	CMT	Cow side test for SCC in milk	Vets, Producers
Standard Plate Count	SPC	Total number of bacteria in a milk sample	Regulatory, Coop/Plant, Independent/University
Preliminary Incubation	PI	Number of psychotrophic (cold loving) bacteria in a milk sample	Coop/Plant, Independent/University
Bulk Tank Milk Cultures	BTMC	Estimates total number and type of bacteria in a milk sample	Vets, Coop/Plant, Independent/University
Cow/Quarter Cultures	—	Infection status of cows/quarters and pathogen type	Vets, Independent/University, Coop/Plant

NDSU EXTENSION SERVICE
North Dakota State University, Fargo, ND 58105

MAY 1997

The bacterial count is another primary measure of milk quality. Bacteria are present in milk as a result of milking infected mammary quarters, contamination from the environment during milking, dirty milking equipment, and growth during milk storage. The majority of bacteria present in milk are as a result of contamination from the environment and dirty equipment. The contribution from infected mammary quarters generally is small by comparison. Milking wet, dirty udders, together with poorly cleaned and sanitized inflations, milking claws, hoses, pipelines, and bulk tanks are primary sources of high bacterial counts. Overuse of inflations leads to cracking of the rubber and ideal areas for bacteria to grow and is a frequent cause of high bacterial counts.

The types of information derived by analysis of a milk sample by one or more tests designed to determine either SCC or bacterial content are listed in Table 2. No one test simultaneously determines both. Analysis of bulk tank milk samples yields information on the herd, while analysis of milk samples from individual cows/quarters yields specific information about that cow/quarter. Whole herd information can also be obtained by testing individual milk samples from all cows in the herd.

Bulk Tank Milk Testing

Tests run on bulk tank milk samples fall into three categories: 1) regulatory tests, 2) coop/plant quality premium tests, and 3) informational tests. Regulatory tests establish that the milk being shipped by producers meets the legal **minimum** quality standards established by the Food and Drug Administration (FDA) and adopted by state departments of health. These regulations are in the Pasteurized Milk Ordinance (PMO). Tests are conducted for SCC, bacterial numbers, the presence of antibiotics, and the presence of added water. The upper legal limit for SCC is 750,000 cells/ml. (as of January 1, 1997) The primary bacterial count used is the standard plate count (SPC), sometimes referred to as the plate loop count. The upper legal limit for SPC is 100,000 bacteria/ml.

Coop/plant quality premium tests include determination of SCC and bacterial numbers, generally by both the SPC and preliminary incubation (PI) methods. Minimum standards to receive bonus payment for quality milk will vary among milk procurement agencies, but in general bonus payments start at 300,000 somatic cells/ml and 10,000 bacteria/ml by both the SPC and PI methods. There are generally other requirements that must be met, such as absence of antibiotics.

Informational tests include the regulatory and coop/plant quality premium tests. In addition, many veterinarians and other laboratories do bulk milk tank cultures (BTMC). This test *estimates* the total number of bacteria in the bulk tank milk and provides information as to the specific types of bacteria present. It is a good place to start when troubleshooting a herd mastitis problem. The SPC and PI tests do not reveal the specific types of bacteria present.

Table 2. Information derived from mastitis and milk quality tests.

Test	Importance of Information	Disadvantages
BTSCC	1. Indicator of herd mastitis prevalence.	1. No indication of which cows/quarters are infected. 2. No indication of pathogens involved. 3. Poor monitor of environmental mastitis.
SPC	1. A monitor of milking equipment sanitation, milking time hygiene, and efficiency of milk cooling.	1. No indication of bacterial types. 2. No indication of specific source of contamination.
PI	1. Indication of bacterial contamination from environmental sources. 2. Low values necessary for quality bonus payments.	1. No indication of causative agents. 2. No indication of the specific environmental source.
Individual Cow SCC	1. Monitor of subclinical mastitis in a cow. 2. Can be used to assess subclinical mastitis in a herd 3. Informed management decisions (culling). 4. Assess monetary losses associated with subclinical mastitis.	1. No indication of causative agents. 2. Poor monitor of environmental mastitis. 3. Poor indicator of clinical lmastitis.
CMT	1. Inexpensive, rapid, and subjective evaluation of quarter SCC at cow side.	1. Interpretation is difficult. 2. Relative numbers of pathogens are poorly related to infection prevalence. 3. The source of organisms other than contagious pathogens is not indicated.
BTMC	1. Estimates SPC. 2. Detects presence of specific pathogen types. 3. Indicates primary bacterial contaminants. 4. Can be used to evaluate milking time hygiene.	1. Interpretation is difficult. 2. Relative numbers of pathogens are poorly related to infection prevalence. 3. The source of organisms other than contagious pathogens is not indicated.
Cow/Quarter Cultures	1. Only method that determines infection status of a cow/quarter. 2. Identifies specific causative agents in clinical and subclinical mastitis.	1.Costly. 2. Requires special training to collect and analyze samples.

Testing Milk From Individual Cows

The primary purpose for testing milk from individual cows/quarters is to evaluate mastitis. None of the tests applied to milk from individual cows are used by regulatory agencies or coop/plant quality premium programs. Individual cow tests are simply informational and the next logical step for troubleshooting herd mastitis problems.

The most widely used program for determining the SCC of milk from individual cows is the Dairy Herd Improvement (DHI)-SCC program. Some independent mastitis testing laboratories offer a similar service, and some milk procurement agencies will test milk samples from individual cows for SCC. The DHI-SCC program determines somatic cells in composite milk at monthly intervals. These data can be used to determine which cows are likely to be infected, but they cannot be used to determine which of the four mammary quarters are infected or the type of pathogen causing the infection. The California Mastitis Test (CMT) is the most widely used cow-side test for estimating the SCC of individual quarters.

Somatic cell counts measure inflammation and are an indirect measure of the presence or absence of infection. The true infection status of a cow/quarter can only be determined by microbiological analysis (culturing) of aseptically taken milk samples. Milk samples to be tested can be either composite samples (an equal volume of milk from each quarter is drawn into the same tube) or individual quarter samples. This type of testing determines the presence or absence of pathogens and the type of pathogen. Results from multiple samples taken over time are more reliable indicators of infection status than results from a single sample. When culturing a single milk sample, four types of results are possible: 1) the sample yields the correct result; 2) a pathogen is isolated, but the quarter is truly not infected – *a false positive;* 3) nothing grows (no isolation), but the quarter is truly infected – *a false negative;* and 4) the sample is contaminated, three or more pathogen types grow and the results are impossible to interpret – contaminated sample. The number of samples yielding incorrect results will vary between 10 and 20% of milk samples when routinely sampling cows. The percent incorrect samples can be as high as 30 to 50% if samples are only from clinical quarters.

Conducting Milk Quality Tests

Bulk Tank Milk Tests

Regulatory tests are conducted in laboratories operated by state departments of health or equivalent agencies or in laboratories approved by these agencies. The PMO indicates that milk from all herds will be tested at least four times in any six-month period. Somatic cell counts are determined almost exclusively by electronic counting methods using a series of milk samples with varying cell concentrations. Cell numbers in the standards are determined by the direct microscopic method and the cell count is referred to as the direct microscopic somatic cell count (DMSCC). The DMSCC method is considered the standard method to which all other cell counting methods are compared. Even with calibrated machines there is approximately 15% error in any single number generated. A 15% error means that a cell count of 100,000 cells/ml could really be anywhere between 85,000 and 115,000 cells/ml.

The standard plate count method accurately determines the total number of bacteria present in a milk sample, but it does not determine the type of bacteria present. To run the SPC, a precise volume of milk is added to a given quantity of media and the plate incubated for 24 hours. The number of colonies is accurately counted and expressed as bacteria/ml of milk. Other names often used to describe the SPC are “loop count” and “bacteria count.”

Coop/plant quality premium tests are generally conducted in laboratories operated by the coop or plant. Some tests may be carried out in independent laboratories, and some coops/plants may utilize the test data derived by regulatory agencies.

Most coop/plant quality premium programs determine SCC by electronic means and generally use a Fossomatic or equivalent machine. The Fossomatic counts the number of DNA particles or somatic cell nuclei. Proper calibration of the machines is essential. There is no single “standard milk sample” by which all machines are standardized. Most laboratories frequently test the accuracy of their machines by comparing the cell count generated to the value derived by the DMSCC method.

Most coops/plants determine the number of bacteria in milk using both the SPC and PI methods. The value of the PI count is that is gives a better indication of the shelf life of fluid milk. To determine the PI count the raw milk sample previously used to determine the SPC is

Individual Cow Tests

incubated at 55° F for 18 hours and then the bacterial count is determined using the SPC method.

Veterinarians and others are frequently interested in not only the number of bacteria present in bulk tank milk, but also the various types of bacteria. A test that is growing in use is bulk tank milk culturing (BTMC). In contrast to the SPC and PI methods, BTMC is not standardized, not quantitative, and exact methods vary among laboratories. A common practice is to spread approximately .01 ml of milk evenly over the entire surface of an esculin blood agar plate. Some laboratories use media that is selective for growth of staphylococci, streptococci, coliforms, or mycoplasma in addition to the esculin blood agar. The total growth on esculin blood agar approximates, but is not identical to, the SPC. The test is primarily used to determine the presence of contagious pathogens in the dairy. The primary contagious pathogens are *Staphylococcus aureus*, *Streptococcus agalactiae*, and *Mycoplasma* spp.

Individual cow SCC are most frequently determined in DHI laboratories, but independent laboratories do offer this service. Cells are counted electronically, generally using a Fossomatic machine. The DHI-SCC program generally reports the values as the Linear Score, but some report the value as thousands of cells (i.e. 100,000 = 100). The scale for linear score is from 0 to 9, where a linear score of 4 is equal to 200,000 cells/ml and linear score 6 is equal to 800,000 cells/ml. The linear score is preferred as it can be related directly to production losses. Each increase of 1 in linear score corresponds to a doubling of SCC and a milk loss of 400 lbs/lactation (1.5 lbs/day) on second lactation or older animals and 200 lbs/lactation (.75 lbs/day) on first lactation animals.

High SCC quarters can be determined at cow side using the California Mastitis Test (CMT). The CMT test is an estimate of the SCC.

Veterinarians usually conduct bacterial analysis of milk samples from individual cows and quarters in their own laboratories or they use the services of independent or university laboratories. The primary purpose of culturing milk from individual cows is to determine the infection status of the cow or quarter and to determine the specific pathogens infecting the herd. Milk samples for culture must be taken with great care. Teats must be clean and dry and the teat end thoroughly scrubbed with alcohol pads prior to collection. Either composite milk from all four quarters or individual quarter samples can be tested. The most accurate method is to culture individual quarter samples. Composite milk samples are often used in an attempt to reduce the cost of testing. However, composite milk samples have limited microbiological value and they do not reveal which quarters are infected.

Using the Information to Manage Mastitis and Milk Quality

The production of quality milk begins with the understanding that mastitis must be controlled and sanitary conditions must exist throughout the cow's environment. Bulk tank milk tests for SCC, SPC, and PI provide producers valuable information about the current status of mastitis and sanitation in their herds. Coop/plant incentive programs have greatly increased producers' awareness of these quality tests. Realistic goals are BTSCC of less than 200,000 cells/ml and SPC and PI counts of less than 5,000 bacteria/ml. Many dairymen consistently produce milk with SCC less than 100,000 cells/ml and less than 5,000 bacteria/ml. A question frequently asked is whether or not SCC can get too low. The SCC goals suggested are in the range of counts associated with uninfected quarters and are not physiologically abnormal.

Somatic cell counts are reduced by controlling mastitis and, more specifically, subclinical mastitis. The BTSCC is a function of the percentage of quarters infected in the dairy herd. The contagious mastitis pathogens, such as *S. aureus, S. agalactiae,* and *Mycoplasma* spp. are frequently causes of subclinical mastitis, high percentage of quarters infected, and BTSCC of 500,000 cells/ml or greater. On occasion, high SCC herds are found to have a significant problem with the environmental streptococci. The BTSCC is the first clue to the amount of subclinical mastitis in the herd, and the DHI-SCC program can be used to identify the high SCC cows within the herd. A general rule is that cows with linear scores of 4 or greater are very likely to be infected and the goal should be to have 90% of the cows with linear scores of 3 or less.

Many producers try to make comparisons between DHI-SCC herd means and BTSCC derived from coops/plants. Direct comparisons are generally not valid. Somatic cell counts are very dynamic within individual cows for a given infection status and the infection status of the herd is variable from day to day. Bulk tank milk SCC represents the milk from cows actually milked into the bulk tank, while DHI-SCC herd means may include cows whose milk was discarded. Samples may have been taken on different days, derived from a different number of milkings, analyzed in different laboratories, and cells counted by different methods.

The specific bacterial cause of high SCC is important information for purposes of implementing a control procedure. Contagious pathogens are reduced by teat dipping with efficacious products, dry cow therapy, use of single service towels for udder preparation, and properly maintained and functioning milking machines. Environmental mastitis is reduced by minimizing exposure to the environmental pathogens in the environment (inorganic bedding materials), milking clean dry teats and udders, and minimizing liner slips during milking.

Bulk tank milk cultures are a quick way to determine if the contagious pathogens are present in the herd. The presence of contagious pathogens in bulk tank milk almost always indicates infected mammary quarters in the herd. However, the absence of contagious pathogens does not prove that

no cows are infected. Environmental pathogens present in bulk tank milk have multiple origins and are more likely a reflection of milking time hygiene than infected cows. Total bacterial numbers from BTMC should approximate the SPC, provided quantitative technique was used to determine BTMC. Interpretations based on a single bulk tank sample can be very misleading. Multiple samples over time are highly recommended to obtain maximum value of BTMC.

The relative numbers of the various pathogens determined using BTMC can be useful when trying to determine the possible cause of high SPC or PI counts. High SPC or PI counts are most often the result of dirty equipment, poor milking time hygiene, or improper cooling of milk. On occasion high SPC or PI counts may be the result of intramammary infections in the dairy herd. A high prevalence of quarters infected with *S. agalactiae* or the environmental streptococci can result in a high SPC. Spikes in PI count can, on occasion, be attributed to severe coliform infections that get milked into the bulk tank. Numbers of coliform bacteria can reach several million per milliliter in the infected quarter and often the cow shows no signs of clinical mastitis until the following milking. The milk from such cows represents a high number of coliform bacteria entering the bulk tank and coliform bacteria are a prime contributor to PI count.

AS-1131

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