Milk composition alterations in mastitic goats: A comparative study with healthy animals

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Abstract

Mastitis in goats is an important pathological condition leading to considerable deterioration in milk quality as well as quality and is mainly encountered in subclinical form. This deteriorated quality affects the profitability of farm especially in terms of future crop health and productivity. Therefore, this study investigates the effect of mastitis on milk composition during various lactation stages in goat (*Capra hircus*). Using sterile polypropylene tubes, milk from 50 lactating goats over different lactation phases (early, mid, and late) was collected aseptically and then subjected to milk composition analysis, including protein, fat, lactose, solids-not-fat (SNF), and total solids (TS) using Foss Milko-Scan^{TM} Mars. Protein content in both the left and right quarters showed a significant decline during the second and third stages of lactation compared to the first stage. Fat concentrations increased progressively until mid-lactation but subsequently declined in the late lactation phase. Lactose levels in the right quarter exhibited a significant rise in the later stages of lactation. In contrast, total solids (TS) content decreased as lactation progressed, a trend also observed in the solids-not-fat (SNF) content. Affected goats exhibited higher protein, fat, and TS levels whereas decline was seen in lactose. The study highlights the complex variation in milk composition, with implications for dairy production and herd health management. Further research on lactation management and strategies to mitigate mastitis impacts on milk quality is recommended.

Keywords: Goat, lactation, mastitis, milk composition

Introduction

As of 2021, the global goat population stands at 1111 million (BAHS, 2023), with India accounting for 148.88 million goats, marking a 10% increase from the previous census and making it the second-largest goat producer worldwide. India, with 39 recognized goat breeds leads globally in goat milk production, contributing 6.46 million tonnes annually (BAHS, 2023). Milk is a highly nutritious secretion, and its composition is influenced by various factors, including the health status of the animal. In goats, milk composition, such as fat, protein, lactose, solids-not-fat (SNF), and total solids (TS), is crucial for both economic and nutritional purposes. However, conditions like mastitis—an inflammatory disease of the mammary gland—can significantly alter these parameters, adversely impacting milk quality and yield compromising its market value and processing qualities (Danilov et al., 2019). Healthy goat milk is known for its high digestibility and balanced composition of nutrients, making it a popular choice for human consumption. However, mastitic milk is characterized by increased somatic cell counts (SCC), altered protein and fat concentrations, and reduced lactose content, which are markers of inflammation and tissue damage (Contreras et al., 2007; Rasouli & Mosaferi, 2017). Understanding these variations is essential for improving milk quality and implementing effective herd health management practices. This study focuses on analyzing milk composition variations in healthy and mastitic goats to identify the extent of changes and their implications for dairy production systems, quality assurance and animal health management.

Materials and Methods

This study was conducted at the Goat Farm of the Department of Animal Genetics and Breeding, College of Veterinary Sciences, Lala Lajpat Rai University of Veterinary and Animal Sciences (LUVAS), located in Hisar, Haryana, India with longitude and latitude North 29.143249758054584 and East 75.69968355945132 respectively. The farm is situated in a semi-arid zone with a sub-tropical climate. The experimental sheds were aligned along the East-West axis. Throughout the study, the animals were managed under uniform conditions. The research received prior approval from the Institutional Animal Ethics Committee (IAEC) under registration number 1669/GO/ReBiBt-S/Re-L/12/CPCSEA (dated 06/12/2012) in the IAEC/LUVAS/27/12 meeting held on June 27, 2023. Data collection was carried out from October 2023 to January 2024. Initially, the history of each goat was reviewed using farm records and staff input. Fifty apparently healthy lactating goats were randomly chosen and monitored during their lactation period, which was categorized into early (10–40 days), mid (41–90 days), and late (91–150 days) phases, following the classification by Singh et al. (2014). Each goat was sampled three times, corresponding to these phases. Milk samples were collected in the early morning to ensure consistency and reduce variability. Before sample collection, the udders were cleaned and disinfected to maintain hygiene and prevent contamination. For each goat, 50 ml of milk was collected from each quarter into sterile polypropylene tubes, labeled with the goat's identification number, and transported under refrigerated conditions for analysis. To ensure accurate analysis, milk samples were preheated to a temperature of 35–40°C using a water bath. After performing Somatic Cell Count using LactoScan SCC Analyzer (Milkotronic Ltd. Stara Zagora, Bulgaria), animals having SCC of less than 10 lakh cells/ml were considered healthy and more than 10 lakh cells/ml were considered mastitic (Olechnowicz and Jaskowski, 2004). The milk composition, including fat percentage, protein percentage, lactose percentage, solids-not-fat (SNF) percentage, and total solids (TS) percentage, was analyzed in the laboratory using the Foss Milko-Scan™ Mars. The collected data were analyzed using SPSS software (version 20). Descriptive statistics were generated, and a one-way analysis of variance (ANOVA) was performed to identify significant differences. Pairwise comparisons were made using the post hoc Duncan test. A chi-square test was employed to compare parameters between healthy and mastitic animals. Correlations among various parameters were determined using the Pearson correlation matrix.

Results and Discussion

The effects of lactation stages on milk composition in *Capra hircus* are summarized in Table 1. Protein content in both left and right quarters significantly decreased during the second and third stages compared to the first. Similar trends were observed by Mestawet et al. (2012) and Ibnelbachyr et al. (2015), while others reported contrasting results, with protein decreasing from early to late lactation (Mahmoud et al., 2014). Fat concentrations increased until mid-lactation and declined in late lactation, likely due to lipolysis influenced by enzymes in the mammary gland (Gajdusek et al., 1993). While some studies agree with these findings (Strzałkowska et al., 2009), others observed higher fat content during early and late stages (Mestawet et al., 2012; Ibnelbachyr et al., 2015). Lactose levels in the right quarter significantly increased in later stages, consistent with Mahmoud et al. (2014), although others reported decreasing lactose levels as lactation progressed (Pavic et al., 2002). Total solids (TS) decreased during subsequent lactation stages in this study, differing from most research showing TS increased during late lactation due to reduced milk yield (Noutfia et al., 2014). These findings underscore the complex variability in milk composition during lactation. Similar decrease was also noticed in SNF content also.

Table 1: Effect of stage of lactation on milk composition of *Capra hircus*

Parameters	Early lactation	Mid lactation	Late lactation
Fat LQ (%)	3.81 ± 0.30	4.17 ± 0.36	3.92 ± 0.27
Fat RQ (%)	4.03 ± 0.34	4.14 ± 0.35	3.85 ± 0.28
Pro LQ (%)	4.38^{b} ± 0.28	3.52^{a} ± 0.05	3.71^{a} ± 0.05
Pro RQ (%)	4.28^{b} ± 0.21	3.48^{a} ± 0.05	3.72^{a} ± 0.05
LAC LQ (%)	4.83 ± 0.05	4.83 ± 0.04	4.82 ± 0.05
LAC RQ (%)	4.79^{a} ± 0.05	4.85^{ab} ± 0.03	4.87^{b} ± 0.04
TS LQ (%)	14.03 ± 0.47	13.48 ± 0.38	13.13 ± 0.30
TS RQ (%)	14.09 ± 0.48	13.49 ± 0.36	13.16 ± 0.31
SNF LQ (%)	9.99 ± 0.25	9.07 ± 0.06	9.15 ± 0.06
SNF RQ (%)	9.85 ± 0.18	9.12 ± 0.06	9.23 ± 0.06

LQ- Left Quarter, RQ- Right Quarter; Different superscript represent significant (P<0.05) differences between various stages of lactation; Pro-Protein; LAC-Lactose; TS-Total Solids; SNF-Solids Not Fat

Table 2: Change in milk composition of non-affected and affected animals during different stages of lactation

Parameters	Early lactation		Mid lactation		Late lactation	
	Healthy (44)	Mastitic (6)	Healthy (42)	Mastitic (8)	Healthy (29)	Mastitic (21)
Fat LQ (%)	3.46^{a} ±0.29	6.36^{b} ±0.78	3.42 ±0.20	3.95 ±0.45	3.73 ±0.36	4.16 ±0.44
Fat RQ (%)	3.72^{a} ±0.34	6.35^{b} ±0.92	3.47 ±0.21	3.68 ±0.48	3.63 ±0.37	4.09 ±0.44
Pro LQ (%)	4.36 ±0.30	4.55 ±0.82	3.5 ±0.06	3.62 ±0.13	3.66 ±0.06	3.76 ±0.08
Pro RQ (%)	4.19 ±0.23	4.94 ±0.61	3.48 ±0.05	3.5 ±0.12	3.67 ±0.06	3.72 ±0.07
LAC LQ (%)	4.83 ±0.06	4.78 ±0.15	4.85 ±0.05	4.73 ±0.11	4.92^{b} ±0.05	4.74^{a} ±0.06
LAC RQ (%)	4.83^{b} ±0.05	4.49^{a} ±0.13	4.85 ±0.04	4.84 ±0.09	4.94^{b} ±0.05	4.77^{a} ±0.06
TS LQ (%)	13.7^{a} ±0.49	16.48^{b} ±1.33	13.57 ±0.41	12.98±0.95	13.02 ±0.40	13.32 ±0.48
TS RQ (%)	13.74^{a} ±0.50	16.70^{b} ±1.35	13.52 ±0.40	13.35±0.91	12.98 ±0.40	13.28 ±0.49
SNF LQ (%)	9.99 ±0.27	10 ±0.72	9.11 ±0.06	8.85 ±0.14	9.25 ±0.08	9.05 ±0.09
SNF RQ (%)	9.83 ±0.20	10.04 ±0.54	9.14 ±0.06	8.98 ±0.15	9.27 ±0.08	9.11 ±0.09

LQ- Left Quarter, RQ- Right Quarter; Different superscript represent significant (P<0.05) differences between non-affected and affected animals; number in brackets () in respective group represent number of animals; Pro-Protein; LAC-Lactose; TS-Total Solids; SNF-Solids Not Fat

Table 2 summarizes the differences in milk composition between healthy and mastitic animals. Protein content was higher in mastitic animals, aligning with findings by Leitner et al. (2004), who reported increased whey protein, albumin, and IgG levels in infected glands, though total protein differences were not always significant. Fat content in mastitic animals was higher during entire lactation, supported by Ying et al. (2002). However, some studies, such as Leitner et al. (2004) found no significant differences in fat content, while others noted fat reductions in high somatic cell count (SCC) milk due to lipolysis caused by infection (Stuhr and Aulrich, 2010). Lactose levels were reduced in complete lactation. Min et al. (2007) similarly reported lower lactose concentrations in infected glands. Lactose reduction may result from altered secretion mechanisms influenced by plasmin activation (Raynal-Ljutovac et al., 2007). Total solids (TS) increased significantly in mastitic goats during early lactation, consistent with Mohanty et al. (2022). While SNF showed no significant changes, it tended to decrease during mid and late lactation in mastitic goats, also reported by Mohanty et al. (2022).

Conclusion

The study highlights the dynamic variation in milk composition during lactation in *Capra hircus*. Protein and SNF% decreased in later stages, while fat increased until mid-lactation but declined lately. Mastitic animals showed higher protein, fat, and total solids, underscoring lactation stage effects. Future research could explore the studies on improving lactation management, enhancing milk quality in infected animals, and developing strategies to mitigate negative impacts of mastitis on milk yield and composition would be valuable.

Authorship Contribution Statement

Man Singh and Vishal Sharma designed the research; Narender Singh and Sandeep Dhillod reviewed and finalized the manuscript, Anuj Singh carried out statistical analysis; Ashish and Amandeep performed milk sampling, milk analysis and prepared initial draft of manuscript.

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