Prevalence and Risk Factors of Mild Mastitis in Crossbred Dairy Cows

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Abstract

Background: Mastitis is a major concern for the dairy industry, significantly impacting milk production and animal health. This study aimed to identify the factors influencing mild mastitis in crossbred dairy cows in Bangladesh, focusing on farm size, breed, parity, body condition score (BCS), milk yield, and lactation stage. Methods: A total of 17 dairy farms, including seven large farms in the Rajshahi district and ten medium-sized farms in Rajshahi and Sirajganj, were surveyed. The California Mastitis Test (CMT) was conducted to assess the prevalence of mild mastitis, and a structured questionnaire was used to collect data on cow breed, age, farm size, calf number, BCS, milk yield, and lactation stage. Statistical analyses were performed to determine the associations between these factors and mild mastitis prevalence. Results: Mild mastitis was detected in 39.6% of the studied cases, with a significantly higher prevalence in Friesian (41.7%) and Sahiwal crosses (41.2%) compared to indigenous breeds (24%). CMT results showed that 24.6% of the tested quarters had subclinical mastitis, with 1.9% and 10.1% exhibiting strong and mild responses, respectively ($P<0.05$). Parity 2 to 4 showed a significantly higher prevalence of mild mastitis (46.5%) than parity 5 to 10 (30.3%) ($P<0.05$). Cows with poor BCS had an increased prevalence (44.3%) of mild mastitis, particularly among those producing 1 to 5 liters of milk per day. Additionally, a significant difference ($P<0.05$) was observed in the prevalence of subclinical mastitis between cows in late lactation (178–283 days) and early lactation (31–90 days). Conclusion: The findings indicate that breed, farm size, parity, BCS, milk yield, and lactation stage significantly influence the occurrence of mild mastitis in crossbred dairy cows. Effective management strategies, including improved nutritional support and early detection, are essential to mitigate the impact of subclinical mastitis and enhance dairy productivity in the studied regions.

Keywords: Mild mastitis, crossbred dairy cows, California Mastitis Test, body condition score, lactation stage

Significance | This study identified the key risk factors of mild mastitis aids in improving dairy cow health, productivity, and farm management practices.

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1. Introduction

Mastitis is one of the major devastating diseases in the dairy industry. Economic consequences of subclinical mastitis include reduced milk yield, poorer quality milk, increased culling rate, and increased cost of veterinary services and medicine. It is an inflammation of the mammary gland that can affect dairy cows in both clinical and subclinical forms. Furthermore, mastitis—especially in its subclinical form—is the most prevalent and expensive production disease in the dairy industry globally (Seegers et al., 2003; Halasa et al., 2007). The presence of pathogenic organisms in the milk that cause an inflammatory reaction in the udder and are only detectable by screening or laboratory testing is known as subclinical mastitis (SCM). As a result, symptoms of inflammation, such as swelling, heat, redness, discomfort, or systemic reactions like fever that can be identified through visual

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observation or palpation, are not seen. Only a bacteriological culture of milk can accurately identify the causal agent or agents (Erskine et al., 2001). Subclinical mastitis affects cows in every dairy herd, while the percentage of affected cows varies from 15–75% and quarters from 5–40%. According to Kader et al. (2002), the main causes of mastitis in Bangladesh were *Streptococcus spp.*, *Bacillus spp.*, *Escherichia coli*, and *Staphylococcus spp*. In subclinical udder infections, Chowdhury (2011) also discovered the same pathogens alongside others, such as *Antinobacter*, *Micrococcus*, *Pseudomonas*, and *Klebsiella spp*. The majority of adult lactating cattle are susceptible to infection during the dry season or when nursing. The mammary gland is the main source of infection. Transmission happens during milking by the hands of the milker or through post-milking sanitation. Additionally, during the periparturient phase, a cow's immunity level decreases, making it more vulnerable to an udder infection than at other times (Overton and Waldron, 2004). After milking, teat canals typically stay dilated for about two hours, allowing bacteria to enter the udder. Herd size, floor conditions, feeding schedule, cow age, and udder cleanliness were identified by Rahman et al. (2009) and Chowdhury (2011) as risk factors for subclinical mastitis in Bangladesh. Although the economic cost of subclinical mastitis is not quantified in Bangladesh, the dairy industry is particularly concerned about it because it is so detrimental. Controlling subclinical mastitis in cows is critical for the dairy industry to be profitable and sustainable. Since subclinical mastitis may only be identified by measuring the inflammatory components and pathogens in the milk, clinical mastitis can be identified by the farmer (Pakrashi et al. 2023). Furthermore, udder changes (swelling, hard, hot, and painful condition), milk changes (clots, watery, peculiar reddish hue), and general condition changes (decreasing milk output, fever, weakness, and loss of appetite) are simply indicative of clinical mastitis. Conversely, farmers frequently fail to recognize the symptoms of subclinical mastitis because they are not immediately apparent. According to some accounts, the California Mastitis Test (CMT) can identify undiscovered changes in cows' milk with ease (Leslie et al., 2002). One of the best tests for identifying subclinical mastitis in cows is the CMT. CMT, on the other hand, is an indirect technique that provides initial information on mastitis.

However, microbial infection, which is impacted by multiple risk factors, is nearly invariably linked to subclinical mastitis. Other studies have identified the following as risk factors: breed, age, parity, nutritional status, herd size, lactation stage, udder and teat morphology, milk yield, milking technique, somatic cell count of milk, water supply, barn size, residual suckling, udder towel, and hygienic practices of dairy laborers (Radostits et al., 2000; Kivaria et al., 2004). Studies on mastitis and subclinical mastitis have been conducted in Bangladesh (Islam et al., 2011; Sarkar et al., 2013; Rahman et al., 2009). The dairy industry is rapidly expanding in Bangladesh, and many farmers today are interested in raising crossbred dairy cows because of their excellent yield. There have been numerous studies on mastitis and subclinical mastitis in Bangladesh, but none that focused only on crossbred dairy cows from commercial farms. Therefore, the current study aims to identify the risk factors and epidemiological effects of subclinical mastitis in crossbred dairy cattle in Bangladesh.

2. Materials and Methods

2.1 Study area, period, and cow management

The study was carried out at different dairy cattle farms (large farm = 7, moderate to small farm = 10) in Rajshahi Division during the period from January 2022 to June 2023. The cows were stall-fed primarily straw, concentrates, and very little fresh forage while they were restrained in the barn. Regular vaccinations and anthelmintics were given to the cows. Although many farmers milked their cows once a day during the later stages of lactation, the cows were manually milked twice a day while the calves were at their feet. The dairy cattle of different breeds (n=346) from a chosen group of farms were tested for subclinical mastitis. The farms and cows were inspected according to the prescribed form (**supplementary material**).

2.2 Sample and data collection

Mastitis-infected milk was collected from various dairy cattle of different breeds from different selective farms as a sample for the subclinical mastitis test. Then the samples were transferred to the lab for confirmation of subclinical mastitis by the California Mastitis Test (CMT). Types of breeds, size of the farm, housing and management conditions, parity, age, body condition score, milk yield, and lactation period were recorded from 346 cows of 7 large farms in Paba and Motihar in Rajshahi and 10 medium-sized farms in Sirajganj district through the use of a questionnaire. Interviews with the farmers and manager and a review of any farm registers were used to complete the questionnaires.

2.3 Determination of subclinical mastitis by the California Mastitis Test

The California Mastitis Test (CMT) was used to evaluate 1436 quarters of 346 nursing cows to identify subclinical mastitis. As directed by the manufacturer, 10% Teepol (Leucocytest®, Rhone Meriux, Lyon, France) was used for the CMT. For this, a plastic paddle with four receptacles was utilized **(Figure 1a**). About 2 ml of foremilk was extracted from each of the four teats of each cow individually and placed into the corresponding cup of the paddle after the teats had been cleaned and numerous strips of milk discarded. Two milliliters (ml) of the reagent were added to each cup of the plastic paddle containing milk. Then, using a swirling motion, the reagent and milk were combined in the plastic paddle cups. The outcome was assessed right away through visual inspection. For subclinical mastitis, the absence of coagulation or

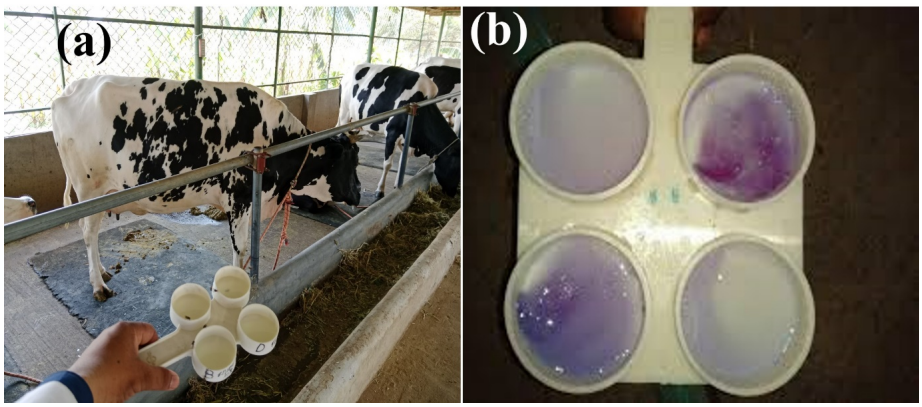


Figure 1. Sample collection for CMT (a) and CMT reaction and clotted milk (b).

Table 1. The influence of breed, farm size, and housing management condition on the prevalence of subclinical mastitis.

Variables		No. of tested cows	No. of positive cows	Prevalence rate (%)	P – Value
Breed	F crossbred	12	4	33.3[b]	0.0237
	L x F	276	115	41.7[a]	
	L x J	16	5	31.3[b]	
	L x SL	17	7	41.2[a]	
	Local	25	6	24[c]	
Farm size	Large	118	54	45.7[a]	0.0392
	Medium	234	87	37.2[b]	
House management	Good	122	25	20.5[c]	0.0381
	Moderate	115	38	33[b]	
	Poor	107	43	40.2[a]	

a,b,c,d Values with different superscripts within the same column varied significantly from each other (P<0.05). Here, F = Friesian, L = Local, J = Jersey, and SL = Sahiwal.

Table 2. CMT score of milk from crossbred cows and quarters affected with subclinical mastitis.

CMT Score		Subclinical mastitis rate (%)	P- value
Cows (218)	Trace	10.6[b]	0.0431
	Moderate	18.8[a]	
	Distinct	14.7[b]	
	Strong	5.9[c]	
Quarters (1122)	Trace	7.3[b]	0.0328
	Moderate	10.9[a]	
	Distinct	5.3[c]	
	Strong	1.5[d]	

a,b,c,d Values with different superscripts within the same column varied significantly from each other (P<0.05).

Table 3. The influence of age, parity, BCS, milk yield, and lactation period on the prevalence of subclinical mastitis.

Variables		No. of tested cows	No. of positive cows	Prevalence rate (%)	P–value
Age (years)	2 to 3	67	25	37.3	0.283
	4 to 6	123	53	43.1	
	7 to 12	91	37	40.7	
Parity	1st	58	32	55.2[b]	0.0392
	2nd	151	68	45.1[a]	
	3rd	79	28	35.5[c]	
BCS	2 to 3	91	36	39.5[a]	0.0482
	3 to 4	163	75	46.01[a]	
	4 to 5	26	9	34.6[b]	
Milk yield (L)	1.0-5.0	53	21	39.6[b]	0.0293
	6.0-10.0	157	64	40.8[b]	
	11.0-27.0	75	33	44.0[a]	
Lactation period (days)	7 to 30	34	15	44.1[a]	0.0428
	31 to 90	67	23	34.3[a]	
	91 to 180	101	47	46.6[a]	
	181 to 285	89	35	39.3[b]	

a,b,c,d Values with different superscripts within the same column varied significantly from each other (P<0.05).

gel formation in the milk was seen as negative, whereas the presence of coagulation or gel formation in the milk was interpreted as positive (**Figure 1b**).

2.4 ***Statistical analysis***

The collected data were recorded into a Microsoft Excel® worksheet and organized for further analysis. Descriptive statistics were applied to determine the prevalence of subclinical mastitis. To analyze the data and assess the correlation between various parameters and the incidence of subclinical mastitis, DMRT was performed using SPSS 20 software. A variance was considered significant when the P value was less than 0.05.

3. Results

3.1Breed, Farm Size, and Housing Management Conditions

In the current study, 1122 mammary gland quarters from 17 farms and 346 cows were evaluated by CMT to determine whether subclinical mastitis was present. A variety of risk factors were also assessed for their impact on the incidence of subclinical mastitis, including breed, size of the farm, housing and management conditions, parity, age, body condition score, milk yield, and lactation period. The influence of breed, farm size, and housing management condition on the prevalence of subclinical mastitis is presented in **Table 1**. The results revealed that breed affected the incidence of subclinical mastitis in 39.6% of cows, out of which 346 cows had preclinical mastitis; 137 of them tested positive. In comparison to local cows (24%), the incidence of subclinical mastitis was considerably (P<0.05) higher in Friesian cross (41.7%) and Sahiwal cross (41.2%). Furthermore, a significantly (P<0.05) greater number of cows on a large farm in Rajshahi (45.7%) than on medium farms in Sirajganj (37.2%) had subclinical mastitis. The housing and management conditions, like good, moderate, and poor conditions, affected subclinical mastitis by CMT in 20.5%, 33.0%, and 40.2% of crossbred dairy cattle. A significantly (P<0.05) greater number of cows in poor management conditions were affected by subclinical mastitis and followed by moderate and good.

3.2 CMT Score (Severity of Mastitis)

The CMT score of milk from crossbred cows and quarters affected with subclinical mastitis is presented in **Table 2**. Based on CMT reactivity, it was observed that 6.9% of the cows displayed a severe reaction to CMT, 18.8% of the cows exhibited a moderate reaction, 14.7% of the cows showed a clear reaction, and 10.6% of the cows showed a trace reaction. There was a statistically significant (P<0.05) variation among the several categories of subclinical mastitis in crossbreed dairy cows. Furthermore, it was noticed that 7.3% of the quarters exhibited a trace reaction, 10.9% a moderate reaction, 5.3% a clear reaction, and 1.5% a severe reaction to CMT. There was a significant difference (P < 0.05) between the different subclinical mastitis classifications in different quarters.

3.3 Age, Parity, Body Condition Score (BCS), Milk Yield, and Lactation Period

The influence of age, parity, BCS, milk yield, and lactation period on the prevalence of subclinical mastitis under this study is shown in **Table 3**. The incidence of subclinical mastitis in cows belonging to different age groups ranged from 37.3% to 40.7%, with no significant variation in occurrence seen across the groups (P>0.05). It was revealed that the rate of subclinical mastitis in cows at 1st parity to 3rd parity was substantially (P<0.05) higher at 1st parity (55.2%) than that of 2nd parity (45.1%) and 3rd parity (35.5%). Furthermore, subclinical mastitis was found in considerably (p<0.05) greater numbers of cows with BCS 3 to 4 (46.01%), followed by BCS 2 to 3.0 (39.5%) and BCS 4 to 5 (34.9%). The results revealed that the incidence of subclinical mastitis was substantially (P<0.05) greater in 11-27 liter milk-yielding cows (44.0%) than in the 1 to 5 liter yielding cows (39.6%). Finally, subclinical mastitis was found in a considerably (P<0.05) greater number of cows from 91 to 180 d (46.6%) and followed by 7 to 30 d (44.1%), 181 to 285 d (39.3%), and 31 to 90 d (34.3%) of lactation.

4. Discussion

The present study employed the California Mastitis Test (CMT) to assess the prevalence of subclinical mastitis (SCM) in dairy cows and to evaluate the influence of several risk factors on its occurrence. CMT remains one of the most accessible, cost-effective, and practical tools for the early detection of SCM in dairy herds, as corroborated by Midleton et al. (2004) and Dingwell et al. (2003).

4.1 ***Breed, Farm Size, and Housing Management Conditions***

Subclinical mastitis affected 41.7% of Friesian-cross cows and 39.6% of all cows examined in this study, consistent with the 44.8% prevalence reported by Sinha et al. (2011) in Sirajgonj, Bangladesh. However, higher (57.0%; Kader et al., 2002) and lower (15.1%; Chowdhury, 2011) rates have been previously documented, likely reflecting differences in herd size, agro-climatic conditions, farm management practices, and milking hygiene. Breed significantly influenced SCM prevalence, with Friesian-cross and Sahiwal-cross cows exhibiting markedly higher infection rates compared to indigenous breeds. This heightened susceptibility among crossbred cows may be attributed to their larger udder size, higher milk yield, and associated metabolic demands, which predispose them to intramammary infections. Comparable findings were reported by Kader et al. (2002) and Rahman (2010), underscoring the role of breed in mastitis susceptibility. Farm size also emerged as a critical determinant; cows from large farms in Rajshahi exhibited a higher prevalence (45.8%) compared to those from medium-sized farms in Sirajganj (37.2%). The increased incidence in larger farms may be explained by management challenges associated with maintaining hygiene standards amidst larger animal populations. Housing and management quality significantly impacted SCM prevalence. Poor

management conditions were associated with the highest rates of infection, followed by moderate and good management conditions. These findings emphasize the critical role of optimal housing and hygiene practices in minimizing subclinical mastitis.

4.2 CMT Score (Severity of Mastitis)

CMT reactivity among cows revealed that the majority exhibited moderate subclinical mastitis, while severe cases were less common. Specifically, 18.8% showed moderate reactions, 14.7% clear reactions, 10.6% trace reactions, and 6.9% severe reactions. These observations align with those of Varatanovic et al. (2010), highlighting the importance of regular screening to prevent the progression of subclinical infections to clinical mastitis. At the quarter level, trace (7.3%) and moderate (10.9%) reactions predominated, while clear (5.3%) and severe (1.5%) reactions were less frequently observed. These quarter-level findings are consistent with Jha et al. (2010) but differ from Sharma et al. (2010) and Ogola et al. (2007), who reported notably higher quarter-level prevalence rates in India and Kenya, respectively. Such variations likely reflect differences in farm hygiene and management practices across geographic regions.

4.3 Age, Parity, Body Condition Score (BCS), Milk Yield, and Lactation Period

In the current study, cow age did not significantly influence SCM prevalence, with infection rates ranging between 37.3% and 40.7% across different age groups ($P>0.05$). Although aging has been theorized to compromise teat sphincter function and immune competence, these effects were not statistically evident in the present cohort. Parity, however, significantly influenced mastitis incidence. First-parity cows exhibited the highest SCM prevalence (55.2%), significantly exceeding that observed in second- (45.1%) and third-parity (35.5%) cows ($P<0.05$). Although younger cows generally possess stronger immune defenses, first-lactation animals may experience higher infection rates due to physiological stress and environmental adaptation challenges, consistent with previous findings. Body condition score was also a significant factor. Cows with a BCS between 3.0 and 4.0 demonstrated the highest prevalence (46.01%), followed by those with BCS 2.0–3.0 (39.5%) and BCS 4.0–5.0 (34.9%). While Atasever and Erdem (2009) reported a negative correlation between BCS and somatic cell count (SCC), Smith et al. (2017) described a positive relationship, suggesting that the interplay between nutritional status and mastitis susceptibility remains complex and warrants further investigation. Milk yield exhibited a strong association with SCM. High-yielding cows (11–27 liters/day) showed a significantly higher prevalence (44.0%) compared to low-yielding cows (1–5 liters/day, 39.6%). This is consistent with the findings of Grohn and Rajala (2000) and Chassagne et al. (1998), who linked higher milk production to increased udder health challenges due to greater physiological stress.

Finally, the lactation stage was significantly associated with SCM prevalence. Cows between 91 and 180 days of lactation exhibited the highest infection rate (46.6%), followed by those between 7 and 30 days (44.1%), 181 and 285 days (39.3%), and 31–90 days (34.3%). The increased susceptibility during early and mid-lactation periods likely reflects peak milk production demands and heightened microbial exposure. These findings are in line with observations by Kabir (2003), Rahman (2010), Mungube et al. (2004), and Ghosh et al. (2004), who also reported elevated mastitis rates during these critical periods.

5. Conclusion

The current study used the California Mastitis Test (CMT) to determine the prevalence of subclinical mastitis in cows and quarters and to assess influencing factors. Subclinical mastitis affected 41.7% of crossbred Friesian cows and 39.6% of cows across all breeds. Medium farms showed a lower incidence compared to large farms, likely due to differences in herd size and hygiene practices. Subclinical mastitis was significantly higher in crossbred Friesian and Sahiwal cows, possibly due to higher milk yield and anatomical differences. Most cases were moderate in severity. Prevalence varied with parity, with cows in their 2nd to 4th lactations more affected. Age showed no significant effect, although younger cows may have stronger defenses. Subclinical mastitis was more common in cows with higher body condition scores (BCS) and those producing 11–27 liters of milk daily. Additionally, the incidence was higher during the 31–90-day lactation stage, likely due to increased milk production and greater susceptibility to infection. These findings highlight the importance of regular CMT screening and improved management practices to control subclinical mastitis in dairy herds in tropical countries like Bangladesh.

Author contributions

All authors made equal contributions to the study design, statistical analysis, and drafting of the manuscript. The corresponding author, along with the co-authors, reviewed and approved the final version of the article prior to submission to this journal.

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Competing financial interests

The authors have no conflict of interest.

References

Atasever, S., & Erdem, H. (2009). Association between subclinical mastitis markers and body condition scores of Holstein cows in the Black Sea Region. Turkish Journal of Animal and Veterinary Advances, 8(3), 476–480.

Chassagne, M., Barnouin, J., & Chacornac, J. P. (1998). Biological predictors for early clinical mastitis occurrence in Holstein cows under field conditions in France. Preventive Veterinary Medicine, 35(1), 29–38.

Chowdhury, M. K. (2011). Epidemiology of bovine mastitis in Bangladesh [PhD thesis]. Bangladesh Agricultural University.

Dingwell, R. T., Leslie, K. E., Schukken, Y. H., Sargeant, J. M., & Timms, L. L. (2003). Evaluation of the California mastitis test to detect an intramammary infection with a major pathogen in early lactation dairy cows. Canadian Veterinary Journal, 44(5), 413–416.

Erskine, R. J., Walker, R. D., Bolin, C. A., Bartlett, P. C., & White, D. G. (2001). Trends in antibacterial susceptibility of mastitis pathogens during a seven-year period. Journal of Dairy Science, 85(5), 1111–1118.

Ghosh, C. P., Nagpaul, P. K., & Prasad, S. (2004). Factors affecting subclinical mastitis in Sahiwal cows. Indian Journal of Dairy Science, 57(2), 127–131.

Grohn, Y. T., & Rajala-Schultz, P. J. (2000). Epidemiology of reproductive performance in dairy cows. Animal Reproduction Science, 60–61, 605–615.

Halasa, T., Huijps, K., Østerås, O., & Hogeveen, H. (2007). Economic effects of bovine mastitis and mastitis management: A review. Veterinary Quarterly, 29(1), 18–31.

Islam, M. A., Islam, M. Z., Islam, M. A., Rahman, M. S., & Islam, M. T. (2011). Prevalence of subclinical mastitis in dairy cows in selected areas of Bangladesh. Bangladesh Journal of Veterinary Medicine, 9(1), 73–78.

Jha, A. K., Hoque, M. N., Kamal, M. M., Rahman, M. M., Bhuiyan, M. M. U., & Shamsuddin, M. (2010). Prevalence of mastitis and efficacy of different treatment regimens on clinical mastitis in cows. SAARC Journal of Agriculture, 8(1), 79–89.

Kabir, M. Z. (2003). Distribution of bacteria in milk of cows with subclinical mastitis udder and their public health and economic implications [Master's thesis]. Bangladesh Agricultural University.

Kader, M. A., Samad, M. A., Saha, S., & Taleb, M. A. (2002). Prevalence and etiology of subclinical mastitis with antibiotic sensitivity to isolated organisms among milch cows in Bangladesh. International Journal of Dairy Science, 55(3), 214–223.

Kivaria, F. M., Noordhuizen, J. P. T. M., & Kapaga, A. M. (2004). Risk factors associated with subclinical mastitis in smallholder dairy cows in Tanzania. Tropical Animal Health and Production, 36(6), 581–592.

Leslie, K. E., Jansen, J. T., & Lim, G. H. (2002). Opportunities and implications for improved on-farm cowside diagnostics. Proceedings of the DeLaval Hygiene Symposium (pp. 147–160).

Middleton, J. R., Hardin, D., Steevens, B., Randle, R., & Tyler, J. W. (2004). Use of somatic cell counts and California mastitis test results from individual quarter milk samples to detect subclinical intramammary infection in dairy cattle from a herd with a high bulk tank somatic cell count. Journal of the American Veterinary Medical Association, 224(3), 419–423.

Mungube, E. O., Tenhagen, B. A., Kassa, T., Regassa, F., Kyule, M. N., Greiner, M., & Baumann, M. P. O. (2004). Risk factors for cow mastitis in the central highlands of Ethiopia. Tropical Animal Health and Production, 36(5), 463–472.

Ogola, H., Shitandi, A., & Nanua, J. (2007). Effect of mastitis on raw milk compositional quality. Journal of Veterinary Science, 8(3), 237–242.

Overton, T. R., & Waldron, M. R. (2004). Nutritional management of transition dairy cows: Strategies to optimize metabolic health. Journal of Dairy Science, 87(Suppl. 1), E105–E119.

Pakrashi, A., Rahman, A., Eiffert, S., & Sahoo, A. (2023). Early detection of subclinical mastitis in lactating dairy cows using cow-level features. Journal of Dairy Science, 106(7), 4978–4990.

Radostits, O. M., Gay, C. C., Blood, D. C., & Hinchcliff, K. W. (2000). Mastitis. In Veterinary Medicine (9th ed., pp. 603–612). W. B. Saunders.

Rahman, M. A., Bhuiyan, M. M. U., Kamal, M. M., & Shamsuddin, M. (2009). Prevalence and risk factors of mastitis in dairy cows. The Bangladesh Veterinarian, 26(2), 54–60.

Rahman, M. M., Islam, M. R., Uddin, M. B., & Aktaruzzaman, M. (2010). Prevalence of subclinical mastitis in dairy cows reared in Sylhet district of Bangladesh. International Journal of Biological Research, 1(2), 23–28.

Sarkar, S. C., Parvin, M. S., Rahman, A. K. M. A., & Islam, M. T. (2013). Prevalence and risk factors of subclinical mastitis in lactating dairy cows in north and south regions of Bangladesh. Tropical Animal Health and Production, 45(5), 1171–1176.

Seegers, H., Fourichon, C., & Beaudeau, F. (2003). Production effects related to mastitis and mastitis economics in dairy cattle herds. Veterinary Research, 34(5), 475–491.

Sharma, N., Pandey, V., & Sudhan, N. A. (2010). Comparison of some indirect screening tests for determination of subclinical mastitis in dairy cows. Bulgarian Journal of Veterinary Medicine, 13(2), 98–103.

Sinha, B., Rahman, M. S., Hannan, M. A., Rahman, M. M., Bhuiyan, M. M. U., & Bari, F. Y. (2011). Prevalence of mastitis in dairy cows in selected areas of Bangladesh. International Journal of BioResearch, 1(5), 5–9.

Smith, G. L., Friggens, N. C., Ashworth, C. J., & Chagunda, M. G. G. (2017). Association between body energy content in the dry period and post-calving production disease status in dairy cattle. Animal: an international journal of animal bioscience, 11(9), 1590–1598. https://doi.org/10.1017/S1751731117000040

Varatanović, N., Podžo, M., Mutevelić, T., Podžo, K., Čengić, B., Hodžić, A., & Hodžić, E. (2010). Use of California Mastitis Test, somatic cell count, and bacteriological findings in diagnostics of subclinical mastitis. Biotechnology in Animal Husbandry, 26(1), 65–74.