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Linear Score of Somatic Cell Count Associations with Milk Components from Milk Analysis Recordings

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Abstract: Bovine mastitis is a prevalent and costly disease that has a significant impact on the welfare of dairy cows. The production losses resulting from clinical mastitis (CM) and subclinical mastitis (SCM) can be evaluated using somatic cell count (SCC). One commonly used parameter derived from SCC is the Linear Score (LS), which is a logarithmic conversion of SCC based on base 2. This study aims to explore whether the Linear Score of somatic cell count correlates with other milk components and if it can serve as a reliable predictor of "healthy" and "infected" cows in milk analysis reports. The study emphasizes the significant correlations and impact of mastitis (quantified by the Linear Score) on milk composition, including increases in fat ($t = -3.794$, $p = 0.000$), protein ($t = -5.227$, $p = 0.000$), and casein ($t = -4.483$, $p = 0.000$), as well as decreases in lactose ($t = 8.762$, $p = 0.000$). However, the study does not support associations between LS and non-fat dry matter ($t = -1.583$, $p = 0.115$) or ketone bodies ($t = -1.602$, $p = 0.111$). Additionally, the Linear Score approach highlights the importance of using SCC as a diagnostic tool for detecting mastitis, monitoring milk quality, and assessing the efficiency of treatment protocols.

• Introduction

Bovine mastitis is a common and expensive disease that significantly impacts the welfare of dairy cows. Production losses caused by clinical mastitis (CM) and subclinical mastitis (SCM) can be assessed through the somatic cell count (SCC). SCC is a standard diagnostic tool used to detect mastitis and is typically measured monthly at the cow level on most farms as part of the milk recording system. An SCC value exceeding 200,000 cells/mL is considered indicative of SCM. An elevated SCC signals an inflammatory response, which can significantly decrease milk production.

This study aims to examine the relationship between the linear score of somatic cell count and various milk components, assessing its potential as a predictive indicator for distinguishing "healthy" and "infected" cows based on the Milk Analysis Report in the Official Recording of Milk Production.

• Material and method

The data considered in this study were collected from a dairy farm located in the western region of Romania. To obtain the data, milk samples were taken as part of the official milk production control from 296 cows. The samples were then transported to an accredited laboratory for milk quality testing, where they were processed. After processing, the laboratory issued a milk analysis report. The analysis report issued includes several parameters such as fat content, protein content, casein content, lactose, somatic cell count, and others. The selection criteria were determined based on the validity of SCC data and laboratory results for fat, proteins, caseins, lactose, pH, and other relevant parameters. After applying these criteria, 273 lactating cows remained in the study. The somatic cell count (SCC) in milk serves as an indicator of udder health by calculating the linear score of SCC, which converts SCC values into a linear logarithmic scale using the following equation:

$$LS\ SCC = \log_2 (SCC/100) + 3$$

According to farm practice, the interpretation of the linear score of somatic cell count (LS SCC) is as follows:

- A linear score below 4.0 indicates that the udder is not infected, classifying the cow as "healthy."
- A linear score of 4.0 or higher suggests an udder infection, categorizing the cow as "infected."

Milk components were analyzed based on these LS SCC-defined categories. Statistical analysis was performed using SPSS Statistics for Windows, Version 17.0 (Chicago: SPSS Inc., USA). The Student's *t*-test was applied to compare groups, with statistical significance set at $p < 0.050$.

• Results and discussions

At the farm level, the average Linear Score of Somatic Cell Count (LSSCC) was 4.18±0.12, indicating the presence of infection at the milking parlor. When analyzed retrospectively according to the LS SCC classification, healthy cows (LS SCC < 4.0) had an average score of 2.56±0.07, while infected cows (LS SCC ≥ 4.0) had a significantly higher average of 5.89±0.11. The difference between these groups was -3.33±0.13, which was statistically significant ($t = -25.488$, $p = 0.000$), confirming a strong association between elevated somatic cell counts and infection status. According to the LS SCC classification, 133 cows were identified as infected and 140 as healthy. The Linear Scoring of Somatic Cell Count (LS SCC) showed significant correlations with various milk components, highlighting its potential impact on milk composition and quality. Positive correlations (Table 2) were observed between LSSCC and several parameters, including fat ($r = 0.306$, $p = 0.000$), protein ($r = 0.362$, $p = 0.000$), casein ($r = 0.315$, $p = 0.000$), total dry matter ($r = 0.275$, $p = 0.000$), milk urea nitrogen (MUN) ($r = 0.236$, $p = 0.000$), total urea ($r = 0.248$, $p = 0.000$), beta-hydroxybutyrate ($r = 0.151$, $p = 0.012$), somatic cell count (SCC) ($r = 0.689$, $p = 0.000$), and direct somatic cell count (SCCD) ($r = 0.787$, $p = 0.000$). These positive correlations suggest that an increase in somatic cell count, typically associated with mastitis or other udder health issues, leads to higher levels of these milk components. In contrast, LSSCC was negatively correlated with lactose ($r = -0.594$, $p = 0.000$) and pH ($r = -0.216$, $p = 0.000$).

Table 2. Linear score correlation with milk components (N = 273)

Specification		Fat	Protein	Casein	Lactose	N-FDM	Total DM
LS SCC	Pearson Correlation	.306**	.362**	.315**	-.594**	.094	.275**
	Sig. (2-tailed)	.000	.000	.000	.000	.120	.000
Specification		**pH**	**MUN**	**Acetone**	**BHB**	**DSCC**	**SCC**
LS SCC	Pearson Correlation	-.216**	.236**	.053	.151*	.689**	.787**
	Sig. (2-tailed)	.000	.000	.385	.012	.000	.000

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

• Conclusions

Infected cows (with higher somatic cell count, SCC) exhibited significantly higher milk fat content, higher protein level, higher casein content, higher MUN levels, higher β-hydroxybutyrate compared to healthy cows.
Infected cows showed a decrease in lactose content and pH compared to healthy cows, likely due to the inflammation, cellular and metabolic changes in the mammary gland caused by infection.
The findings highlight the importance of monitoring somatic cell count, as LSSCC is not only a key indicator of infection but also influences the composition and quality of milk. Founded associations and correlations suggest that an elevated LSSCC can significantly impact milk's suitability for processing and may require intervention to maintain milk quality.

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