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Prevalence and Risk Factors of Subclinical Mastitis of Goats in Banadir Region, Somalia

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ABSTRACT

Introduction
Mastitis is one of the major diseases that affect dairy goat production. It occurs after several microbes invade and colonize the secretory tissue, leading to inflammation of the mammary glands. While mastitis can be caused by many infectious or non-infectious agents, it is classified as clinical and subclinical. Mastitis is one of the major problems and the top complaint from stakeholders of dairy goats in the Banadir region.

Objectives
The objectives of the study were to determine the prevalence of mastitis in goats and to find out the significant risk factors associated with mastitis in goats.

Methodology
A cross-sectional study was carried out between January and July 2022. The study population was all the lactating goats and does in the Banadir region. A total of 207 lactating goats were randomly selected from goat farms in some selected districts of the Banadir region and screened for subclinical mastitis using the California Mastitis Test (CMT).

Results
Based on CMT results, an overall subclinical mastitis prevalence of 67.6% was found. According to the risk factors, the study revealed that the lactation period (p=0.002) and body condition (p=0.005) had a significant association with the prevalence of mastitis, whereas the late lactation stage and poor body condition had the highest prevalence (73% and 79%, respectively). However, there was no statistically significant association between mastitis infection and risk factors such as study udder injury (p=0.191), age (p=0.284), hygiene (p=0.319), and parity number (p=0.620).

Conclusion
The current research has shown that mastitis is extensively common among lactating goats in the area under study, with numerous risk factors identified that make the udder susceptible to infections.

Recommendation
The study recommends farmers be vigilant and closely monitor their dairy goats for mastitis during the late stage of lactation and in advanced age, immediate treatment of injured udders, and regular screening.

Keywords
Banadir; Goats; Mastitis; Prevalence; Risk factor; Subclinical.

INTRODUCTION

Mastitis, an inflammation of the mammary gland, is defined by changes in milk's physical, chemical, and bacteriological properties, along with pathological alterations in glandular tissues, irrespective of the cause.[1] Early detection and prompt action are key to reducing tissue damage and production loss in combating mastitis, with a focus on prevention and control of both clinical and subclini-

cal forms due to treatment's limited success.[2]

Milk from goats suffering from mastitis presents a significant risk to veterinary health and poses epidemiological concerns. In addition to causing hygiene and health issues, the mammary gland inflammatory processes also cause economic losses due to reduced milk productivity, early culling of animals, and treatment costs.[3]

Mastitis commonly occurs due to inadequate hygiene practices and can be triggered by injuries to the mammary tissue or teats resulting from trauma, nursing, fly bites, or other skin wounds that serve as crucial barriers against infection. Additionally, mastitis can be associated with the presence of viral, bacterial, or fungal pathogens and their toxins. When exposed to stressful conditions like extreme temperatures, muddy or wet living environments, or sudden dietary changes, a does immune system may become compromised, making it challenging to fend off the invasion of foreign agents that contribute to diseases such as mastitis.[4-6]

Another predisposing factor is the abnormal anatomy of the udder, or teat. Infection takes place when pathogens make their way to the mammary gland. These infectious agents enter *via* the milk duct, engage with the cells of the mammary tissue, and then proliferate. Some microorganisms release toxins. The mammary gland becomes inflamed in response to these toxins and can contract infection after birth, but infection can also occur during lactation and after dry periods.[7]

Although it is not possible to completely eradicate mastitis in a goat flock, its occurrence can be minimized. Essential factors for control include practicing good husbandry and maintaining proper sanitation. It is important to ensure that the barn, milking area, and exercise space have effective drainage and ventilation systems, creating a clean and comfortable environment for the goats. The pasture area should be kept free of excessive debris and barbed wire. Additionally, all goats should undergo dehorning and receive regular foot care, reducing the risk of traumatic injuries to the teats and udder.[7]

Goats displaying open, draining abscesses should be isolated or, ideally, removed from the herd. It is crucial to follow proper milking procedures and maintain hygiene standards. Clipping the hair on the udders and flanks is necessary to prevent the accumulation of dirt and excessive moisture. Teat and udder preparation involves washing the teats and the base of the udder with a warm water disinfectant solution, utilizing a disposable paper towel for each goat. This process aims to remove visible dirt and debris and stimulate milk letdown. Afterward, another disposable paper towel should be used to thoroughly dry the teats and udder. Before commencing milking, it is important to examine a foremilk sample on a strip plate or strip cup. Milkers should take care to maintain clean and dry hands, preferably using rubber gloves.[1]

Goats are significant for the subsistence of a large population in the developing world, especially the weaker and downtrodden sections, who are the most vulnerable members of society in terms of undernourishment and poverty. The dairy goat industry has rapidly gained importance throughout the world in recent years.[3]

Goats are important for the livelihood of many people in the Third World, especially women, children, and the elderly, who are the most vulnerable members of society in terms of undernourishment and poverty. In semiarid areas where animal feed availability is scarce and poor, goats are efficient utilizers of fibrous feed, and because of their small body size and low feed intake, they are more useful and economical to the owners.[8,9]

The animal population in Somalia was estimated to be 52 million herds, of which 30.5 million are goats, with 80-91% females and 9-20% males, averaging 0.6 liters of milk per goat daily.[10] The predominant goat breeds in the area include the long-eared Somali goat, the short-eared Somali goat, and, to a lesser degree, the Somali Arab goa.[11] Despite the large number of animals in Somalia, there is a shortage of milk availability, which led to extensive consumption of imported powder milk, which subsequently led to discouragement in the development of the dairy sector in Somalia. The shortage of milk and milk production could have many causes, but a prime cause is believed to be mastitis. However, information on mastitis in Somalia, particularly in the Benadir region, is lacking or inadequate.[12] Although many studies related to the problem under investigation have been conducted in many parts of the world, there is a literature gap in the study area, as there is not a single study carried out exclusively on mastitis in dairy goats in the Banadir region. Therefore, this study is intended to bridge this knowledge gap and find out the prevalence and risk factors of mastitis in goats.

The overall objective of this study is to determine the prevalence and risk factors of mastitis in goats in the Banadir region of Somalia.

METHODS

Study Design

A cross-sectional study was conducted from January to July 2022 to determine the prevalence of mastitis in the study area. The California Mastitis Test (CMT) was used to examine all lactating animals.

Study Animals

The study animals were lactating dairy goats of different ages and stages of lactation in the Banadir region. The breeds were local breeds.

Study Area

The Benadir region consists of 18 districts. It borders the middle Shebelle in the north and east, the lower Shebelle in the west, and the Indian Ocean in the south.

The study was carried out in seven districts of the Bena-

dir region, namely, Dharkenley, Wadajir, Dayniile, Kaaran, Yaqshiid, Heliwa, and Wartanabada districts. The region lies between latitude 2°2'59"N and longitude 45°15'44"E.[13] Although by far the smallest administrative region in Somalia, it has the largest population, estimated to be about 1,650,227 (including 369,288 internally displaced persons), and covers an area of approximately 96,878 km^2.[13,14]

These are high-potential areas that are densely populated, and the goat population is also high. The sites were purposively selected based on the large population of goats. Samples were collected randomly from the goat household's farms.

Sample Size Determination

The sample size was determined using the formula by Arya et al[15]. Sample size=n=$(Z_\alpha^2 pq)/L^2$, where n is the required sample size, Z_α=1.96 is the normal deviation at the 5% level of significance, q is the estimated prevalence (in percentages), and L is the precision of the estimate, which is considered to be 5%=0.0516.

Since the prevalence of mastitis in goats in some districts of the Benadir region is estimated at 16%.[12]

$$\text{Sample size } n = \frac{Z_\alpha^2 pq}{L^2}$$

$$n = \frac{(3.8416 \times 0.16 \times 0.84)}{0.0025} = \frac{0.51631104}{0.0025} = 206.524 = 207$$

The total sample size was 207 lactating dairy animals.

Sample Procedure

All milk samples were collected from each teat of the goat's udder during the ongoing milking process and analyzed by the CMT, which was done at the goat side. Before sampling, the udder of the goat was thoroughly washed with water and dried with a clean towel. The first 3-4 streams of milk were discarded, and then 5-10 mL of milk was collected from each teat aseptically and put in a separate CMT paddle held at a slightly horizontal position in order to avoid contamination from the udder.[16]

Milk samples from each half of the udder are collected on a clean CMT paddle. The CMT paddle features four shallow cups labeled A, B, C, and D, designed to distinguish the specific quarter of the udder from which the milk sample was taken. Each of the four shallow cups has marking lines measuring 2 mL. Interviews were conducted to collect additional data.

California Mastitis Test

The test was conducted according to Mellenberger et al.[17] California mastitis reagent was used to screen dairy animals. From each halve of the udder, each of the milk samples measuring 2 mL was placed in two of the cups on the California mastitis test (CMT) paddle, and using a syringe, an equal amount of CMT reagent was added to each cup and mixed well. The test result was scored from 1-5 according to the Scandinavian scoring system, where 1 is a negative result (no gel formation), 2 is traceable (possible infection), and 3 or above indicates a positive result, where 5 has the most gel formation.18 According to the Scandinavian scoring system, the test was scored according to the agglutination and viscosity level of mixtures (reagent and milk). The interpretation was in such a way that the CMT score was 1 negative (no gel formation), score 2 was traceable gel formation (possible infection), and score 3 was visible gel formation. 4 and 5 had the most gel formation. Apart from 1 where there was no gel formation, the rest, 2 to 5, were considered positive.

Data Analysis

All data collected were entered into a Microsoft Excel 2019 spreadsheet as a database and into Statistical Package for the Social Sciences (SPSS) for statistical analysis. Descriptive statistics were generated using the same statistical package. Differences in proportions were assessed using the frequency tables in the SPSS program.[16]

The significance of risk factors on the presence of mastitis (the variable outcome) was calculated using the chi-square ($\chi 2$) technique to test the existence of a statistical association between mastitis and the risk factors (explanatory variables) such as site, age, stage of lactation, body condition score, udder injury parity number, and hygiene. In all chi-square test applications, the level of $p<0.05$ was considered statistically significant.[12]

RESULTS

The study found that the overall prevalence of goat mastitis in the Banadir region is 67.6 (Table 1).

Table 1. *Overall Prevalence of Mastitis in Goats*

Result	Frequency	Percentage
Positive	140	67.6
Negative	67	32.4
Total	207	100.0

When infection in quarters was compared, out of the 140 positive animals, 104 (74%) samples were infected with both halves, while 16% of the animals were infected with the right halves and 10% with the left halves. This result shows the right half has more infection than the left. (Table 2).

Table 3 explores mastitis prevalence in relation to risk factors such as udder injury, age, animal hygiene, body condition score, and parity number.

Table 2. *Prevalence of Mastitis According to Quarter Infected*

Variable	Category	Frequency	Percentage
Infected halve.	Left	14	10
	Right	22	16
	Both	104	74
Total		140	100.0

Table 3. *Prevalence of Mastitis in Relation to Risk Factors*

Variables	Category	Negative	Negative %	Positive	Positive %	χ2	*p*-value
Udder injury	Yes	15	27%	41	73%	1.092	0.191
	No	52	35%	99	65%		
Total		67		140			
Hygiene level	Poor	22	27	61	73	2.28	0.319
	Fair	33	35	60	65		
	Good	12	39	19	61		
Total		67		140			
Lactation Stage	Early	22	56	17	44		0.002
	Mid	30	27	83	73		
	Late	15	27	40	73		
Total		67		140			
Body condition	Poor	19	21	71	79		0.005
	Medium	13	33	26	67		
	Good	35	45	43	65		
Total		67		140			
Parity number	1-3	45	35	85	65	0.955	0.620
	4-5	15	27	40	73		
	>6	7	32	15	68		
Total		67		140			

The analysis revealed a higher mastitis prevalence in animals with udder injuries (73%) *versus* those without (65%), yet the difference wasn't statistically significant (chi-square=1.092, *p*-value=0.191). The study found mastitis prevalence increased with age—64%, 70%, and 82% for age groups 1-3, 4-6, and ≥7 years, respectively. However, this trend was not statistically significant (chi-square ($\chi 2$)=2.515, *p*-value=0.284). According to animal hygiene, the study found that 73% of the animals with poor hygiene conditions were infected with mastitis, 65% of those with fair hygiene, and 61% of those with good hygiene were also found to be positive for mastitis, although the difference wasn't statistically significant ($\chi 2$=2.28, *p*-value=0.319).

Animals with poor body conditions exhibited the highest prevalence (79%), compared to those with medium (67%) and good body conditions (65%). Notably, this factor showed a statistically significant difference in mastitis prevalence across groups (chi-square value of 10.797; *p*-value of 0.005). The study found a higher prevalence of mastitis in goats with 4-5 parity numbers (73%; 40/55) and >6 parity numbers (68%; 15/22) compared to 1-3 parity numbers (65%; 85/130). Although there is no significant difference (chi-square=0.955, *p*-value=0.620).

DISCUSSION AND CONCLUSION

The results of the study showed that the overall prevalence of subclinical mastitis in some selected districts of the Banadir region on CMT results was 67.6%. The findings in this study were in close agreement with results reported in Kenya 61%,[16] Bangladesh 50.9%,[19] and Pakistan 61.8%.[20]

The results recorded in this study were higher than those recorded in other studies: Ethiopia 25%,[21] India 19.89%,[22] Pakistan 38%.[23] However, the results of the study were lower than those recorded in Bangladesh, with 71.6% by Begum et al.[24] The prevalence of subclinical mastitis differs among countries. This might be due to the differences in host and management risk factors that influence intra-mammary infection in goats.[16]

There was a positive association between the prevalence of mastitis and the presence of lesions on the tongue or udder. This finding was not unexpected since injuries to the teats and

udders could provide a portal of entry for microorganisms, thus causing infection.[25] This finding agreed with a study in Colombia,[26] which reported no association between the occurrence of mastitis and the presence of lesions on the teats or udder of dairy goats.

According to the current study, animals aged 7 years or older recorded a higher infection rate (82%) than those in age groups 1-3 years (64%) and 4-6 years (70%). Although the difference was not statistically significant (p=0.284), some other studies support the findings in this study. A study carried out in Indonesia reported no significant association between age and subclinical mastitis.[27] Another study in the United States reported a significant association between older age and the high prevalence of mastitis.[26] The reasoning behind this could be that older animals are subjected to stress resulting from the production of milk for a long time and the multiple births, which make such animals easily susceptible to infectious agents due to their low immunity.[28]

According to the distribution of the infection on the udder, the study revealed that the majority of the positive animals (74%) were infected with both halves, and 26% of the animals were infected with only one half (left half or right half). Similar findings were declared in Kenya.[29] The study has also shown that the right half had a higher prevalence (16%) than the left half (10%), which is contrary to the findings of studies carried out in Spain.[28]

The results of this study revealed that there was an association between poor hygiene and an increased rate of infection. These results agreed with the previous finding,[30] which reported that there was a high association between poor hygiene and the prevalence of mastitis. This is underscored by the observation that the majority of pathogens responsible for subclinical mastitis in goats are present in the animals' surroundings and on their skin. So, farmers who did not clean and change their pen bedding frequently created an environment where pathogens could harbor and hence infect the goat's udder and halves.[16]

A statistically significant association (p=0.002) was found between the lactation stage and the prevalence of mastitis. Animals in the late stage of lactation were found to have the highest prevalence (73%), while those in the early stage of lactation had the least prevalence (17%). These findings agree with the result by researchers,[19,25,31] who concluded that the later stage of lactation had more infection than the earlier lactation stage; the reason could be the accumulation of infectious agents in the previous lactations.[32]

A significant association (p=0.005) was also found between body condition score and the rate of infection with mastitis, where animals with poor body condition had the highest prevalence of mastitis (79%). This could be associated with the reduced defense status of the animals, which increases susceptibility to udder infections by opportunistic organisms. The association of poor body conditions with increased mastitis prevalence has already been demonstrated in dairy cattle.[33] There was no significant association (p=0.620) between increased parity and the occurrence of mastitis in goats. Similar results were declared by a researcher in Ethiopia who found no association between the occurrence of mastitis and parity.[19] A similar infection pattern was reported elsewhere.[33] Contrarily, another finding reported that goats in their third and fourth parties were more prone to mastitis infection than goats in their first or second parties.[30] The increasing prevalence of the parity number may be due to the decreased immunity of the animal to exposure to pathogens.

RECOMMENDATIONS

The current research indicates that mastitis is a common condition among lactating goats in the study region, with various risk factors identified that make the udder susceptible to infections. The important risk factors found in the study include age, parity, udder injury, hygiene, body condition score, halves infected, and lactation. and is a major health problem for dairy animals and will have an adverse effect on the productivity of dairy goats, hence needing serious attention. There was a strong association between mastitis and risk factors, as stipulated by lactation stage and body condition. The association between mastitis and some risk factors was not very strong. All of these are indications that mastitis is posing a major challenge to goat production in the study, which necessitates the effort to control and mitigate its effects. There, the following recommendations are forwarded:

1. Farmers should be trained on the control of mastitis and the use of good milking hygiene, post-milking teat dipping, dry-off therapy, and culling of chronically infected goats.

2. Among the risk factors, poor body condition can be improved through supplementary feeding of lactating animals and treatment against parasitic infections.

3. Farmers should be informed to be vigilant and closely monitor their dairy goats for mastitis during the late stage of lactation and in advanced age, since this is the time when mastitis usually occurs.

4. The goat farmers should be encouraged to obtain CMT test kits, and some members of the group should be trained on how to use them.

5. Instead of attempting self-treatment, farmers ought to seek guidance from a qualified professional when dealing with mastitis in goats.

6. Immediate treatment of udder injuries and wounds is essential to prevent the onset of mastitis.

7. Further investigations into pathogens involved in goat mastitis should be carried out, which will optimize our knowledge of causative agents and control interventions.

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DATA AVAILABILITY

Datasets used and analyzed during the current study are available from the corresponding author on request.

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ETHICAL STATEMENT

The approval of ethical committee was taken for conducting this study and followed all the animal ethics and welfare guidelines.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

REFERENCES

1. Mbago P. Bovine mastitis on selected farms in Kamwenge District: prevalence and antibiograms of the causative bacteria. 2022. Website. http://makir.mak.ac.ug/handle/10570/10838. Accessed February 9, 2024.

2. Lianou DT, Michael CK, Gougoulis DA, et al. High milk somatic cell counts and increased Teladorsagia burdens overshadow noninfection-related factors as predictors of fat and protein content of bulk-tank raw milk in sheep and goat farms. *Foods*. 2022; 11(3): 443. doi: 10.3390/foods11030443

3. Hristov K, Popova T, Pepovich R, Nikolov B. Characterization of microbial causative agents of subclinical mastitis in goats in Bulgaria. *Int J Curr Microbiol Appl Sci*. 2016; 5(8): 316-323. doi: 10.20546/ijcmas.2016.508.034

4. Gabli Z, Djerrou Z, Bensalem M. Prevalence of mastitis in dairy goat farms in Eastern Algeria. *Vet World*. 2019; 12(10): 1563-1572. doi: 10.14202/vetworld.2019.1563-1572

5. Mandefrot MZ. Investigation of palpable udder defects in non-dairy ewes: A thesis presented in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Veterinary Science [dissertation]. Palmerston North, New Zealand: Massey University; 2023.

6. Abayeneh G, Tamir D. Prevalence of bovine mastitis and its associated risk factors among dairy cows in Ethiopia during 2005–2022: A systematic review and meta-analysis. *Vet Med Int*. 2022; 2022: 7775197. doi: 10.1155/2022/7775197

7. Cheng WN, Han SG. Bovine mastitis: Risk factors, therapeutic strategies, and alternative treatments—A review. *Asian-Australas J Anim Sci*. 2020; 33(11): 1699-1713. doi: 10.5713/ajas.20.0156

8. Mataveia GA, Visser C, Sitoe A. Smallholder goat production in Southern Africa: A review. *IntechOpen*. 2021. doi: 10.5772/intechopen.97792

9. Hossain MS, Akhtar A, Hossain MH, Choudhury MP, Islam F. Goat husbandry practices in Southern region of Bangladesh. *J. Biosci. Agric. Res.* 2015; 5(2): 59-64. doi: 10.18801/jbar.050215.55

10. Somalia National Development Plan (NDP) - 2020-2024. The Ministry of Planning, Investment and Economic Development. Website. https://mop.gov.so/somali-national-development-plan-9-2020-2024/. Accessed February 9, 2024.

11. Muigai A, Matete G, Aden HH, Tapio M, Mwai O, Marshall K. The indigenous farm genetic resources of Somalia: Preliminary phenotypic and genotypic characterization of cattle, sheep and goats. ILRI (aka ILCA and ILRAD), 2016. Website. https://core.ac.uk/download/pdf/132683417.pdf. Accessed February 9, 2024.

12. Dubad AB, Mahmud MS, Hasan HM. Prevalence of mastitis in camel, cattle, and goats at Benadir Region in Somalia. *J Vet Sci Technol*. 2019; 10: 1000587.

13. Wikipedia. Mogadishu climate and temperature. Website. https://en.wikipedia.org/wiki/Mogadishu. Accessed February 9, 2024.

14. United Nations Population Fund (UNFPA). Population Estimation Survey 2014 for the 18 Pre-War Regions of Somalia. 2014. Website. https://somalia.unfpa.org/sites/default/files/pub-pdf/Population-Estimation-Survey-of-Somalia-PESS-2013-2014.pdf. Accessed February 9, 2024.

15. Arya R, Belavendra A, Sushil K. Sample size estimation in prevalence studies. *Indian J Pediatr*. 2012; 79: 1482-1488. doi: 10.1007/s12098-012-0763-3

16. Mbindyo CM, Gitao CG, Bebora L. A cross-sectional study on the prevalence of subclinical mastitis and antimicrobial susceptibility patterns of the bacterial isolates in milk samples of smallholder dairy goats in Kenya. *American Journal of Research Communication*. 2014; 2(8): 30-51.

17. Mellenberger R, Roth CJ. California Mastitis Test (CMT). Fact Sheet. Dept. of Animal Sciences, Michigan State University and Dept. of Dairy Science, University of Wisconsin-Madison; 2000.

18. Adwan GM, Abu-Shanab B, Adwan K. Enterotoxigenic Staphylococcus aureus in raw milk in the North of Palestine. *Turk J Biol*. 2005; 29(4): 229-232.

19. Akter S, Md. Mizanur Rahmana, Md. Abu Sayeed, et al. Prev-

alence, aetiology and risk factors of subclinical mastitis in goats in Bangladesh. *Small Ruminant Research*. 2020; 184: 106046. doi: 10.1016/j.smallrumres.2020.106046

20. Jabbar A, Saleem MH, Iqbal MZ, et al. Epidemiology and antibiogram of common mastitis-causing bacteria in Beetal goats. *Vet World*. 2020; 13(12): 2596-2607. doi: 10.14202/vetworld.2020.2596-2607

21. Balemi A, Gumi B, Amenul K, et al. Prevalence of mastitis and antibiotic resistance of bacterial isolates from CMT positive milk samples obtained from dairy cows, camels, and goats in two pastoral districts in Southern Ethiopia. *Animals*. 2021; 11(6): 1530. doi: 10.3390/ani11061530

22. Mishra AK, Sharma N,Singh DD, et al. Prevalence and bacterial etiology of subclinical mastitis in goats reared in organized farms. *Vet World*. 2018; 11(1): 20-24. doi: 10.14202/vetworld.2018.20-24

23. Pirzada M, Ali A. Prevalence of subclinical mastitis in dairy goats caused by bacterial species. *J. Anim. Health Prod.* 2016; 4(2): 55-59. doi: 10.14737/journal.jahp/2016/4.2.55.59

24. Begum M, Hossain MS, Md Ershaduzzaman, Md. Shahin Alam et al. Epidemiological studies on subclinical mastitis in dairy goats in northern regions of Bangladesh. *Bangladesh Journal of Livestock Research*. 2016; 19(1-2): 112-122. doi: 10.3329/bjlr.v19i1-2.26433

25. Makau LN. *Prevalence of Mastitis and Associated Risk Factors in Dairy Goats in Machakos County, Kenya*. [dissertation]. Nairobi, Kenya; University of Nairobi; 2017.

26. Manrique LET, Acuña EES, Becerra RJA, Abella JCV. Determination of risk factors related to prevalence of subclinical mastitis in dairy goats in Boyacá-Colombia. *Journal MVZ Córdoba*. 2022; 27(Supl): e2774. doi: 10.21897/rmvz.2774

27. Fatmawati M, Suwanti LT, Mufasirin, et al. Epidemiological studies of subclinical mastitis in dairy goats in Lumajang Regency, East Java, Indonesia. *Jurnal Ilmu-Ilmu Peternakan*. 2023; 33(3): 372-380.

28. Mehdid A, Martí-De Olives A, Fernández N, Rodríguez M, Peris C. Effect of stress on somatic cell count and milk yield and composition in goats. *Res Vet Sci*. 2019; 125: 61-70. doi: 10.1016/j.rvsc.2019.05.015

29. Ndegwa EN. *Prevalence of Dairy Goat Mastitis in Central Kenya Highlands*. [dissertation]. Nairobi, Kenya; University of Nairobi; 1999.

30. Mahlangu P, Maina N, Kagira J. Prevalence, risk factors, and antibiogram of bacteria isolated from milk of goats with subclinical mastitis in Thika East Subcounty, Kenya. *J Vet Med*. 2018; 2018: 3801479. doi: 10.1155/2018/3801479

31. Persson Y, Larsen T, Nyman AK. Variation in udder health indicators at different stages of lactation in goats with no udder infection. *Small Rumin Research*. 2014; 116(1): 51-56. doi: 10.1016/j.smallrumres.2013.10.004

32. Khasapane NG, Byaruhanga C, Thekisoe O, Nkhebenyane SJ, Khumalo ZTH. Prevalence of subclinical mastitis, its associated bacterial isolates and risk factors among cattle in Africa: A systematic review and meta-analysis. *BMC Veterinary Research*. 2023; 19(1): 123. doi: 10.1186/s12917-023-03673-6

33. Fesseha H, Mathewos M, Aliye S, Wolde A. Study on prevalence of bovine mastitis and associated risk factors in dairy farms of Modjo town and suburbs, central Oromia, Ethiopia. *Vet Med Res Rep*. 2021; 12: 271-283.