Bio Vet Innovator Magazine

Volume 2 (Issue 1) JANUARY 2025

OPEN ACCESS

Popular Article

Udder Health of Dairy Cattle

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DOI: https://doi.org/10.5281/zenodo.14836437

Received: January 21, 2025
Published: January 26, 2025

Introduction:

Every dairy farm aims to value the production potential of its animals and produce as much high-quality milk as possible. Poor milk quality impacts the dairy business, resulting in decreased manufacturing potential and shorter shelf life for milk and dairy products. Over the course of several decades, dairy farming has evolved into a vital source of high-quality foods and revenue for many of the world's population. Nevertheless, it must continue to develop to ensure the sustainable production of dairy products that fulfils the demands of a growing global population. Milk quality is a concept that encompasses the nutritional, physicochemical, hygienic sanitary, and organoleptic properties. Milk somatic cell count (SCC) is used as a marker in all developed countries to assess the incidence of mastitis in dairy farms, inform processors regarding the quality of raw milk, and quantify farm-level hygiene. Among the several milk quality screening assays available, the estimation of milk SCC is the most reliable test for detecting the asymptomatic type of mastitis (subclinical mastitis). In some countries, producers receive reimbursement for delivering milk with a low somatic count due to its more desirable technical characteristics and a longer shelf life.

Udder Health And Its Importance:

A dairy cow's lactation may be classified into three distinct stages: early, middle, and late. Milk is continually generated by milk-secreting epithelial cells in a lactating mammary gland (Al-Mubarak and Al-Haddab, 2013). However, the highest milk production yield is observed in the early lactation stage. Subsequently, a physiological reduction in milk production may be observed as the lactation continues. Previous research has shown that the SCC is psychologically more significant in the first few weeks after calving and rapidly declines between 25 and 45 days after that. Afterward, it may steadily increase again during the late lactation stage. Ensuring the quality of milk and dairy products remains challenging, especially if effective means and strategies for monitoring udder health and preventing bovine mastitis have not been appropriately implemented.

Bovine mastitis, or udder inflammation, is the costly disease affecting dairy farms, leading to substantial financial losses (Gurunathan *et al*.2021). It impacts nearly half of all cows at some point, even on farms with good hygiene practices, although its prevalence varies widely among farms. Udder inflammation poses a major challenge to the dairy industry, resulting in economic losses and potential public health risks (Romain, 2000). During lactation, an infection in one udder quarter can reduce milk production by at least 10%. Mastitis also leads to increased somatic cells and bacteria in raw milk, which elevates the activity of proteolytic and lipolytic enzymes. Plasmin, a caseinolytic enzyme derived from plasminogen, enters milk due to damage to mammary epithelial cells, leading to casein breakdown. This degradation produces foul-smelling metabolites that replace the fresh milk aroma and cause poor curding, ultimately reducing cheese production. Effective udder health management is crucial for dairy farms, as controlling mammary inflammation is essential to minimize foodborne diseases and ensure safe dairy products. Factors influencing bovine mastitis include microorganisms, immune response, environment, barn and milking parlor conditions, cleanliness, nutrition, and human management practices.

The efficiency of the milking routine and the performance of milking equipment play a critical role in ensuring milk quality and udder health in dairy cows. The teat canal serves as the primary physical barrier, preventing bacteria from entering the udder. Between milkings, the muscles around the teat canal should remain constricted, keeping the canal securely closed to block infections from accessing the udder. This defence is strengthened by keratin cells within the teat canal, which are rich in lipids. When the teat skin is smooth, elastic, and free from lesions, it is better positioned to resist pathogen invasion, thereby reducing the risk of mastitis. However, even brief stress on the teats can compromise their natural ability to fend off pathogens. While teat-end hyperkeratosis receives most attention, other short-term teat issues, like discoloration, sores, edema, and congestion, can indicate poor milking performance. Teat-end scoring is a valuable technique for evaluating hyperkeratosis and other teat lesions, providing farmers insights into milking equipment efficiency and routine effectiveness. Research has found that impaired circulation can increase the risk of subclinical mastitis. Hyperkeratosis has been associated with tissue changes around the teat canal, allowing bacteria easier access to the mammary gland. For this reason, regularly assessing teat-end scores on at least 20% of the herd can help monitor changes over time and prevent a decline in milk quality.

Methods To Determine The Udder Health:

Various tests have been developed to detect changes in milk yield during the progression of mammary gland infections. Most of these tests aim to identify specific physicochemical changes, such as an increase in somatic cell count (SCC) through direct or indirect measurement methods. These tests often use organic detergents, like the California Mastitis Test, Wisconsin Mastitis Test, and R-masti test. Other indicators include the buildup of chlorides, increased pH, electroconductivity (EC), viscosity, catalase activity, a rise in udder skin surface temperature, and the presence of particles with a diameter of 0.1 mm. Udder infections can also be identified by analysing various biomarkers, including enzymes that signal tissue damage. Colorimetric and fluorometric tests can measure the activity of lysosomal N-acetyl-β-D-glucosaminidase (NAGase) and lactate dehydrogenase (LDH) in milk. A significant portion of NAGase is produced by damaged udder epithelial cells, as seen in cases of mastitis. Research by Hovinen et al. (2016) suggests that NAGase activity may effectively indicate both subclinical and clinical mastitis.

Intramammary infections lead to a breakdown of the blood–milk barrier, resulting in elevated levels of immunoglobulin G (IgG) in milk. Both LDH and serum albumin (SA) can pass through this barrier, making them useful indicators for predicting IgG transfer into milk and detecting intramammary infections. One commercially available method for assessing LDH activity is the Udder Check™ from Porta Check, which uses paper-based test strips to detect colour changes in the presence of an LDH-specific substrate, with severity assessed by comparing colours against a chart. However, comparative tests show this tool is less accurate than other methods, such as the California Mastitis Test. Additional potential biomarkers for mastitis diagnosis under study include procalcitonin (PCT), neopterin (NPT), haptoglobin (HP), serum amyloid A (SAA), proinflammatory cytokines (IL-1β, IL-8, TNF-α, IFN-γ), and lactose.

New diagnostic methods, like infrared thermography (IRT), have shown effectiveness in assessing udder health and detecting subclinical mastitis. IRT is a convenient, non-invasive diagnostic tool that uses infrared imaging to measure the infrared energy emitted from the udder surface, converting it into thermal images or thermograms. The sensitive thermal camera can detect even small changes in surface temperature or inflammation. Paired with a mobile application, IRT becomes a portable diagnostic tool. In a study, Zaninelli (2018) evaluated IRT's potential for diagnosing mastitis and found a strong correlation with somatic cell count. This method has demonstrated sensitivity and specificity comparable to the California Mastitis Test (CMT), effectively distinguishing clinical and subclinical mastitis in both large and small ruminants. With further refinement, IRT could become a valuable, user-friendly tool for on-farm use due to its non-invasive nature, allowing farmers to monitor milk quality early in the intramammary phase. By assessing each mammary compartment separately, increased local temperature can signal inflammation, preventing the mixing of healthy milk with mastitic milk and reducing quality deterioration and food-borne disease risks.

Conclusion:

Routine assessment of management practices and real-time data collection are essential for monitoring udder health. The primary goal of udder health management is to control key factors—such as hygiene, body condition, teat end condition, milk parameters, and medical interventions—to ensure optimal udder health. However, due to mastitis being a multifactorial disease, it is challenging to eliminate all risks. Therefore, ongoing monitoring of udder health data is necessary to detect irregularities before they escalate into clinical complications.

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