

GOAT MILK QUALITY



BASICS

DEFINITION

- The quality of goat milk can be defined by its physical-chemical and microbiological characteristics such as flavor, nutritional value, absence of pathogens or antibiotics, and low bacteria and somatic cell count (SCC).
- Goat milk, as defined in the U.S. Grade A Pasteurized Milk Ordinance (PMO), is the normal lacteal secretion, practically free of colostrum, obtained by the complete milking of 1 or more healthy goats.

OVERVIEW

- Differences in enumerating somatic cell counts (SCC) exist between the bovine and caprine species, with much higher SCC levels being considered normal in goats.
- The US Food & Drug Administration [Public Milk Ordinance](#) 2013 considers goat milk above 1,500,000 cells per mL as abnormal milk.
- Diagnosis of clinical and subclinical mastitis has been demonstrated to be important to the quantity, quality, and food safety status of milk produced in both species.
- Veterinarians responsible for animal health and well being for caprine herds and caprine dairy herd managers should monitor the SCC at freshening and throughout the lactation cycle.

SYSTEMS AFFECTED

Mammary

GENETICS

Selection for better udder confirmation (base above hocks) and low SCC Estimated Breeding Values (EBVs) are advised.

GEOGRAPHIC DISTRIBUTION

Worldwide, depending on breed

SIGNALMENT

Species

Caprine

Breed Predilections

Commercial dairy goat breeds

Mean Age and Range

N/A

Predominant Sex

Female

CAPRINE MILK COMPOSITION

- Physical-chemical characteristics are particularly important in the production of dairy products. Caprine milk contains about 3.8% fat (varies with breed).
- Caprine milk fat composition differs from bovine milk. Goat milk has smaller fat globules and is richer in shorter chain fatty acids.
- Caprine milk fatty acids (capric, caprylic, and caproic) are responsible for the characteristic flavor and odor.
- The lipid membrane is more fragile and improper handling can easily disrupt them, producing off flavors.
- Diagnosis of subclinical mastitis is important to the quantity, quality, and food safety status of milk produced in the caprine species.
- Though the National Conference on Interstate Milk Shipments (NCIMS) delineates differences between milk composition and SCC of caprine and bovine milk, PMO sanitary requirements for Grade A cow milk still apply to goat milk.
- It is important that veterinarians and caprine dairy managers monitor the SCC at freshening and throughout the lactation cycle.
- Unlike the bovine with merocrine milk secretion, the caprine mammary gland produces milk through apocrine secretion.
- Lactational cistern and alveolar differences may occur throughout the 305-day production cycle. Cytoplasm (cytoplasmic particulate debris as well as epithelial cells) is shed with the milk in DNA-free particles in caprine mammary secretions.
- These cytoplasmic particles are similar in size to the leukocytes found in goat's milk. Secondary to inclusion of this particulate debris, false SCC counting can easily occur.
- Goat's milk contains fairly high cell content due to the apocrine secretory process. Cellular debris, as well as intact ductal and acini epithelial cells, is readily noted in the caprine sample.

Table 1 Goat milk composition

Protein %	3.0	Vitamin D (IU/g fat)	0.7
Fat %	3.8	Calcium%	0.19
Vitamin A (IU/g fat)	39	Iron%	
Vitamin B1/thiamin (ug/100 mL)	68	Phosphorus%	0.27
Riboflavin (ug/100 mL)	210	Cholesterol (mg/100 mL)	12
Vitamin C (mg ascorbic acid/100 mL)	2	Calories/100 mL	70

BACTERIAL CONTAMINATION

- Bacteria are the primary biological contaminant in goat milk.
- They can be divided in mesophilic, psychrotrophic, and thermophilic bacterial groups.

Mesophilic Bacteria

Mesophilic bacteria grow better at room temperature (20 to 40°C) and high numbers of these bacteria are common when hygiene is poor and the milk is not properly refrigerated. They are in part responsible for milk acidity.

Psychrotrophic Bacteria

- Psychrotrophic bacteria are capable of growing at refrigeration temperatures.
- They produce proteases and lipases that break down protein and fat, producing off flavors.
- These enzymes are heat resistant and can be active after pasteurization, reducing the product shelf life.
- The surface of the teats and the milking equipment are the most important sources of psychrotrophs.
- Psychrotrophic bacteria are associated with poor milking hygiene, cleaning and disinfection of the milking equipment and the bulk tank, inadequate refrigeration (between 5 and 15°C), and long storage periods.

Thermophilic Bacteria

- Thermophilic bacteria can survive pasteurization and also produce proteases, lipases, and phospholipases. They can reduce milk quality.
- The initial contamination level and the bacterial multiplication rate will determine the bacterial load of the raw milk.
- Initial contamination level can be due to 4 factors: (1) mammary gland contamination level due to mastitis, (2) milking hygiene and milking management, (3) bulk tank and equipment cleanliness, and (4) water quality used in clean up.

MACHINE MILKING

- Machine milking produces better quality goat milk than hand-milking but machines must be well maintained. Worn liners must be replaced and twisted liners corrected.
- Vacuum level, pulsation rates and pulsation ratios need to be set as per manufacturer's recommendations with annual or every 750 hours checks performed by a specialist.

SOMATIC CELL COUNT (SCC)

- Caprine milk has normally a higher SCC than cows. This is due in part to goats having an apocrine secretion process as opposed to cows that have alveolar merocrine secretion.
- These cytoplasmic particles are similar in size to the leukocytes found in goat's milk. Secondary to inclusion of this particulate debris, false SCC counting can easily occur.
- Though the National Conference on Interstate Milk Shipments NCIMS delineates differences between milk composition and SCC of caprine and bovine milk, PMO requires SCC for Grade A goat milk to be less than 1.5 million cells/mL.
- In Swedish dairy goat herds, the mean SCC in sides with no bacterial infection was 481,000 cells per mL compared to 711,000 with intra-mammary infection and 1,010,000 cells per mL if a *Staph aureus* infection was present. These researchers used a portable deLaval cell counter. French research found culture negative milk had a SCC of 520,000 cells per mL and milk samples with *Staph spp* had 1,040,000 cells per mL.
- Research in the Netherlands found lower SCC in herds that culled rather than treated cases of mastitis, used rubber liners (rather than silicone liners) and that fed pelleted feed.
- Stage of lactation (late), seasonal effects (fall lactation), decreasing production through the lactation period, estrus, increased parity, prolificacy (multiple births higher), manual milking (vs machine milking), evening milking (vs morning milking), unbalanced rations, and breed effects tend to confound the sampling studies by increasing the SCC score.
- Milk yield and mammary production in goats during and after once-daily milking can affect SCC. More frequent milkings can increase the migration of neutrophils into the mammary gland, improving mammary gland defense against pathogens.

- Epithelial cell numbers as well as macrophages increase significantly in late lactation.
- Marked differences in SCC between halves can be used as an indicator of test specificity and reflect the potential for a high cell count being attributed to infection in that half.
- A UK study found that 93% of uninfected sides had SCC below 1,000,000 cells per ml with a mean of 428,000 cells per mL.
- Coliform and Mycoplasma infections will drastically increase the neutrophil counts within the milk samples.
- There appears to be some correlation with caprine arthritis encephalitis infection (CAE) and higher somatic cell counts.
- Goat milk collected during an estrus period will show an increase in the number of neutrophils.
- It is important that veterinarians and caprine dairy managers monitor the SCC at freshening and throughout the lactation cycle.

Californian Mastitis Test (CMT)

- Zero and trace reactions with CMT are normal for goats but a reaction of >1 (i.e. 2 and 3) were associated with intra-mammary infections. New Zealand research found that using a cut-off point of CMT 1 had a sensitivity, specificity, and positive and negative predictive values of 0.74, 0.74, 0.42, and 0.92, respectively.
- Swedish research found a good relationship between SCC measured on a portable deLaval cell counter and CMT results and also a very strong association between CMT and bacterial growth with a CMT value of 1 indicating no bacteria and greater or equal to 2 indicating bacterial growth.

CAUSES AND RISK FACTORS

Low milk quality is directly related to poor milking hygiene, inadequate cleaning and disinfection of equipment, improper refrigeration during storage and transportation, unhealthy animals, and water quality.

A joint study of Dutch and Californian dairy goat herds found the only controllable risk factor for intra-mammary infections and high SCC was an udder base below the hocks.

Research in Norway found that while Bulk Milk Cell Count (BMCC) averaged 1,000,000 cells per mL, when goat herds eradicated CAE, caseous lymphadenitis and Johne's disease, as part of their healthy goat project, bulk milk cell counts halved to 500,000 cells per mL



DIAGNOSIS

Laboratory Tests

- Frequently sample, test and culture bulk tank milk.
- Prior to taking the sample, agitate the tank for 5 minutes and then collect the milk from the top (not from the outlet). Refrigerate sample immediately.
- Generally, request a standard plate count (SPC), coliform count, preliminary incubation count (PI), bulk tank culture for mastitis pathogens, and laboratory pasteurized count (LPC). Those results will provide an idea concerning the health status of the herd, the hygiene practices, and whether refrigeration is adequate.
- The direct microscopic somatic cell count (DMSCC) of stained (pyronin Y-methyl green stain or a modified Wright's stain) milk samples is considered the caprine industry gold standard.
- The pyronin Y-methyl green staining technique stains for both DNA and RNA. The cytoplasm of epithelial cells and cytoplasmic particles stain red and the chromosomes stain lavender.

- Fossomatic (Foss-O-Matic™, Foss Electric Hillerød, Denmark) methodology used in bovine milk evaluation through the Dairy Herd Improvement Association (DHIA) counts both WBCs and epithelial (not cytoplasmic particulate matter). Fossomatic techniques use a specific DNA stain that elucidates cell nuclei.
- Coulter counter technology enumerates leukocyte cells as well as particulate material while the milk passes by an electronic counting cell. These Coulter readings tend to double laboratory Fossomatic scores.
- Milk sample electrical conductivity has been reviewed and been found to be a poor indicator of udder health in dairy goats.

N-acetyl- β -D-glucosaminidase (NAGase) is an enzyme present in both the cytoplasm of epithelial cells and cytoplasmic particulate material. It is considered a marker for inflammation in bovine as well as caprine milk samples. NAGase levels increase with inflammation as well as in late lactation goat milk and colostrum. Therefore, NAGase testing has fairly poor sensitivity for the elucidation of SCC in goats and would be more reflective of an inflammatory process.

AGE-RELATED FACTORS

Increasing age is associated with higher SCC and likelihood of sub-clinical mastitis.

ZOONOTIC POTENTIAL

Raw milk can be a source of pathogens and a public health concern. Pathogens can come from the environment, feeds, or indirect contamination with feces, or can even be shed directly into the milk.

PRODUCTION MANAGEMENT

- Antibiotic residues and presence of toxins, such as aflatoxin, are other threats to milk quality.
- Test every lot of feed and store properly; to avoid antibiotic residues, discard the milk from does that have been treated with antibiotics, follow the withdrawal period, and make sure to use drugs approved for lactating animals.



MISCELLANEOUS

SEE ALSO

Mastitis: Bulk Tank Monitoring and Somatic Cell Counts (www.fiveminutevet.com/ruminant)

Mastitis: Coliform

Mastitis: Fungal

Mastitis: Involvement of Milking Equipment and Stray Voltage (www.fiveminutevet.com/ruminant)

Mastitis: Milking Procedures and Teat Disinfection (www.fiveminutevet.com/ruminant)

Mastitis: Minor Bacteria

Mastitis: Monitoring (www.fiveminutevet.com/ruminant)

Mastitis: Mycoplasma

Mastitis: No Growth

Mastitis: Pharmacology (www.fiveminutevet.com/ruminant)

Mastitis: Small Ruminant

Mastitis: Staphylococcal

Mastitis: Streptococcal

Milk quality and composition (www.fiveminutevet.com/ruminant)

Quality Assurance for Meat Goats (www.fiveminutevet.com/ruminant)

ABBREVIATIONS

BMCC= bulk milk cell count
CAE = caprine arthritis encephalitis
CFU = colony forming units
CMT = California mastitis test (also known as Rapid Mastitis Test)
DHIA = Dairy Herd Improvement Association
DMSCC = direct microscopic somatic cell count
LPC = laboratory pasteurized count
NCIMS = National Conference on Interstate Milk Shipments
PI = preliminary incubation count
PMO = Pasteurized Milk Ordinance
SCC = somatic cell count
SPC = standard plate count

Suggested Reading

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