

MASTITIS: BULK TANK MONITORING AND SOMATIC CELL COUNTS



BASICS

OVERVIEW

- o Monitoring bulk tank milk is done to assess milk quality for regulatory purposes and manufacturing standards, and to estimate the prevalence of mastitis within the herd.
- o Both microbiological analysis and somatic cell measurements are used to monitor bulk tank milk.
- o Somatic cell counts (SCC) are closely related to udder health, and are accepted as the international standard measurement of milk quality.

PATHOPHYSIOLOGY

- o The influx of leucocytes (primarily PMN's) into the udder constitutes one of the initial responses to infection.
- o Studies have shown that over 90% of the cells present early in mastitis may be neutrophils, and that udder cells only account for less than 7% of the cell population.

CAUSES AND RISK FACTORS

- o The major factor affecting SCC is mastitis or inflammation of the mammary gland. This is true for SCC's at both the cow level and herd level.
- o Other factors such as parity, stage of lactation, and season of year have minor impacts on the cow's SCC. A summary of these other influences is:
 - o Type of infection: Major pathogens (e.g., *Staphylococcus aureus*) cause the greatest increases in SCC. Minor pathogens (e.g., *Corynebacterium bovis*) usually cause a 2-3-fold increase in SCC over non-infected quarters.
 - o Fluctuation during infection: Somatic cells reach their peak within hours or days following infection. In chronic infections, the SCC tends to fluctuate up and down with time.
 - o Parity & Stage of Lactation: There is little change in the SCC of uninfected cows as cows age, or in later lactation. The rise in SCC near the end of lactation may be due to a dilution effect.
 - o Seasonal effects: SCC's are often observed to be higher in summer and lower in winter. The increase in summer is probably explained by greater exposure to pathogens due to cow behavior and bedding contamination.
 - o Other factors: There is no evidence that stray voltage will have a direct influence on SCC of healthy udders. Similarly, estrus has no significant effect. There are some reported breed differences in SCC at the same infection status.



DIAGNOSIS

Bulk Tank Somatic Cell Counts:

- o The bulk tank somatic cell count (BTSCC) is a better indicator of mastitis caused by contagious organisms, such as *Staphylococcus aureus* and *Streptococcus agalactia*, which usually cause subclinical mastitis of long duration.
- o Uses of BTSCC or herd SCC include:
 - o Estimation of the prevalence of subclinical mastitis.
 - o Monitoring improvement or lack of improvement in milk quality programs.
 - o Estimating the prevalence of mastitis by cohort analysis of days-in-milk or parity groups.
 - o Estimating the new infection rate.
 - o Estimating milk production losses.
 - o Assessing milk quality.

Individual Cow Somatic Cell Counts:

- o Uses of individual cow or quarter SCC include:
 - o Estimating infection status of the gland or an individual quarter.
 - o Selecting cows or quarters for culture.
 - o Monitoring effectiveness of the dry cow program by measuring SCC at dry off and at freshening.
 - o Selecting cows for milking order, early dry-off, or possible culling.
 - o Estimating milk production losses.

OTHER LABORATORY TESTS

Monitoring bulk tank milk by culturing:

- o Bulk tank cultures are also used to monitor bulk tank milk.
 - o Bulk tank cultures are quantitative measurements of both the number and types of bacteria in bulk tank milk.
 - o High bacterial counts in the absence of an elevated SCC is often indicative of poor cooling, ineffective equipment sanitation, or poor milking hygiene.
- o Uses of bulk tank cultures:
 - o Determine the presence of subclinical mastitis.
 - o Assess the level of milking hygiene.
 - o Assess the effectiveness of sanitation.
 - o Determine contagious vs. environmental mastitis agents.
 - o Organisms found within the cow include *Staphylococcus aureus*, *Streptococcus agalactia* and mycoplasma.
 - o Organisms found on teat skin include coagulase-negative staphylococci, environmental streptococci, and corynebacteria.
 - o Organisms found in the environment include coliforms, *Pseudomonas*, *Streptococcus uberis*.

Microbiological tests of milk quality:

- o Standard Plate Count (SPC):
 - o Estimates the number of aerobic bacteria in a milliliter of raw milk
 - o The US regulatory limit stated in the Pasteurized Milk Ordinance (PMO) is 100,000 cfu/ml, with most farms striving for <10,000 cfu/ml

- o Preliminary Incubation (PI) Count:
 - o Estimates the number of cold-loving bacteria per milliliter of pasteurized milk.
 - o It was previously thought to be useful in estimating the potential shelf life of milk after pasteurization; however, more recent studies have been unable to support this correlation.
 - o This is not a regulatory test in the PMO but is used by milk plants
 - o Especially useful in comparison with SPC
 - o Counts > 20,000cfu/ml or more than 3-4 times higher than SPC are considered high
- o Lab Pasteurized Count (LPC)
 - o Estimates the number of bacteria that can survive pasteurization for 30 minutes
 - o This is not a regulatory test in the PMO but is used by milk plants to test final product quality
 - o Counts >200cfu/ml are considered high
- o Coliform Count (CC)
 - o Estimates the coliform bacteria present in raw or pasteurized milk
 - o Mostly reflective of milking hygiene (also influence by environmental mastitis)
 - o Regulatory test in the PMO
 - o Pasteurized milk limit of 10cfu/ml or 100cfu/ml in transported bulk tank milk

DIAGNOSTIC PROCEDURES

- o California Mastitis Test (CMT):
 - o Cowside test used to estimate the SCC of individual quarters.
 - o CMT reagent reacts with the nuclear material of somatic cells. Positive samples form a gel upon mixing.
 - o Best results are attained by performing on samples collected just prior to milking, but after forestripping.
 - o To perform the CMT, equal volumes of milk and CMT reagent are mixed in the paddle and observed for the degree of gelling.
 - o Interpretation is based on the degree of gelling.
- o Electronic SCC:
 - o Usually conducted by DHI testing organizations or some private laboratories.
 - o Evaluations are performed on composite milk samples, so information on quarter status is not available.
 - o Results are often reported and summarized by the DHIA processing centers.
- o On-farm, rapid SCC detection:
 - o Several commercial products are available for on-farm estimation of both individual cow and bulk tank SCC.
 - o Results may be available in 2 - 45 minutes.
- o Interpretation:
 - o SCC are reported as raw or actual SCC, and somatic cell score (SCS). SCS was previously referred to as Linear Score (LS).
 - o SCS are calculated from the log value of the SCC (see Table 1).
 - o SCS are related to milk production losses (see Table 2).
 - o The average linear score for the lactation most accurately reflects reduced milk yield.
 - o The production losses of older cows are approximately 2X first lactation cows.
 - o Herd SCC or the BTSCC is determined by the number of infected quarters, severity of infections, duration of infections, and the new infection rate.
 - o In the U.S., the current regulatory limit for BTSCC is 750,000 cells/ml.
 - o Establishing a threshold value is important for estimating infection status:
 - o Quarters and cows with SCC's below 200,000 are usually not infected.

- Quarters and cows with SCC's greater than 300,000 cells/ml are very likely infected. However, some cows with major pathogens do have SCC's below 250,000 cells/ml.
- Using 200,000 cells/ml as the threshold will increase sensitivity and reduce specificity, but will increase the odds of detecting more infections.
- Both the raw SCC and the SCS should be analyzed.
 - Linear scores are used to estimate production losses.
 - Compare the actual SCC to the SCS:
 - SCC reflects the severity of the infections.
 - SCS reflects the number of cows infected.
- Both cow-level and herd-level SCC and SCS information should be analyzed monthly.
- DHIA SCC does not always correlate with the bulk tank SCC.

Table 1: Relationship between linear scores and somatic cell counts

SCS (or LS)	Somatic Cell Count/ml	
	Midpoint	Range
0	12,500	0 to 17,000
1	25,000	18,000 to 34,000
2	50,000	35,000 to 70,000
3	100,000	71,000 to 140,000
4	200,000	141,000 to 282,000
5	400,000	283,000 to 565,000
6	800,000	566,000 to 1,130,000
7	1,600,000	1,131,000 to 2,262,000
8	3,200,000	2,263,000 to 4,525,000
9	6,400,000	Over 4,525,000

Source: National Mastitis Council Monograph, Madison, WI

Table 2: Relationship between SCS (or LS), SCC and Milk Production Losses

Lactation Average SCS (or LS)	Lactation Average SCC	Accumulated pounds lost milk production by lactation	
		Loss Lact. 1	Loss Lact. 2+
1	25,000	-	-
2	50,000	-	-
3	100,000	200	400
4	200,000	400	800
5	400,000	600	1,200
6	800,000	800	1,600
7	1,600,000	1,000	2,000

Source: National Mastitis Council Monograph, Madison, WI

Goals for SCC:

1. Herd SCS & SCC
 - Goal: SCS of <3.

- Goal: SCC of <200,000.
- 2. Percentage of cows with SCS ≥ 6
 - Goal $\leq 5\%$.
 - Indicates high SCC cows.
 - First lactation should be lowest.
- 3. Percentage of cows with SCS ≤ 3
 - Goal $\geq 85\%$.
 - Represents the “uninfected” cows.
 - First lactation should be $\geq 90\%$.



MISCELLANEOUS

ABBREVIATIONS

- BTSCC: Bulk tank somatic cell count
- CMT: California mastitis test
- LS: Linear score
- SCC: Somatic cell count
- SCS: Somatic cell score
- PMNs: Polymorphonuclear leukocyte
- PMO: Pasteurized milk ordinance

Suggested Reading

Current Concepts of Bovine Mastitis, 1996, 4th Edition, National Mastitis Council, P. O. Box 156, 605 Columbus Avenue South, New Prague, MN 56071 USA (currently out of print and under revision)

Laboratory Handbook on Bovine Mastitis, Revised Edition, 1999, National Mastitis Council, P. O. Box 156, 605 Columbus Avenue South, New Prague, MN 56071 USA

Microbiological Procedures for Use in the Diagnosis of Bovine Udder Infection and Determination of Milk Quality. National Mastitis Council, P. O. Box 156, 605 Columbus Avenue South, New Prague, MN 56071 USA

3rd International Symposium on Mastitis & Milk Quality Proceedings, 2011, National Mastitis Council, P. O. Box 156, 605 Columbus Avenue South, New Prague, MN 56071 USA

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