

Effect of Mastitis on Milk Production and Composition in Dairy Cows

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Abstract

Bovine mastitis is considered the leading cause of economic losses in dairy farms worldwide due to the associated treatment costs, reduced cow performance, milk quantity, and quality decline, as well as early culling. The purpose of this study was to examine the relationship between somatic cell count (SCC), and physicochemical milk parameters in Romanian Black and White spotted dairy cows. In the study conducted between March and September of 2022, on a farm from the Northeast Romania, a total of 62 cows, with ages ranging from 3 to 5 years, average days in milk (DIM) 75 +/- 35 days, and milk production 22 +/- 1.8 kg (mean +/- SEM and clinical signs of mastitis were enrolled. Cows were clinically examined and milk samples were collected in order to evaluate milk SCC and physicochemical parameters such as fat, protein, lactose, casein, dry matter percentage, and density using the fluoro-optic method (Combiscope, Delta Instruments). Statistical analysis was carried out using Graphpad Prism software. A correlation matrix was computed to establish the relationship between the number of somatic cells, and the physicochemical parameters of milk. A very small significant negative relationship was observed between somatic cell score and lactose percentage ($r = -0.56$), as well as milk fat ($r = -0.39$) and protein ($r = -0.37$). In conclusion, bovine mastitis has a negative impact on both milk production and composition, however further studies involving both healthy and cows with mastitis are needed for a more robust evaluation of clinical mastitis effect on milk parameters.

Keywords: dairy cows, mastitis, physicochemical parameters, somatic cells.

1. Introduction

Mammary gland inflammation, often known as mastitis, is typically triggered by a bacterial infection or a physical injury. Bovine mastitis is considered the leading cause of economic losses in dairy farms worldwide due to the associated treatment costs, reduced cow performance, milk quantity, and quality decline, as well as early culling [1].

Mastitis also represents a public health threat since it is often related to the release of bacteria and toxins in milk [2]. The somatic cell count has long

been used as a reliable indicator of milk quality given its influence on both flavouring and storability. The somatic cell count represents the most commonly used marker for identifying intramammary infections [3-4]. A lower SCC is desirable for cheese manufacturing, and it also results in packaged milk having a greater potential shelf life. The purpose of this study was to examine the relationship between somatic cell count (SCC), and physicochemical milk parameters in Romanian Black and White spotted dairy cows.

2. Materials and methods

The study was conducted between March and September of 2022, on a farm from the North-East

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Romania. Cows were clinically examined and classified into two groups [5] (Figure 1).

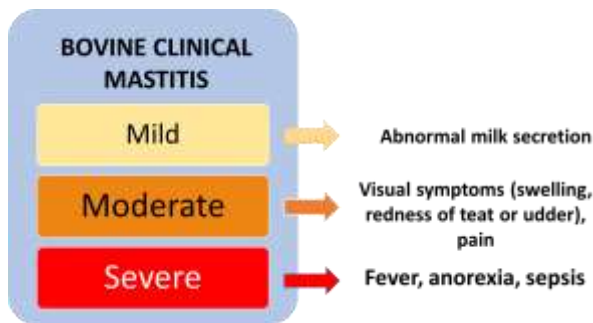


Figure 1. Bovine mastitis classification [5]

A total of 62 cows, with ages ranging from 3 to 5 years, average days in milk (DIM) 75 +/- 35 days, and milk production 22 +/- 1.8 kg (mean +/- SEM and clinical signs of mastitis were enrolled in the study carried out. Cows were clinically examined and milk samples were collected in order to evaluate milk SCC and physicochemical parameters such as fat, protein, lactose, casein, dry matter percentage, and density using the fluoroptic method (Combiscope, Delta Instruments) (Figure 2).



Figure 2. Combiscope, Delta Instruments equipment for the assessment of milk quality

Examination of the mammary gland and milk was carried out for each of the cows included in the study. The physical evaluation of the udder aimed at identifying the signs of inflammation, differences in firmness and asymmetry of the quarters.

Milk quality assessment was performed following an individual as well as topical-glandular approach. Subsequently, milk samples were collected from each quarter and the somatic cells count as well as the physicochemical parameters were determined.

The macroscopic examination of the samples was carried out to observe the colour of the milk

secretion and the consistency (presence or absence of clots or coagulation, watery secretion).

The clinical evaluation of the mammary gland and milk secretions is often paired with the milk somatic cell count (SCC), and it is frequently accompanied by its bacteriological culture in order to identify the bacteria that is responsible for the condition [6-8].

Microscopic identification of the pathogen agents was carried out using the ClearMilk Assay. Samples containing one colony of of major pathogen such as *E. coli* or *Staphylococcus aureus* were considered positive for the respective pathogen while or other pathogens, the presence of three or more colonies was considered positive.

The study was conducted in accordance with the European Union's Directive 2010/63/EU on the protection of animals used for scientific purposes. Statistical analysis was carried out using Graphpad Prism software. A correlation matrix was computed to establish the relationship between the number of somatic cells, and the physicochemical parameters of milk.

3. Results and discussion

The purpose of this study was to examine the relationship between somatic cell count (SCC), and physicochemical milk parameters in Romanian Black and White spotted dairy cows. After carrying out the macroscopic evaluation of the milk samples, several modifications were identified such as colour modifications ranging from pale yellow to darker yellow, as well as consistency modifications, consisting in milk clots of various sizes or watery secretion (Figure 3).

The pathogens identified in the milk samples from cows with mastitis were: *E. coli* (8.06%), *Coagulase-Negative Staphylococci* (CoNS), 37.13%, *Streptococcus uberis*, 19.35 %, *Streptococcus dysgalactia*, 27.41%, *Staphylococcus aureus* (3.45%) and *Candida albicans* (4.83%), mix growth (both Gram – and Gram+) (3.22%) (Figure 4).

The content of protein was also affected by the mammary inflammation, with a negative correlation being observed between the percentage of protein and the somatic cell score (Figure 4). Additionally, a very small significant negative relationship was observed between somatic cell score and lactose percentage, ($r = 0.56$, $p < 0.001$).



Figure 3. Macroscopic modifications (colour and consistency) in milk samples from dairy cows with mastitis included in the study



Figure 4. Identification of the pathogen agent (*Streptococcus uberis*) from mastitis milk sample using the ClearMilk on-farm culturing system

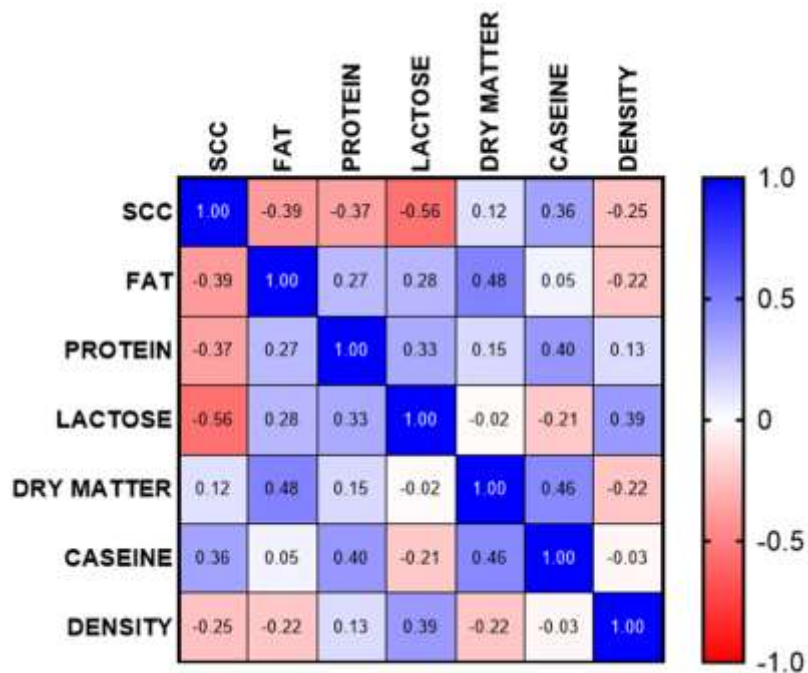


Figure 5. Correlation matrix among the number of somatic cells and the physicochemical parameters of milk

Our findings suggest that protein, lactose, and fat concentrations in milk are all altered by the degree of inflammation in the mammary gland. Milk amyloid A (M-SAA), haptoglobin (HP), cathelicidin (CATH), and lactoferrin (LF) are just some of the non-enzymatic milk proteins that have been explored as potential alternative biomarkers of mastitis due to their relationship with mammary gland inflammation [9]. This never-ending quest

for improvement has led to the discovery of a wide variety of non-enzymatic milk proteins [10]. A reduction in fat percentage is to be foreseen during mastitis due to the mammary gland's diminished synthetic and secretory capabilities [11]. This could possibly be caused by the modification induced to the milk globule membrane by leucocyte lipases or by plasmin through lipoprotein hydrolysis. Plasmin affects the

quality of dairy products by hydrolysing casein, which alters milk coagulation qualities, cheese yields, and cheese ripening. Plasmin is also recognized for its ability to withstand even UHT treatment.

According to a study conducted by [12], infections within the mammary glands of cows modify the physicochemical composition of milk, however, the extent to which this occurs is dependent on the bacteria that caused the mastitis. The number of somatic cells in milk is adversely correlated with the lactose and non-fat solids content [12].

Clinical mastitis is common in every dairy farm, its prevalence ranging from 5% to 65%. There is a wide variety of pathogens that may determine a chronic infection, in which case the clinical symptoms of mastitis such as redness, swelling of the udder, macroscopic modifications of milk secretion will be visible [13,14].

Mastitis control has been conventionally focused on the contagious pathogens such as *Streptococcus agalactiae* and *Staphylococcus aureus*, which are the most common cause for culling in dairy cattle, as well as other gram-positive bacteria, most notably *Streptococcus dysgalactiae*, a pathogen which is classified as both contagious and environmental. Typically, diagnosis of bovine mastitis is based on an increased somatic cell counts (SCC) and/or the identification of culturable pathogens in the milk [10,15]. A study conducted by [16] showed that the effectiveness of antibiotic therapy is linked to the SCC at the time of treatment, thus prospective studies ought to look at whether a novel SCC-dependent mastitis therapeutic approach may improve bovine mastitis cure rates and overall udder health [16].

4. Conclusions

In the current case study, the SCC was found to have an impact on overall milk production, percentages of fat, protein, lactose, and casein, but further studies involving both healthy and cows with mastitis are needed for a more robust evaluation of clinical mastitis effect on milk parameters. Bovine mastitis has a negative impact on both milk production and composition. Biosecurity strategies may be employed to prevent both clinical and subclinical mastitis on dairy farms. Routine biosecurity application during the milking process, as well as periodic udder health

monitoring, should be considered in order to improve milk quality in dairy farms.

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