Mastitis in Lactating Cows, Camels and Goats in Borana, Southern Ethiopia

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Abstract

Mastitis is a complex and multi-factorial disease, the occurrence and severity of which depends on factors related to the animal, the environment and pathogens involved. Mastitis reduces the quality and quantity of milk, and is a disease of great economic and public health importance. A cross-sectional study was conducted to estimate the prevalence of mastitis and identify the associated risk factors in cows, camels and goats in Yabello district of Borana zone, Southern Ethiopia. A total of 980 lactating animals (400 cows, 370 camels and 210 goats) were sampled and examined clinically for mastitis presence. Milk samples were further tested by California Mastitis Test (CMT) to detect subclinical mastitis. The study results revealed that 49.75% of the cows, 35.41% of camels and 24.76% of goats had udder infections. Cows had significantly higher mastitis prevalence than camels and goats. Quarter/halve level prevalence was 24.94% in cows, 12.64% in camels and 15.71% in does while 76 teats (63 in cows and 13 in camels) were found to be blind. Risk factors identified for cows were age above five years (OR=5.75), parity of 3 and above (OR=3.13), early lactation stage (OR=0.49), animals having teat lesions (OR=1.50) and teat affected by ticks (OR=2.3). Similarly, early lactation stages, udder tick infestations and teat lesion were the risk factors for camels. Mastitis prevalence was higher in multifarious goats, does above five years, and those with udder ticks and teat lesions. In conclusion, mastitis was widely prevalent in lactating cows, camels and goats in the pastoral area, where milk is the major staple food. Hence, proper control strategies and awareness of livestock keepers are needed to reduce mastitis prevalence and its negative impacts on milk production in the study area.

Key words: Cattle; Camels; Goats, Mastitis, Risk factors, Ethiopia.

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INTRODUCTION

Ethiopia holds large potential for dairy development due to its large livestock population and suitable agro-ecology of the country. In Ethiopia, milk production is traditionally from indigenous breeds, whose milk yield per animal/lactation is affected by multifaceted constraints (Felleke and Geda, 2001). Data of central statistical authority of Ethiopia (CSA, 2009) showed that cattle have the largest contribution (81.2%) of the total national annual milk output in Ethiopia, followed by goats (7.9%) and camels (6.3%). In spite of the substantial potential, the dairy sector is not developed to the expected level. Per head productivity of lactating animals has always been sub-optimal given the low genetic potential of the animals, poor nutrition and prevailing diseases.

Mastitis is a multi-etiological and complex disease, which can be defined as inflammation of the parenchyma of mammary glands featured by physical, chemical and pathological changes taking place in glandular tissues. The occurrence of disease is an outcome of interplay between infectious agents, host and environmental factors (Radosttits et al., 2007; FAO, 2014). Mastitis is one of the most important economically devastating diseases of dairy animals affecting particularly farmers in developing world, with different levels of economic losses (Hogeveen et al., 2011). It results in severe economic losses from reduced milk production, value of discarded milk, treatment and labor costs, and milk withdrawn following treatment in addition to causing premature culling. In view of the degree of inflammation, mastitis can be classified as clinical and sub clinical. Depending on the organisms involved, mastitis is classified as contagious or environmental (Quinn et al., 2004). Various risk

factors have been identified for mastitis in dairy animals such as breed, milk production level, hygiene, milking practices, age, parity and stage of lactation (Radostitset al., 2007). The diagnosis is performed by clinical examination (inspection and palpation) for clinical mastitis, California Mastitis Test (CMT) for subclinical form of mastitis, and bacterial isolation for confirmatory diagnosis (Quinn et al. 2004).

Although some authors reported the prevalence of mastitis from different animals in pastoralist systems in Ethiopia (Megersa et al., 2010; Adane et al., 2012; Regassa et al., 2013), there is still dearth of compiled research reports regarding the magnitude and associated risk factors of mastitis among lactating cows, camels and goats kept under pastoral system in the same eco-zone. Therefore, the objectives of the study were to estimate prevalence of clinical and sub clinical mastitis among lactating cows, camels and goats and factors associated with mastitis occurrence in the study area.

MATERIALS AND METHODS

General description of the study area

The study was conducted in Yabello district, Borana zone, Oromia Regional State, southern Ethiopia. Yabello district is geographically located at 5° 23′ 49″ N, 39° 31′ 52″ E, and at a distance of 564 km South of Addis Ababa. The Borana area is characterized by arid and semi-arid conditions and by a pastoral/agro-pastoral production system.Cattle (232 949) are dominating animal species followed by goats (98 781), sheep (39 073) and camels (22 972) (Coppock, 1994).

Study population, study design and sampling procedures

Lactating cows, camels and goats which were managed under extensive husbandry systems in the selected pastoral associations (PAs') of the study area constituted the targeted population. A cross-sectional study was conducted from August 2016 June 2017 to estimate prevalence of mastitis and determine associated risk factors among lactating cows, camels and goats mastitis. Four administration kebeles or pastoral associations (PAs), namely, Darito, Dida-Yabello, Gagna and Surupawere randomly selected out of 18 Kebeles of the district, and included in the present study. Households from selected PAs were included in the study based on at least two species ownership and their willingness to take part in the study. Subsequentlylactating cows, camels and goats from households were sampled and examined for mastitis and individual milk samples were tested for subclinical mastitis using California Mastitis Test.

Sample size determination

The sample size was determined using the formula given by Thrusfield, (2005) by taking the species specific prevalence from the previous studies in same area such as 59.1% (Adane et al., 2012), 44.8% (Regassa et al., 2013) and 15.5% (Megersa et al., 2010) for cows, camels and goats, respectively. Likewise, confidence level of 95% and desired absolute precision 5% were used based on the following formula:

$$n = \frac{1.96^2 * (P * (1 - P))}{d^2}$$

Where n=required sample size,
P=expected prevalence,
d=desired precision

An attempt was made to increase the sample size by 5% to compensate any loss during sample collection and processing. Eventually, a total of 980 dairy animals (400 cows, 370 camels and 210 goats) were sampled and examined or tested for mastitis. The calculated sample size was proportionally allocated to the respective kebeles based on the estimated total target population.

Data collections

Variables considered as risk factors were age, parity, lactation stage, presence of ticks and lesions on udder/teat. Age of the study animals were determined by the information from the owner and dentition characteristics (Abegaz and Awgichew, 2009; Andrews, 2015). Three level groupings were made for age, parity and stage of lactation respective to the three species whereas tick infestation and udder/teat lesion were recorded as dummy variable i.e. present or absent of the case. Tick infestation was considered as tick positive when one or more ticks were present on teat/udder.

Udder examinations

The udder was inspected and palpated to detect fibrosis, inflammatory swellings, visible injury and swelling of supra mammary lymph nodes. The size and consistency of teats were inspected for the presence of any abnormalities, such as disproportional symmetry, swelling, firmness and blindness. Tick infestation and presence of teat lesion were also noted. Physical appearance of milk including color, consistency, and viscosity, presence

of clots, flakes, blood and watery secretions were used to check for clinical mastitis (Radostits et al., 2007).

California mastitis test (CMT)

Milk samples were examined for visible abnormalities and screened by CMT according to Quinn et al. (2004). A squirt of milk, about 2 ml from each teat was placed in each of shallow cups in the CMT paddle after discarding the first few streams of milk from each teat. An equal amount of the commercial CMT reagent was added to each cup. A gentle circular motion was applied to the mixtures in a horizontal plane for 15 seconds. The interpretation was in such a way that CMT score of 0 was taken as negative, while CMT scores of trace, 1+, 2++ and 3+++, were considered positive. Cows, camels and goats were considered positive for subclinical mastitis, when at least one teat of an animal was positive in the CMT.

Statistical analysis

The collected data were checked for completeness and consistency, coded and entered to Excel spread sheet. Different variables were descriptively summarized as proportion or mean, using STATA software version 12 (College Station, TX, USA). Associations between the occurrence of mastitis and potential risk factors were analyzed by univariable logistic regression. Finally, variables with P-value <0.25 were subjected to multivariable logistic regression analysis. We checked multicollinearity among the predictor variables, and those with correlation coefficient below 0.6 were included in the model. Finally, post estimation was evaluated using Hosmer Lemeshow goodness of fit test. The strength of association between the risk factors and the prevalence of mastitis was analyzed using the odds ratio and for all the analysis performed, $p<0.05$ was taken as statistically significant.

RESULTS

Table 1 shows results of mastitis prevalence at animal and quarter levels stratified by animal species. Accordingly, out of a total 400 lactating cows examined, 199 cows had udder infections (49.75%, 95% CL: 44.7-54.8%). The prevalence of clinical and subclinical mastitis were 7.5% and 42.25%, respectively. Out of 1600 cow quarters examined, 63 (3.94%) and 44 (2.75%) of quarters were blind or clinically positive, respectively.

The overall mastitis prevalence in camel was 35.41%, 95% CL: 30.5-40.5) out of which, 3.51% and 31.89% were clinical and sub-clinical cases, respectively. From a total of 1480 camel quarters examined 13(0.89%) of the teats were blind, while 22 (1.49%) and 165 (11.15%) of the quarters were positive for clinical and subclinical mastitis, respectively.

Lactating does had a lower mastitis prevalence of 24.76% (95% CL: 19.1-31.2%) with clinical and subclinical cases being 2.38% and 22.38%, respectively. Studied does had no blind teats unlike other animals. The overall udder halves level prevalence of mastitis was 15.7% (95% CL: 12.4-19.6). Overall, significantly higher mastitis prevalence was observed in cows than camels and goats, but no difference was observed between the later groups.

Table 1. Prevalence of clinical and subclinical mastitis at animal and quarter/halve levels

Species	Animals (N)	Blindteat N(%)	Clinical N(%)	Subclinical N(%)	Total N(%)	95% CI
Animal level						
Cows	400	51 (12.8)	30 (7.5)	169 (42.3)	199 (49.8)	44.7-54.8[a]
Camels	370	11 (2.9)	13 (3.5)	118 (31.9)	131 (35.4)	30.5-40.5[b]
Goats	210	0	5 (2.4	47 (22.4)	52 (24.8)	19.1-31.2[b]
Quarter level						
Cattle	1600	63 (3.9)	44 (2.8)	355 (22.2)	399 (24.9)	22.8-27.1 [a]
Camels	1480	13 (0.9)	22 (1.5)	165 (11.2)	187 (12.6)	11.0-14.4 [b]
Goats	420	0	6 (1.4)	60 (14.3)	66 (15.7)	12.4-19.6[ab]

[ab] Prevalence with different superscriptions differ significantly

Risk factors associated with mastitis prevalence in different animals are shown below for cows (Table 2), camels (Table 3) goats (Table 4). Risk factors analysis revealed that mastitis was significantly associated with tick infestation and teat lesion in all three species. The odds of udder infections were respectively two folds, 10 and 38 times more in lactating cattle, camels and goats with udder tick infestations compared to animals with tick free udders. Likewise, lactating cows, camels and goats with udder or teat lesion had 12, 1.5 and 3.2 times higher odds of mastitis occurrence than their counterparts.

Table 2. Multivariable logistic regression of risk factors associated with cow mastitis

Risk factors	Animals (N)	Positives (N)	Prevalence (%)	Odds Ratio	P-value
Kebeles					
Darito	90	43	47.8		
Dida-Yabello	87	52	59.8	1.93	0.046
Gagna	94	41	43.6	0.88	0.690
Surupa	129	62	48.1	0.87	0.650
Age (yrs)					
3-4	201	75	37.3		
≥ 5	199	123	61.8	5.75	0.000
Parity					
1st	92	39	42.4		
2nd	104	45	44.2	1.64	0.128
3rd	99	51	51.5	3.13	0.010
4thand above	105	64	60.0	2.94	0.028
Lactation(month)					
Early (1 to 3)	119	69	58.0		
Mid (4 to 7)	140	54	38.6	0.49	0.008
Late (≥ 8)	141	75	53.2	0.83	0.499
Teat tick					
Present	98	63	64.3	2.30	0.002
Absent	302	135	44.7		
Teat lesion					
Present	132	78	59.1	1.50	0.044
Absent	268	120	44.8		

Mastitis occurrences have significantly increased with age and parity of the animals in cows and goats, while no difference was observed for camels. The likelihood of udder infection was 5.8 and two times more in cows and does in age group of five and above years. When Kebeles were compared, prevalence was higher in Didayabello than other kebeles for cattle, but the differences were not significant for camels and goats. Prevalence was higher in early lactation stage for both cattle and camels.

Table 3. Multivariable logistic regression of risk factors associated with camel mastitis

Risk Factors	Animals (N)	Positives (N)	Prevalence (%)	Odds Ratio	P-value
Kebeles					
Darito	116	39	33.6		
Didayabello	84	25	29.8	0.95	0.884
Gagna	77	32	41.6	1.93	0.080
Surupa	93	35	37.6	1.31	0.463
Age (years)					
4 to 5	135	41	30.4		
6 to 7	117	42	35.9	1.77	0.317
≥ 8	118	48	40.7	1.82	0.407
Parity (number)					
1	110	35	31.8		
2	107	34	31.8	1.37	0.586
3and above	153	62	40.5	1.33	0.694
Lactation (month)					
Early(1 to 3)	132	72	54.6		
Mid (4 to 7)	118	35	29.7	0.45	0.014
Late (≥ 8)	120	24	20.0	0.28	0.000
Teat ticks					
Present	52	44	84.5	9.87	0.000
Absent	318	87	27.4		
Teat lesion					
Present	56	48	85.7	12.37	0.000
Absent	314	83	26.4		

Table 4. Multivariable logistic regression of risk factors associated with goat mastitis

Risk factors	Animals (N)	Positives (N)	Prevalence (%)	Odds Ratio	P-value
Kebeles					
Daritu	54	15	27.8		
Didayabello	52	12	23.1	1.18	0.759
Gagna	53	12	22.6	0.66	0.483
Surupa	51	13	25.5	1.33	0.606
Age (years)					
2 to 4	112	21	18.8		
5-above	98	31	31.6	2.04	0.041
Parity (number)					
1st and 2nd	74	11	14.9		
3rd and 4th	69	13	18.8	1.13	0.835
$5^{th}$and above	67	28	41.8	18.64	0.003
Lactation (month)					
Early (1 to 2)	73	23	31.5		
Mid (3 to 4)	58	12	20.7	0.68	0.441
Late ($\geq$ 5)	79	17	21.5	0.66	0.362
Teats Ticks					
Present	19	17	89.5	37.88	0.000
Absent	191	35	18.3		
Teats lesion					
Present	23	14	60.9	3.32	0.040
Absent	187	38	20.3		

DISCUSSION

The study showed a high overall cow level mastitis prevalence of 49.8% (95%CI: 44.7%-54.8%), with higher subclinical than clinical mastitis (42.3% vs7.50%). These results are comparable to the 50% prevalence reported from North Shewa and Borana zones of Ethiopia (Belina et al., 2016). The prevalence is higher than some of the reports from Ethiopia such as 34.3% by Megersa et al., (2012) from Hawassa town and 42% by Serda and Dame, (2015) in Arsi Zone. But a higher prevalence as 59.1% (272/460) was also reported by Adane et al., (2012) from Borana area. Observed higher subclinical mastitis (42.25%) than clinical mastitis (7.5%) is what was anticipated and in line with other study reports (Mekibib et al., 2010;Adane et al., 2012; Moges et al., 2012). Such a greater proportion of subclinical mastitis occurrence compared to clinical is attributable to the defense mechanism of the udder that makes it unnoticeably undergoes pathological changes in the mammary gland, while negatively affecting milk production (Radostits et al., 2007). The sub-clinical form can be as large as 15 to 40 times more prevalent compared to clinical form, and usually precedes the clinical form and is of long duration (FAO, 2014). This makes clinical mastitis is the 'tip of the iceberg' whileSubclinical mastitis, invisibly large proportion analogous to the submerged ice, is by far the more costly disease in the dairy of herds. Thus, it can silently result in reduction of milk yield and substantial economic losses without being noticed by the livestock keepers. Herders have no chance of detecting the disease until it develops to clinical forms that can be treated and cured. Consequently, sub-clinical cases remain a continuing source of infection for susceptible animal in the herd results in accumulation of cases as spontaneous self-clearance is very low. High level of subclinical cases generally suggests absence of herd health monitoring and testing in tradition husbandry system which

otherwise would allow early detection of cases and implementation treatments (Karimuriboet al., 2006). Lack of awareness on mastitis control and prevention strategies (e.g. poor hygienic practices and poor milking practices) as well as misconceptions among pastoral herders also contribute to constant transmission of infections among susceptible animals (Amenu et al., 2017).

High prevalence of mastitis among lactating animals, especially in dominant livestock species such as cattle suggests its plausible impact on pastoral livelihood through reduction of milk for family consumption and household income from dairy sale. Intra mammary infection, at subclinical levels, has been reported to affect milk production negatively, mainly due to physical damage to the mammary parenchyma of the affected mammary gland (Radostits et al., 2007). According to FAO (2014), in areas with poor animal health service and lack of treatment means at traditional farming, mastitis occurrence increases causing decrease in milk yield of up to 33% per infected quarter, and poses a public health risk due to consumption of unsafe milk. Though there is no study that quantify the economic impacts mastitis in pastoral areas, reports from other region showed the economic losses due to mastitis to range from 61 to 198 Euro per cow per year (Hogeveen et al., 2011). In addition to reducing milk production, mastitis causing pathogens or their toxins can pose health risk to humans. Thus the high level of mastitis prevalence in pastoral area implicate its paramount importance in food security and public health perspective as the pastoralists are highly dependent on dairy consumption (Amenu et al., 2017).

The prevalence of camel mastitis (35.41%, 95% CI: 30.5%-40.5%)is comparable with the findings of Jemal et al. (2017) from Eastern Ethiopia and Wubishet et al. (2016) from Borana area who found an overall prevalence of 31% and 34.7%, respectively. In contrast, another study reported a higher proportion (44.8%) of mastitis cases in camels in Borana areas (Regassa et al., 2013) while Husein et al. (2013) reported a lower figure of 30.2%fromJijiga.Similarly, observed occurrences udder infection of goats (24.76%, 95% CI: 19.1-31.2%)is higher than previous reports of15.5% (Megersa et al., 2010) from Borana, 18% (Gebrewahid et al., 2012) from Tigrai and 17.8% (Wazha, 2015) from Botswana. The difference in prevalence may be due to concurrent disease involvement (tick infestation), animal health care, agro-ecology, climate, production system that vary from place to place. As mastitis is a complex disease involving interactions of various factors such as management and husbandry, environmental conditions, animal risk factors and causative agents, its prevalence varies considerably (Radostitset al., 2007).

Association of mastitis with increasing age is in line with reports from elsewhere (Adane et al., 2012; Zeryehunet al., 2013; Serda and Dame, 2015; Qayyum et al., 2016). The increasing prevalence of udder infection with an increase age is due to reduced physiological defense mechanism of the udder and relaxed sphincter with advancing age to overcome bacterial pathogens, so that pathogenic organisms get access to the glandular tissue and cause inflammation of mammary glands (Radostitset al., 2007). As animals get older their teats become enlarged and have more relaxed sphincter muscles being subjected to constant suckling by a number of calves, which increase the accessibility and entrance of infectious agent into the teat canal. Similar to age, animals with higher parity were at increased risk of infection which is in line with the finding of Zeryehun et al. (2013). Moreover, occurrence of more cases with age and parity could be due to the fact that mastitis case are not well treated in pastoral areas, so that the disease becomes chronic with the possibility of carryover of infection from one parity to the next (Abdurahman 2006;Megersa et al., 2010).

Early lactation stage had higher relative prevalence (58%) than mid (38%) lactation stage similar to reports elsewhere (Adane et al., 2012; Zeryehun et al., 2013). Absence of dry cow therapy regime can reduce capacity of the quarter to provide phagocytic and bactericidal activity during early lactation and could possibly attributable to high prevalence of mastitis. Higher prevalence during early stages of lactation could be linked to several factors such as high milk production and more favorable conditions for infection occurrences in addition to low immune response related to calving stresses. Most new infection occurs during the early part of dry period and in the first two months of lactation, especially with environmental pathogens (Radostits et al., 2007).

In addition to the above mentioned factors, tick infestation and udder/teat lesions were significantly associated with increased udder infections in all lactating animals examined, which is reasonable given the lack of primary defense barrier to reduce bacterial colonization and infections. Udder or teats of animals in pastoral area are prone to thorny bush

injury or inflicted by ticks that are responsible cause of lesions and predisposing udder to bacterial invasion. Additionally, use of anti-suckling device, fibers from plants or strip of cloth are tied to the teat to prevent the calf from sucking camel is common in pastoral areas that may damage the teat (Abera et al., 2010). According to Viguier et al. (2009), injuries and lesions affecting the teat end frequently result in increased mastitis problems because of interference with the protective effect of the teat orifice, which is a major barrier preventing bacteria from entering the gland. Teat injuries provide a medium for the growth of the pathogenic bacteria and secondary infections which may induce mastitis and or delay healing of mastitis.

CONCLUSIONS

The study revealed high prevalence of mastitis in lactating cows, camels and goats in the Borana, southern Ethiopia, and confirms that the subclinical form is the most prevalent compared to clinical cases in all species studied. The high prevalence of mastitis in a pastoral region implies its negative effect on milk production and consumption where dairy is a major staple food. Observed association of risk factors with prevalence of mastitis in lactating cows, camels and goats, suggest the need to consider them mastitis control program. Therefore, to reduce the occurrence of udder infections among lactating animals in the study areas, appropriate control measures targeting improved animal health service, improved management and milking practices, tick control, and the setting up of monitoring for subclinical mastitis through CMT are needed.

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