Prevalence of Clinical and Subclinical Cattle Mastitis and the Associated Risk Factors in Bomet County, Kenya

Nathan Kipkirui Kosgei[1, 2], Peter Njuguna Ndirangu[2], Senerwa Daniel Mugangai[1] and Christine M. Mbindyo[1]

[1]University of Nairobi and [2]Kenya Agricultural and Livestock Research Organization

Abstract

A survey of mastitis in cattle was conducted in Bomet County of Kenya, using the California mastitis test (Pyörälä *et al.*, 2003). A total of 75 bovines from 50 farms were sampled and the overall cow level prevalence of mastitis was 16 per cent. Out of the 75 bovines sampled, the prevalence of clinical and subclinical mastitis was 4 per cent and 12 per cent respectively. In the intensive system of livestock production, the prevalence was 13.3 per cent, while in the semi-intensive system of livestock production, the prevalence was 2.7 per cent. A questionnaire was also completed by 50 farmers to collect data on risk factors, which included udder hygiene, stage of lactation, parity and floor type of cow housing, breeds (among the breeds, Friesians had a higher prevalence than Ayrshire breeds). This study showed that penicillin and streptomycin (40 per cent) were the most used drug to treat mastitis. In conclusion, the overall prevalence could have been attributed to poor milking practices and inadequate methods applied by farmers in controlling mastitis on their farms due to lack of knowledge as noticed from the discussions with the farmers on mastitis control guidelines (Kerro Dego *et al.*, 2020).

Keywords: Bovine mastitis in Bomet County, California mastitis test, Lactation, Milking practices and mastitis.

Introduction

Dairy is the most important and single largest agricultural sub-sector in Kenya, contributing 19 per cent of the agricultural GDP and 3.5 per cent of the total GDP (Muriuki *et al.*, 2004). A cow in Kenya produces an average of 7–8 litres daily with production of between 2000 and 2400 litres per lactation. The productivity is low compared to 60 litres daily in developed countries such as United States of America which is leading productivity per cow with an average of 14,000 litres per lactation (Wambugu *et al.,* 2011). This low milk production can be attributed to various constraints – among them, animal diseases, poor genetics, poor food quality and quantity, and fluctuating seasonal forage availability (Muriuki, 2011). The most reported animal disease is mastitis, which refers to inflammation of mammary glands (Ndirangu *et al.*, 2019). It is characterised by physical and chemical changes in milk and pathological changes in the gland (Bortolami *et al.*, 2000). The occurrence of mastitis is attributed to interplay of three major factors that include: infectious agents, environment and hosts (cows). It is multi-etiological and caused by several species of bacteria, algae and fungi. However, bacteria causes the majority of mastitis infections and these include *Staphylococcus* spp, *Streptococcus* spp and *Escherichia coli* (Ndirangu *et al.*, 2017; Ndirangu *et al.*, 2022). Mastitis is a global problem because of its adverse effects on animal health, animal welfare because mastitis causes a lot of pain in cows (Suárez *et al.*, 2017), quality of milk and the huge financial losses it causes.

In Kenya, the prevalence of clinical mastitis has been reported by Nkoroi *et al.* (2014), who reported a prevalence of 87.4 per cent and Ndirangu *et al.* (2022) a prevalence of bovine subclinical mastitis of 33 per

cent in Kenya. Bovine subclinical mastitis refers to an inflammatory reaction of the udder tissue in dairy cows without showing obvious clinical signs such as abnormal milk or swollen udders. It is characterised by increased somatic cell counts in milk which indicates an immune response to infection. Mastitis is the single most important production disease – for example, in Ethiopia it has been reported to cause a loss of US$38 per cow per lactation (Mungube *et al.*, 2005) due to the negative impacts that include reduced milk yield, unwanted changes in milk composition and increased cost of medicine and veterinary services (Ayano *et al.*, 2013). It is a great constraint to the development of profitable dairy enterprises, particularly in developing countries like Kenya in which the dairy industry plays a big role in the livelihood of the farmers who rely on the income from the milk sold. This therefore necessitates the application of mastitis control programmes (Kerro Dego *et al.*, 2020). Studies by Kivaria *et al.* (2006) stated that one of the major concerns related to mastitis in Tanzania is that farmers and herd attendants needed to improve their knowledge, attitude and motivation towards udder health. Nkoroi *et al.* (2014) reported that the only measures adequately embraced in Mathira (Nyeri County) were treatment of clinical mastitis and sanitation. Studies by Omore *et al* (1999) stated that mastitis control strategies that should be done includes dry cow therapy and use of strip cups to test mastitis during milking. Flies increase the risk of mastitis in dairy cows by transmitting bacteria via their mouthparts during feeding on teat wounds, leading to Intrammary infections; therefore, there are a number of ways to control flies on dairy farms. These include: sanitation, fly traps, fly repellents, biological control preventing manure from accumulating, eliminating standing water and maintaining good pasture management (Watson *et al.*, 1994).

Previous unpublished reports from Bomet sub-county veterinary office indicated an average of 70 cases of both clinical and subclinical mastitis monthly. Therefore, factors contributing to this observation needed to be identified so as to reduce its prevalence and hence decrease reduced milk yield, milk spoilage and increased costs of medicine and veterinary services (Ayano *et al.*, 2013) and improve animal welfare. This information would also be used to come up with an appropriate mastitis control programme that could then be disseminated. Knowledge about the prevalence, associated risk factors and the level of application of various mastitis control measures is needed for successful management and control of mastitis, which would thus prevent losses incurred as a result of mastitis

This study was coined to determine prevalence of clinical and subclinical mastitis in dairy cattle using the California mastitis test in Bomet County (Pyörälä *et al.*, 2003). This study further sought to establish whether farmers have information about other available mastitis control measures, to determine how efficiently they are applied and to consider challenges that farmers face in the application of mastitis control measures.

Materials and methods

Study area

This study was undertaken in Bomet County, which is located between latitudes 0°29 and 1° 03 south and between longitudes 35° 05 and 35 35 east (Figure 1). The county was selected due to its predominantly agricultural nature, with dairy farming being a major enterprise.

Bomet County had a population of 875,689 in 2019 and covers an area of 1630.0 km^2. It experiences a warm and temperate climate with an average temperature of 17.7°C. The average annual precipitation is approximately 1461 mm (57.5 inches) (Kenya Independent Electoral Boundaries Commission, 2012).

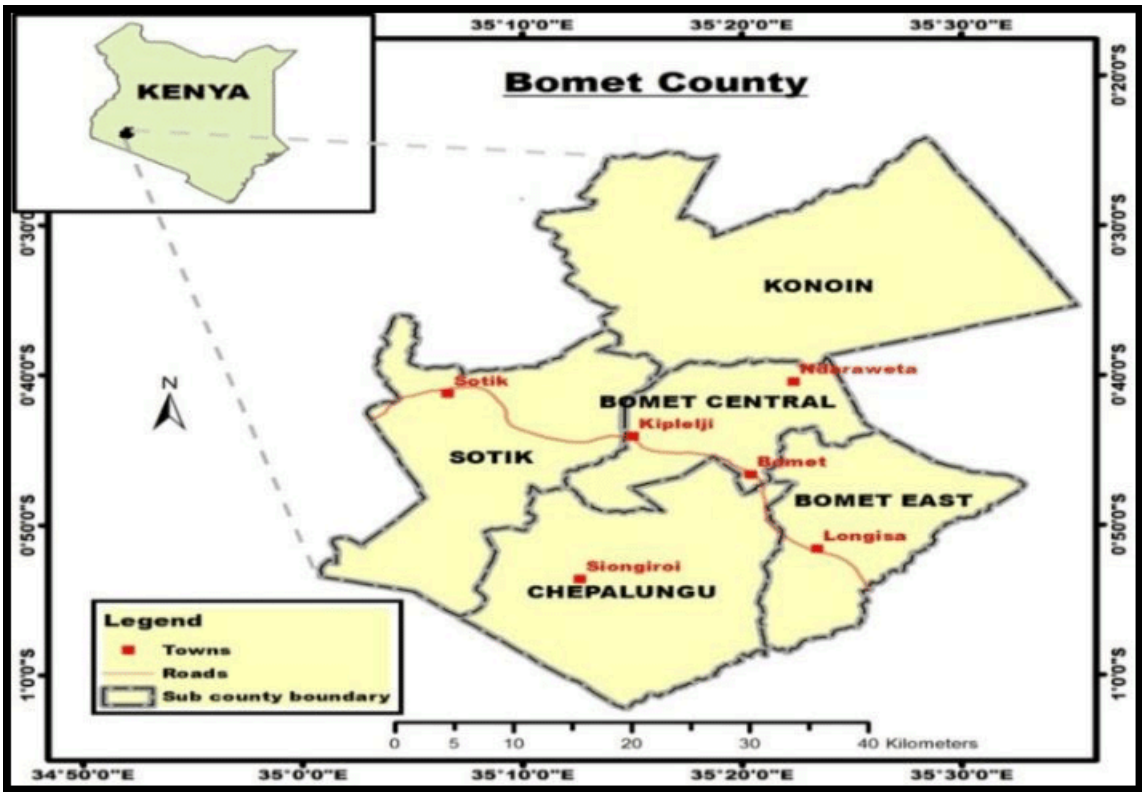

Figure 1: Map of Bomet County (Kenya Independent Electoral and Boundaries Commission, 2012)

Study design

A purposive survey method using a semi-structured questionnaire administered at farm level was used to collect data on mastitis management practices (survey questions in the appendix section), knowledge on mastitis control measures and challenges that the farmers faced. Further, prevalence of clinical and subclinical mastitis was determined at cow level using the California mastitis test (CMT) in the following steps: Prior to milk sample collection, the teats of lactating cows were washed with water and then wiped with cotton wool dipped in 70 per cent alcohol disinfect. About 2 millilitres of milk from each teat of the lactating cow was milked directly onto the corresponding cup/well of the CMT paddle and an equal amount of 3 per cent CMT reagent added to each cup and mixed well. Supplementary data was also collected through observation and discussion with owners/managers and milkmen/herdsmen. A total of 50 smallholder farmers were included.

Study population

The study surveyed 75 lactating cows, where 14 cows were managed under complete zero grazing and 61 under semi-intensive systems. The cows under study had varying parity of between one and three calves, and more than three calves, the stages of lactations were 1–2 months, 3–6 months and more than 7 months of lactation. The breed under study were Friesian and Ayrshire.

Detection of clinical and subclinical mastitis

Lactating cows were examined for clinical mastitis by udder inspection or palpation and visual examination of milk for any changes. The udders were visually inspected for change in shape, swellings and palpated for abnormal lesions and the consistency of the udder was felt. The milk was also checked for flakes, clots and

other abnormalities. Subclinical mastitis was detected by testing milk samples using the California mastitis test as described by Quinn *et al.* (1999).

The nature of coagulation and viscosity was then examined after 15–30 seconds to detect the presence and severity of the mastitis infection. The results were then scored based on the gel formation: negative meant no gel formation and trace, or positive when there was gel formation and this categorised as +1, +2 and +3 as described by Quinn *et al.* (1999). The California Mastitis testing was carried out during milking time under natural light conditions to get correct results interpretation. See Table 1 and Figure 2.

CMT Scale	Interpretation	Observation
0	Negative	No gel formation
1	Trace–weak positive	Slight precipitation to distinct precipitation with weak gel formation
2	Weak positive–distinct positive	Distinct precipitation mixture thickness with gel formation
3	Strong positive	Strong gel formation which is cohesive with a concave surface

Table 1: CMT scale and their respective interpretation Quinn *et al.* (1999).

Figure 2: Showing results of California mastitis test (from the author's own collection).

Collection of data on farmer's knowledge, mastitis control methods and challenges in controlling mastitis

A semi-structured farm-level questionnaire was administered to 50 farmers in the study area. Additional information was obtained through personal observations and discussions with the farmers. The farmers were interviewed in Kiswahili and Kipsigis languages.

Data management and analysis

The questionnaire data was collected and CMT test results was entered into an MS-Excel data sheet for analysis. Descriptive statistics were generated where prevalence was calculated as number of animals positive for mastitis divided by total number of animals tested. These were calculated for different cattle breeds, grazing system and lactation period. The results were finally summarised into tables and figures.

Results

Characteristics of study animals and their grazing and/or management systems

A total of 50 dairy cattle farms were included in the study. Out of these, six farms practised complete zero grazing while 44 farms practised a semi-intensive management system (12 and 88 per cent) respectively. A total of 75 lactating cows in varying parities were included where 36 were under zero grazing units and 39 were from semi-zero grazing dairy fenced cattle units. The cows were between 1 and 6 months of lactation. The exotic dairy breeds under study were Friesian 39 (52 per cent) and Ayrshire 36 (48 per cent).

Prevalence of mastitis overall

As shown in Table 2, the overall prevalence of mastitis was 12/75 (16 per cent); where 3/75 (4 per cent) had clinical mastitis showing signs such as pus and clots in milk, painful, swollen, hardened udders, and 9/75 (12 per cent) had subclinical mastitis (were CMT positive).

CMT Results	No of cows (n = 75)	Prevalence (%)
CMT Positive	12	16
CMT Negative	63	84

Table 2: Prevalence of mastitis in Bomet County, Kenya (n = 75).

Prevalence of mastitis in intensive and semi-intensive systems

The prevalence of mastitis in intensive farms in this study is higher in farms that practised intensive farming compared to those who practised semi-intensive farming.

Production system	Number of farms (n = 50)	Percentage %
Intensive	6	12
Semi-intensive	44	88

Table 3: Percentage herd size distribution of the farms under study based on production system (n = 50).

Prevalence of mastitis at udder quarter level and CMT scores

Milk samples from seven cows with a total of 28 quarters showed slight precipitation to distinct precipitation with weak gel formation (trace – weak positive), milk from two cows (total of 8 quarters) showed distinct precipitation mixture thickness with gel formation, milk from three cows (total of twelve quarters) showed strong gel formation that was cohesive with a concave surface (strong positive), as shown in Table 4.

CMT scale	Number of quarters that were CMT positive	No of cows who were CMT positive	Total number of quarters for all animals studied	Total no of animals
1	28	7		
2	8	2		
3	12	3		
Total	48	12	300	75

Table 4: Prevalence of mastitis at udder quarter level and CMT scores.

Prevalence of mastitis in relation to breed, age, milk production, parity management system, udder hygiene, stage of lactation and floor type

Analysis for prevalence of mastitis were based on breed, age, parity, production system, udder hygiene, stage of lactation and floor type revealed that mastitis was mostly associated with breed, age group, milk production, udder hygiene, stage of lactation, floor type, production system and parity. Further, high prevalence of the disease was noted in earthen floors, those cows with dirty udders and in cows 3–6 months of lactation. Out of the 75 bovines sampled, Friesian breeds (n=39) had a positive prevalence of seven cows (9.3%; n=75) compared to Ayrshire breeds (n=36) with a positive prevalence of five cows (6.7%; n=75) cows with mastitis. Of those cows with one to three calves (n=43), four cows (5.3%; n=75) were positive for mastitis, while those with more than three calves (n=32), eight cows (10.7%; n=75) were positive for mastitis. Results based on the production system (intensive: n=14; semi-intensive: n=61), showed that ten cows (13.3 %; n=75) were positive for mastitis from intensive system and two cows (2.7%; n=75) of the positive cases were from semi-intensive farms. The results based on stage of lactation shows cows with more than 7 months lactation period (n=45) with mastitis were three cows (4%; n=75) while cows within 3–6 months (n=8) with mastitis were four cows (5.3%; n=75). Those within 1 to 2 months stage of lactation (n=22) with mastitis were five cows (6.7%; n=75). Based on the floor type, the prevalence of mastitis was higher in cows housed in stalls with earthen floors (9 cows, 8 with mastitis = 10.6%) compared to those with concrete floors (5 cows, 2 with mastitis, = 2.6%).

Additionally, the prevalence of mastitis was significantly higher in cows older than 6 years (n=18). This was nine cows with mastitis (12%; n=75) compared to cows less than 6 years of age (n=57). This was three cows (4%; n=75).

Breed	Total number of cows (n=75)	CMT positive	%
Friesian	39	7	9.3
Ayrshire	36	5	6.7

Parity	Total number of cows (n=75)	CMT positive	%
1–3 calves	43	4	5.3
Fewer than 3 calves	32	8	10.7

Production system	Total number of cows (n=75)	CMT positive	%
Intensive	14	10	13.3
Semi-intensive	61	2	2.7

Stage of lactation	No of cows (n=75)	CMT positive	%
>7	45	3	4
3 to 6	8	4	5.3
1 to 2	22	5	6.7

Floor type	No of cows	CMT positive	%
Concrete	5	2	2.6
Earthen	9	8	10.6

Age	No of cows	CMT positive	%
< 6yrs	57	3	4
>6yrs	18	9	12

Stage of lactation	Total no of cows	CMT positive	%
1–2 months	**9**	**2**	**2.6**
3–6 months	**24**	**8**	**10.6**
>7	**42**	**2**	**2.6**

Table 5: Prevalence of mastitis in relation to breed, age milk production, parity management system, udder hygiene, stage of lactation and floor type.

Survey results

Farmer's knowledge and practices in relation to control of mastitis

A very small number of farmers (15 out of 50; 30%) farmers had undergone training in dairy cattle husbandry and had acquired dairy cattle management skills such as sanitation and hygiene, good milking practices, mastitis prevention and treatment. However, all farmers had knowledge about mastitis. The farmers who had not undergone dairy cattle husbandry training and knew about mastitis had known about it from other farmers and veterinarians. Of the farmers interviewed, 80 per cent checked for mastitis during milking time by looking for changes in milk and udder (96.4%) and by use of a strip cup (6%); however, only 6 per cent knew about subclinical mastitis. In addition, 38 per cent of the farmers had experienced cases of mastitis and 12 per cent of those farmers had been involved in treating the cases themselves. Only 6 per cent of the farmers tested the milk sample before treatment. All the farmers considered mastitis as the major production constraint and all hand milked their cows.

Feature	Number		Total	Percentage	
	Yes	No			
Trained in dairy cattle husbandry	15	35	50	30	
Know about mastitis	50	0	50	100	
Check for mastitis	3	47	50	6	
Changes in udder and milk					
Use of the strip cup	3	47	50	6	
Ever had mastitis	19	31	50	38	
Treated mastitis cases	50	0	50	100	
Respond to therapy	31	19	50	72	
Dry therapy	1	49	50	2	
Use of teat dips	1	49	50	2	
Drying the udder after washing	8	42	50	16	
Personnel who treated such cows					
Veterinarian	13			76	
Animal health assistant	2			12	
Self-treated by farmer	2			12	
Awareness of subclinical mastitis	Yes	No		Yes %	No %
Total (n=50)	3	47		6	94

Table 6: Farmer's knowledge and practices in mastitis control.

Methods applied in mastitis control

The majority of the farmers (70%) practised good hygiene, both within the cow sleeping area and milking parlour as a preventive measure. When considering hand-washing, all 50 farmers washed their hands. However, only 24 per cent of the farmers used heated water and only 77 per cent washed hands between milking. Only 16 per cent farmers used towels to clean the udder, and none had culled cows as a result of mastitis cases. One farmer used teat dips while the others did not use it due to lack of knowledge of the availability of this method. Only one farmer utilised the dry cow therapy control method for mastitis, while others employed disinfectants and detergents. The low adoption rate of dry cow therapy was attributed to both a lack of knowledge and the associated costs.

Method	Number	Per cent
Hygiene	35/50	70
Hand washing	50/50	100
Udder washing	50/50	100
Use of towels	8/50	16
Use of teat dips	1/50	2
Treatment of clinical cases	18/18 sick cows	100
Dry cow therapy	1/50	2
Culling	0/50	0
Use of disinfectants/detergents	1/50	2
Use of hot water during hand washing	12/50	24
Wash hands between milking	40/50	77

Table 7: Methods applied in mastitis control.

The cows that had clinical signs were treated using penicillin and streptomycin (40%) while gentamycin was used the least (8%). While 36 per cent knew about intra-mammary infusions. Another 16 per cent of the farmers were not aware which antibiotic had been administered (Figure 3).

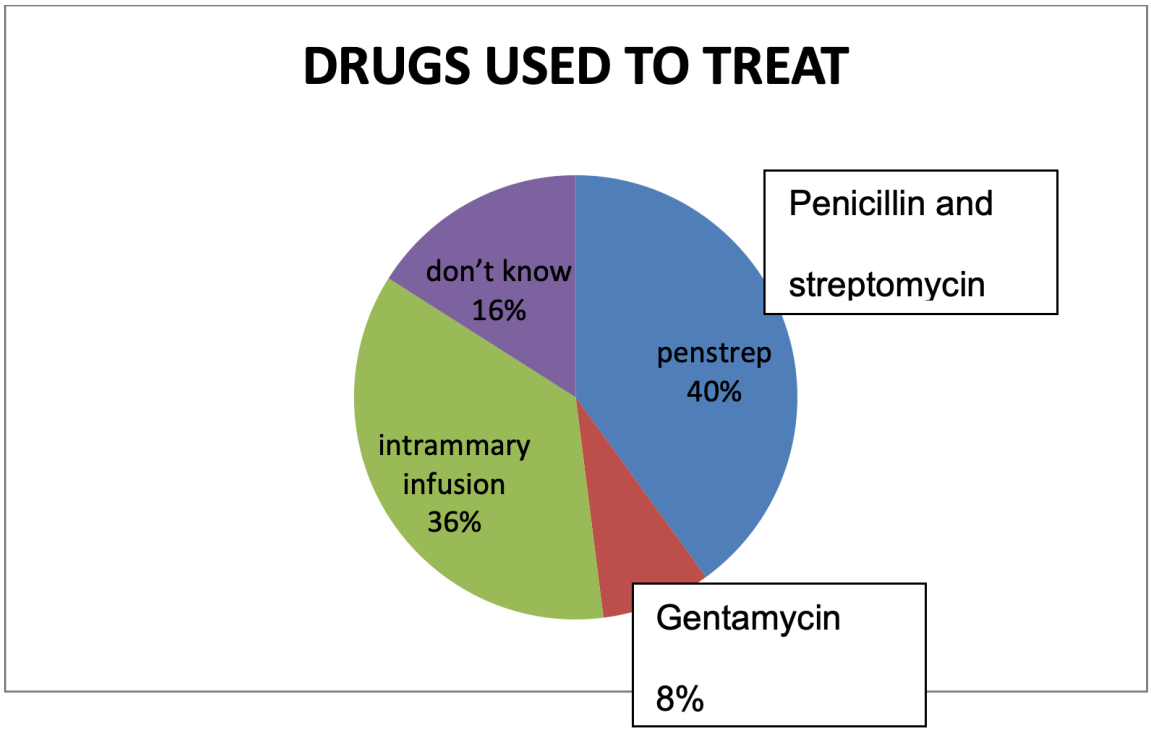

Figure 3: Antimicrobials used to treat clinical cases (route-IM). Intra-mammary infusion constituents (Penicillin G ampicillin).

Challenges faced by farmers in mastitis control

Maintenance of good hygiene and high treatment costs were the biggest challenges that farmers were facing in control of mastitis. Difficulty in maintaining good hygiene was associated with poor floors because some were earthen and even those that were concrete had holes that contained dirty water and urine.

Discussion

The study indicated an overall prevalence of 16 per cent as determined by CMT screening at cow level. The prevalence is lower as compared to eight other previous studies that were done between 2011 and 2021 using California mastitis test by Sarba and Tola (2017), Gitau *et al.* (2014), Gutu *et al.* (2021), Mbindyo *et al.* (2020), Mureithi and Njuguna (2016), Nkoroi *et al.* (2014) and Ondiek and Kemboi (2018) (summarised in Table 8). This indicates that mastitis control programmes in Bomet central sub-county are effective compared to studies done in Embu and Kajiado counties (Mbindyo *et al.*, 2020) and Thika sub-county (Mureithi and Njuguna, 2016). This improvement could be due to improved management skills because 30 per cent of the farmers had attained training in dairy cattle husbandry as compared to 3.9 per cent reported by Nkoroi *et al.* (*2*014). Further all the farmers considered mastitis as a major production constraint, hence they have applied preventive measures such as good hygiene, udder and husbandry hygiene among other practices such as dry cow therapy. This low prevalence could be partly attributed due to low number of sample size as compared to other studies; however, research can be done to reduce incidence by support and education to farmers on control of mastitis with the aim of reducing this prevalence below 16 per cent.

	Current study 2022	Gutu*et al.*, 2021	Mbindyo *et al.*, 2020	Ondiek and Kemboi, 2018	Sarba and Tola, 2017	Mureithi and Njuguna 2016	A`bebe *et al.* 2016	Gitau *et al.*, 2014	Nkoroi *et al.*, 2014
Sample size	75	110	400	41	302	172	529	241	202
Prevalence (%) of mastitis	16	39.67	80	34	41.7	64	76	30	87.9

Table 8: Prevalence of mastitis in current and previous studies.

The prevalence of mastitis in intensive units recorded a high prevalence of 13.3 per cent per cent (n=75) compared to semi-intensive units with a prevalence of 2.7 per cent (n=75) (summarised in Table 5). These findings agree with those of Ait-Kaki *et al.* (2019), Sarba and Tola (2017) and Sori *et al.* (2005), but differ from the study done by Senthilkumar *et al.* (2024) who reported a higher prevalence in semi-intensive farms than the intensive farms. This is expected because intensively managed cows are at a higher risk of the development of mastitis than semi-intensive. The prevalence of mastitis in intensive and semi-intensive system depends on the effectiveness of control methods applied.

Production system	Current study-2022	Asma *et al.* 2019	Sarba and Tola 2017	Mpatswenumugabo *et al.* 2017	Senthilkumar *et al.* 2024	Sori *et al.* 2005
Intensive farms	13.3%	27.8%	42.3%	61.3%	14.06%	37%
Semi-intensive farms	2.7%	21.2%	8.1%	38.7%	36.73%	21.2%

Table 9: Prevalence of mastitis in the current and previous studies based on the farming systems.

From further discussions with the herdsman, 10 per cent of the units revealed that there was no regular cleaning of the units on daily basis, between milkings and weekly

In this study, the prevalence of subclinical mastitis was 12 per cent (n=75), while the prevalence of clinical mastitis was 4 per cent (n=75). These findings were lower than those reported by Mbindyo *et al.* (2020) who reported subclinical mastitis as 74 per cent, while clinical mastitis as 6.8 per cent in Embu and Kajiado counties. Ndahetuye *et al.* (2020) reported 76.2 per cent cases of subclinical mastitis in Rwanda; Mureithi and Njuguna (2016), reported subclinical mastitis as 64 per cent in Thika, Kenya. All of the farmers washed their hands before milking, although 24 per cent of them used unheated water, and 77 per cent washed hands between milking hence minimising transfer of pathogens from cow to cow. In addition, none of the farmers culled chronic mastitis cases. Most of the farmers milked the sick cows last as a preventive measure. Kivaria *et al.* (2006) reported that poor practices such as milking mastitic cow's first leads to spread and sustains mastitis in herds, which then becomes very difficult to be eliminated from the herd. Further, 16 per cent of farmers used a towel for drying the udder, and this might have contributed to reduced spread of mastitis from one animal to another.

This study indicated that Friesian had a higher prevalence than Ayrshire cows of 9.3 per cent and 6.7 per cent respectively (Table 5). This study showed that breed had an influence of the prevalence of mastitis within the population tested, this agrees with the studies done by Islam *et al.* (2011). However, it disagrees with the findings of Mureithi and Njuguna (2016) who found that Ayrshire had the highest prevalence of 80.6 per cent compared to 71.7 per cent of Friesians. The influence of breed on mastitis prevalence can be related to anatomical and the physiological features of the mammary gland of a particular breed which then predisposes it to mastitis (Ameh *et al.*, 1999).

The hind quarters were more prone to infections as compared to fore-quarters and this might be due to anatomical locations of the hind quarters thus predisposing them more to infections (Choudhary and Kashyap, 2019).

All the farmers knew about mastitis and considered mastitis to be a major production constraint and of major concern in animal welfare. This could be partly attributed to the fact that 30 per cent of the farmers had attained training in doing cattle husbandry as compared to the 3.9 per cent seen by Nkoroi a decade earlier (2014) However only three farmers (6%) knew of subclinical mastitis.

This study indicated that good hygiene was practised by a large number of farmers (70%), and this included the cow's environment hygiene and milking hygiene as it is recommended by Wallace *et al.* (2004) to prevent new intra-mammary infections. In addition, treatment of clinical cases represented another significant aspect of their practices, in accordance with Nkoroi *et al.* (2014), who noted that sanitation and clinical case treatment were the two primary practices implemented. Only 2 per cent of farmers used dry cow therapy, while 16 per cent used towels. Notably, none of the farmers utilised teat dips. These practices could have influenced the observed prevalence.

There are variations in the challenges that farmers faced in controlling mastitis and, in this study, maintenance of good hygiene practices – which includes proper hygiene, clean structures, clean milking processes, gentle and proper handling and proper milking techniques – treatment of clinical mastitis was a major challenge. Poor practices in mastitis control and hygiene were a problem because of poor flooring and poor access to water source in some farms, overuse of antibiotics, improper milking techniques, inadequate sanitation, overcrowding and poor ventilation. Some farms had poor floors with potholes that contained pools of dirty water, while others had no drainage system. Even those with drainage systems were poorly constructed and contained stagnant dirty water. The majority of the farmers (94%) knew nothing about subclinical mastitis. This perhaps explains why treatment was the second most used method in dealing with mastitis. It can be seen that lack of knowledge on subclinical mastitis may explain the inadequate application of preventive measures. The high costs of treatment could be partly related to the fact that the major antibiotic being used is penicillin and streptomycin (40%) while gentamycin was the least used (8 per cent). However, studies indicate high sensitivity of micro-organisms to gentamycin and Kanamycin and low sensitivity to penicillin, ampicillins, amoxicillin, streptomycin and tetracycline (Gitau *et al.*, 2014). Mugenyi (2014) recorded a sensitivity of 98 per cent for gentamycin in mastitis cases. Other factors that might have contributed to high bacterial resistance – hence the reason why high treatment exists, as observed in this study –could have been lack of testing milk samples before treatment and lack of completing the treatment regime.

Conclusion and recommendations

Conclusion

This study shows that the overall prevalence of mastitis in Bomet central sub-county was 16 per cent. The prevalence of mastitis was higher in intensive farms (13.3 per cent) compared to semi-intensive farms (2.7 per cent). It was found that associated risk factors such as floor type, breed and stage of lactation contributed to the occurrence of mastitis.

Recommendations

The low prevalence of mastitis reported could be due to an effective mastitis control programme in the region; however, there is room for improvement to further lower the prevalence of mastitis in Bomet central.

The prevalence of mastitis in intensive farms 13.3 per cent is higher than semi-intensive farms 2.7 per cent. This necessitates a study of drivers of mastitis in intensive farms with the aim of controlling them.

This study did not look at culture to determine the specific mastitis pathogens in cows in this region, and we recognise this as a limitation of the study – future studies in the region should consider culturing in order to inform better control programmes.

Acknowledgements

The authors are grateful for logistical support to Bomet County Department of Veterinary Services for coordinating field activities.

List of figures

List of tables

Table 8: Prevalence of mastitis in current and previous studies.

Table 9: Prevalence of mastitis in the current and previous studies based on the farming systems.

Appendix 1: Questionnaire

Farms survey questionnaire for dairy farmers

Demographic information
Farm no
Name of the respondent
Gender
Telephone Number of respondent
Age
Date of the interview
County
Sub-county
Division
Location
Village
GPS coordinates
Agro-ecological zone (AEZ)

Farm background

1. How many cows do you have?

2. Production system: A) Intensive ___ B) Semi-intensive___

3. How many milking cows do you have? _____

4. Do you keep records? _____ Yes No

If yes, specify a) Production___ b) Breeding___ C) others (specify) _____

5. Have you ever experienced cases of mastitis in the farm? Yes No

6. How long did the mastitis get to resolve?

A. Three days

B. One week

C. Never resolved

7. How did you know the cow had mastitis?

A. Reduced milk production

B. CMT

C. Alcohol test

D. Swollen udder

E. Clots in milk

8. How often in the last one year has mastitis occurred?

Which treatment methods were used?

9. Who treated the animals?

A. A vet

B. Animal health assistant

C. The farmer him/herself

10. What is the average cost of treatment?

11. Does mastitis affect milk production? Yes No

Farm management practices such as:-

1. Are you aware of good farm management practices? (yes or no)

2. Are the cows housed with a roof? (yes or no)

3. If yes what is the floor type made of? (concrete or earthen)

4. Is there bedding for the cows? (yes or no)

5. What is the cleaning frequency? (daily or weekly)

6. Do you do proper milking techniques? (yes or no)

7. Do you milk mastitic cow last? (yes or no)

8. Do you wash the udder before milking? (yes or no)

9. Do you dry the udder after washing? (yes or no)

10. If yes, do you use udder towel for each cow? (yes or no)

11. Do you do routine testing for mastitis? (yes or no)

12. Do you use teat dips? (yes or no)

13. Do you do dry therapy? (yes or no)

14. Do you cull affected animals? (yes or no)

15. Do you Mix milk from different cows? (Yes or no)

16. If yes do you milk mastitic cows differently? (yes or no)

17. If yes what do you do with the mastitic milk? _____

Appendix 2

Cow factors and California mastitis test results

Cow ID	Breed	Parity	Milk production per day in L	Stage of lactation (1–2) early (3–6) mid (>7) late	History of mastitis (yes/No)	CMT results for each quarter
Cow 1						FR HR FL HL
Cow 2						FR HR FL HL

References

Ait-Kaki, A., S. Djebala, L. Muhammad Bilal and N. Moula (2019), 'Evaluation of the prevalence of subclinical mastitis in dairy cattle in the Soummam Valley (Bejaia, Algeria)', *Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca: Horticulture, 76*, 143.

Ameh, J. A., T. Edgbe-Nwiyi and L. Tanko Zaria (1999), 'Prevalence of bovine mastitis in Maiduguri Borno State, Nigeria', *Veterinarski arhiv*, *69* (2), 87–95.

Ayano, A. A., F. Hiriko, A. M. Simyalew and A. Yohannes (2013), 'Prevalence of subclinical mastitis in lactating cows in selected commercial dairy farms of Holeta district', *Journal of Veterinary Medicine and Animal Health, 5* (3), 67–72

Bortolami, A., E. Flore, M. Gianesella, M. Corrò, S. Catania and M. Morgante (2015), 'Evaluation of the udder health status in subclinical mastitis affected dairy cows through bacteriological culture, somatic cell count and thermographic imaging', *Pol J Vet Sci, 18* (4), 799–805. doi: 10.1515/pjvs-2015-0104.

Choudhary, J. and S. K. Kashyap (2019), 'Detection of Staphylococcus aureus from bovine mastitis milk', *International Journal of Advanced Biochemistry Research*, doi:10.33545/26174693.2024.v8.i1se.404

Gitau, G. K., R. M. Bundi, J. Vanleeuwen and C. M. Mulei (2014), 'Mastitogenic bacteria isolated from dairy cows in Kenya and their antimicrobial sensitivity', *Journal of the South African Veterinary Association*, *85* (1), 01–08

Islam, M. A., M. Z. Islam and M. S. Rahman (2011), 'Prevalence of subclinical mastitis in dairy cows in selected areas of Bangladesh', *Bangladesh Journal of Veterinary Medicine*, *9* (1) 73–78. Retrieved from banglajol.info.

Kenya Independent Electoral and Boundaries Commission (2012). Map of Bomet County, available at: https://www.researchgate.net/figure/Map-of-Bomet-County-showing-study-area-Source-Kenya-Independent-Electoral-and-Boundaries_fig1_334528614.

Kerro Dego, O., P. A. Pacha, B. E. Gillespie and G. M. Pighetti (2020), 'Experimental *Staphylococcus aureus* mastitis infection model by teat dipping in bacterial culture suspension in dairy cows', *Animals (Basel)*, *10* (5), 751, doi: 10.3390/ani10050751.

Kitila, G., B. Kebede and M. Wakgari (2021), 'Prevalence, aetiology and risk factors of mastitis of dairy cows kept under extensive management system in west Wollega, western Oromia, Ethiopia', *Vet Med Sci*, *7* (5), 1593–99, https://doi.org/10.1002/vms3.503

Mbindyo, C. M., G. C. Gitao and C. M. Mule (2020), 'Prevalence, etiology and risk factors of mastitis in dairy cattle in Embu and Kajiado Counties', *Veterinary Medicine International*, https://doi.org/10.1155/2020/8831172

Mpatswenumugabo J. P., L. C. Bebora, G. C. Gitao, V. A. Mobegi, B. Iraghua, O. Kamana and B. Shumbusho (2017). 'Prevalence of subclinical mastitis and distribution of pathogens in dairy farms of Rubavu and Nyabihu districts, Rwanda', *Journal of Veterinary Science*, *2017* (1): 8456713.

Mugenyi, K. C. (2014). 'Prevalence, control and antimicrobial susceptibility patterns of bovine mastitis causing bacteria in Mityana District', Master's thesis, Uganda: Makerere University.

Mungube, E., B. Tenhagen, F. Regassa, M. Kyule, Y. Shiferaw, T. Kassa and M. Baumann (2005), 'Reduced milk production in udder quarters with subclinical mastitis and associated economic losses in crossbred dairy cows in Ethiopia', *Tropical Animal Health and Production,* 37, 503–12, https://doi.org/10.1007/s11250-005-7049-y

Mureithi, D. K. and M. N. Njuguna (2016), 'Prevalence of subclinical mastitis and associated risk factors in dairy farms in urban and peri-urban areas of Thika Sub County, Kenya', *Livestock Research for Rural Development*, *28* (2).

Muriuki, H. G. (2011), 'Dairy development in Kenya', Rome: Food and Agriculture Organization of the United Nations, available at https://www.fao.org/4/al745e/al745e00.pdf accessed 26 September 2024

Ndahetuye J. B., J. Twambazimana, A.-K. Nyman, C. Karege, M. Tukei, M. P. Ongol, Y. Persson and R. Båge (2020), 'A cross sectional study of prevalence and risk factors associated with subclinical mastitis and intramammary infections, in dairy herds linked to milk collection centers in Rwanda', *Preventive Veterinary Medicine*, 179, https://doi.org/10.1016/j.prevetmed.2020.105007

Ndirangu, P. N., D. Siamba, H. O. Wesonga, E. O. Mungube, M. Maichomo and J. Mugambi (2017), 'Prevalence of bovine mastitis and multi-antibiotic resistant Staphylococcus and Streptococcus species in a research

centre farm at Naivasha, Kenya', *Agricultural and Food Sciences, 65,* 289–301.

Ndirangu, P. N., M. W. Maichomo, P. K. Nyongesa, D. Wamae, J. O. On'gala, N. W. Gicheru, G. Keya, H. O. Wesonga and D. Siamba (2019), 'A novel pH-based pen-side test for detection of sub-clinical mastitis: Validation in cattle and camels, Kenya' *Livestock Research for Rural Development*, 31 (1). https://www.lrrd.org/lrrd31/1/erick31007.html

Ndirangu, P. N., A. K. Kipronoh, E. O. Mungube, I. N. Ogali, S. G. Omwenga, D. N. Ndung'u and M. W. Maichomo (2022), 'Prevalence of bovine mastitis and antimicrobial sensitivities of the bacterial causes in smallholder farms of Kisumu County, Kenya', *Journal of Agriculture and Rural Development in the Tropics and Subtropics*, 123 (2), 247–55.

Nkoroi, J. M. (2014). 'Prevalence of mastitis and effectiveness of mastitis control in dairy cattle in Mathira Constituency, Nyeri County, Kenya', *Kenya Veterinarian*, *38* (1), 24-31. https://www.ajol.info/index.php/tkenya/article/view/56944

Omore, A .O., J. J. McDermott, S. M. Arimi and M. N. Kyule (1999), 'Impact of mastitis control measures on milk production and mastitis indicators in smallholder dairy farms in Kiambu district, Kenya', *Trop Anim Health Prod*, *31* (6), 347–61.

Ondiek, J. O. and F. Kemboi (2018), 'Bovine mastitis prevalence, aetiology, therapeutics and control in Tatton Agriculture Park, Egerton University', *Int.J.Curr.Microbiol.App.Sci., 7* (9), 3417–26 https://doi.org/10.20546/ijcmas.2018.709.424

Pyörälä, S. (2003), 'Indicators of inflammation in the diagnosis of mastitis', *Veterinary Research*, *34* (5), 565–78. ⟨10.1051/vetres: 2003026⟩. ⟨hal-00902767⟩

Quinn, P. J., M. E Carter, B. Markey and G. R. Carter (1999), *Clinical Veterinary Microbiology*. London, UK: Moshy, pp. 21–66.

Sarba, E. J. and G. K. Tola (2017), 'Cross-sectional study on bovine mastitis and its associated risk factors in Ambo district of West Shewa zone, Oromia, Ethiopia', *Vet World, 10* (4), 398–402, available at https://pubmed.ncbi.nlm.nih.gov/28507411/

Senthilkumar, M. Kalaivanan and A. Methai (2024), 'Incidence and risk factors of clinical mastitis in dairy farms of Theni district in Tamil Nadu', *Small*, *110* (23), 20–91, available at: https://www.researchgate.net/publication/356617113

Sori, H, A. Zerihum and S. Abdicho (2005), 'Dairy cattle mastitis in and around Sebeta, Ethiopia', *International Journal of Applied Research in Veterinary Medicine, 3* (4), 332–38.

Suárez, V. H., G. M. Martínez and E. A. Bertoni (2017), 'Mastitis, a health-related indicator of dairy cow welfare and productivity', *Dairy and Vet Sci J, 4* (45), DOI:10.19080/JDVS.2017.04.555650

Wallace J. A., K. Stipetic, Y. H. Schukken, R. T. Dingwell, P. Baillargeon, G. Bacic and K. E. Leslie (2004), 'An evaluation of a treatment protocol for intra-mammary infections in early postpartum dairy cows based on a positive California Mastitis Test result', *The Bovine Practitioner*, *38* (1), available at https://bovine-ojs-tamu.tdl.org/bovine/article/view/1702

Wambugu, S., L. Kirimi and J. Opiyo (2011), 'Productivity trends and performance of dairy farming in Kenya', working paper *AgEcon Search,* Available at https://ageconsearch.umn.edu/record/202598/?v=pdf

Watson, S., S. Sviland and S. A. Ødegaard (1994), 'Identification of risk factors for clinical mastitis in dairy heifers', *Journal of Dairy Science*, *81* (5), 1275–84.

Glossary

Mastitis: Inflammation of the mammary gland, usually caused by bacterial infection.

Clinical mastitis: Mastitis with visible symptoms such as swelling, redness, heat, pain, and abnormal milk.

Subclinical mastitis: Mastitis without visible symptoms, but with detectable changes in milk composition (e.g., increased somatic cell count).

Somatic Cell Counts (SCC): The number of somatic cells (e.g., white blood cells, epithelial cells) in milk, indicating the degree of inflammation in the mammary gland.

Dry cow therapy: Treatment of cows' mammary glands with antibiotics during the dry period (between lactations) to prevent mastitis.

Strip cups: Devices used to examine milk for clots or flakes, indicating possible mastitis.

Purposive survey method: A research method where participants are selected based on specific criteria relevant to the research question.

California Mastitis Test (CMT): A simple on-farm test used to detect subclinical mastitis.

Semi-intensive management farming system: A livestock production system where animals have access to both pasture and confinement areas.

Intensive System: A livestock production system where animals are confined indoors with limited access to outdoor space.

Zero Grazing: A livestock production system where animals are fed entirely indoors and have no access to pasture.

Parities: The number of times a cow has given birth.

To cite this paper please use the following details: Kosgei, N. K. et al. . (2024), 'Prevalence of Clinical and Subclinical Cattle Mastitis and the Associated Risk Factors in Bomet County, Kenya', *Reinvention: an International Journal of Undergraduate Research*, Volume 17, Issue S1, https://reinventionjournal.org/article/view/1378. Date accessed [insert date]. If you cite this article or use it in any teaching or other related activities please let us know by e-mailing us at Reinventionjournal@warwick.ac.uk.