

## Bovine Mastitis: Prevalence and Associated Risk Factors in Alage ATVET College Dairy Farm, Southern Ethiopia

Muluken Tuke<sup>1</sup>, Dawit Kassaye<sup>2</sup>, Yimer Muktar<sup>2\*</sup>, Tsegaye Negese<sup>3</sup> and Kifle Nigusu<sup>3</sup>

<sup>1</sup>Asella City Administration Livestock Development and Fishery Office, Asella, Ethiopia

<sup>2</sup>College of Veterinary Medicine, Haramaya University, P.O. Box 138, Dire Dawa, Ethiopia

<sup>3</sup>Hirna Regional Laboratory, P.O. Box 36, Hirna, Ethiopia

### Abstract

Purposive cross-sectional types of study was carried out to determine the prevalence of mastitis in lactating dairy cows, and assess the associated risk factors in Alage agricultural technical vocational and training (ATVET) college dairy farm. The study was carried out in 138 dairy cows based on data collection, regular farm visit, clinical examination, and California mastitis test (CMT). In the present study, in general the prevalence of mastitis was 94 (68.11%) and (46.37%) at cow and quarter level respectively. The prevalence of clinical and subclinical mastitis was (16.67% and 51.44%), subclinical (5.25% and 41.12%) at cow and quarter level respectively. In this study prevalence of mastitis was considerably correlated with breed, parity and production status (milk yield per lactation period) ( $p < 0.05$ ). However, stage of lactation and age of the cow was not statistically significant in this study. Taking into consideration the different huge losses that could be incurred by both clinical and subclinical mastitis, regular checkup for the exposure of subclinical mastitis and appropriate treatment of the clinical cases should be practiced and also attention should be paid for further detailed investigation and control measure of cases.

**Keywords:** Alage ATVET college; Bovine mastitis; Prevalence; Southern Ethiopia

### Introduction

The world human population is expected to increase from time to time and it will be expected that 7.2 million in the year 2010 the majority of the boost will be in tropical developing countries, where there will be migration from rural areas to urban centers which may led to shift in the pattern of food production, marketing and consumptions [1]. The dairy market is more preferred than meat production and where milk production, provides a regular income generation for the producers since it has easy access to the market. The dairy activity is labor intensive and it creates considerable employment opportunities during production processing and in the marketing area [2].

The proportion of livestock in Ethiopia remained the largest figure in any Africa until recent times but levels of production are one of the lowest. Factors for the poor productivity of livestock in Ethiopia include; disease, poor nutrition, unimproved genotypes, inappropriate managements, socio-economic and institutional constraints [3]. On the other hand, milk production from these animals is not sufficient to the need of the population in the country. Many constraints are faced by increasing the demand for milk and dairy products in the country is huge and the consequential opportunities for the smallholders farming are large. However, low animal output, inappropriate technologies, insufficient research and extension support, poor infrastructure and unfavorable external factors have contributed to the low performance of the dairy cows in general, and of the dairy industry and the products in particular [3]. Only a few modern dairy farms are operational in Ethiopia and most of the milk products come from conventional dairy farm [4].

Mastitis as a disease is the most common and costly production diseases affecting the dairy cattle business worldwide [5]. It is a disease of many mammalian species, at least, 137 infectious causes of bovine mastitis are known to date and in large animal, the commonest pathogens are *S. aureus*, *S. agalactiae*, and other *Streptococcus* species and *Coliforms* [6]. It may also be associated with many other

microorganisms including *Actinomyces pyogens*, *Pseudomonas aeruginosa*, *Nocardia asteroides*, *Clostridium perfringens* and other like *Mycobacterium*, *Mycoplasma*, *Pasteurella* and *Prototheca* species and Yeasts [7]. The majority of the cases are caused by only a few common bacterial pathogens namely *Staphylococcus* species, *Streptococcus*, *Coliforms* and *Actinomyces pyogens* [8,9]. Most of the above mentioned microorganisms are usually found in and around the cows environ thus the dairy animals without doubt can get *via* the udder and easily contracted the disease [10]. In Ethiopia, mastitis has got less emphasis as disease, particularly the subclinical form of mastitis mainly caused by *S. aureus* [11,12].

In Ethiopia, most of the previous studies were focused in Addis Ababa and it's surrounding the capital of the country and fails to represent the incidence of mastitis under different management and ecological situation. Moreover, the subclinical mastitis, has received very little consideration in many of the previous studies. Therefore, the objective of this study was to determine the prevalence of mastitis in lactating dairy cows, and assess the assumed risk factors from milk samples of mastitic cows.

### Materials and Methods

#### Study area and period

The study was conducted from November 2014 to April 2015 in Alage ATVET college dairy farm, Southern Ethiopia. The college is

\*Corresponding author: Yimer Muktar, College of Veterinary Medicine, Haramaya University, P.O. Box 138, Dire Dawa, Ethiopia, Tel: +82-32-560-7169; Email: [yimermktr21@gmail.com](mailto:yimermktr21@gmail.com)

Received April 05, 2017; Accepted July 23, 2017; Published July 24, 2017

**Citation:** Tuke M, Kassaye D, Muktar Y, Negese T, Nigusu K (2017) Bovine Mastitis: Prevalence and Associated Risk Factors in Alage ATVET College Dairy Farm, Southern Ethiopia. J Vet Sci Technol 8: 462. doi: 10.4172/2157-7579.1000462

**Copyright:** © 2017 Tuke M, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

situated at 217 km Southwest of Addis Ababa. Its absolute location is about a longitude of 38°30' East and latitude of 7°30' North. The area covers 4200 hectares of land with an altitude of 1600 meters above sea level. This is characterized by mild subtropical weather with minimum and maximum temperature ranging from 11°C to 29°C. The area experiences bimodal rainfall distribution with an annual average of 700-900 mm. The three defined Seasons based on rainfall distribution are; short rainy season (March to April); long rainy season (June to September) and long dry season (October to January). The dominant soil type is black clay soil (vertisol) with sand slit clay with PH of 7.9 [13].

### Study population

The target population was lactating cattle comprising of 34 Local Borena and 104 Holstein Friesian (HF) breeds with a total of 138 dairy cows. In the study area, the dairy cows managed intensively were kept in exclusive stalls and given with extra diets together with hay and natural grazing pasture.

### Study design

A purposive cross-sectional type of study was carried out on lactating dairy cows of Alage ATVET college. The study dairy farm was selected purposively based on accessibility and willingness of dairy farm owner i.e. the Alage ATVET college to determine the occurrence of bovine mastitis and a total of 138 lactating dairy cows were sampled based on none probability sampling method. Semi structured questionnaire was prepared and information regarding cow attributes and farm attributes were collected. The age, breed, lactation stage, and production status were recorded from farm record documents, farm owners and milkers. The study animals were categorized into the different age, parity groups, and production status according to Quinn. Cows were grouped into three lactation stage groups that are up to less than 4 months (Early), 5-7 months (Middle) and over 8 months (Late) lactation stage according to Quinn [10].

### Sample size determination

The sample size was determined using the formula given by Thrusfield [14] by assuming the expected prevalence to be 10% while the statistical confidence level was 95%. Accordingly, the sample size of lactating cows was determined to be 138.

$$n = \frac{1.96^2 (P_{exp} (1 - P_{exp}))}{d^2}$$

Where: n=required sample size

$P_{exp}$  =expected prevalence

d=desired absolute precision

### Study methodology

**California mastitis test (CMT):** The CMT was carried out to detect the occurrence of subclinical mastitis. It was conducted in each quarter milk sample immediately after collection. A drop of milk, nearly 2 ml from each quarter was placed in each of the four wells of

the CMT paddle and an equal amount of the CMT reagent was applied to each cup. A gentle circular movement was applied to the mixture, in a horizontal plane for seconds. Clinical mastitis was diagnosed on the basis of visible or palpable sign of inflammation together with a change in consistency and color of milk secreted. On the other hand, CMT was applied to all samples for screening of sub clinical mastitis according to the reaction obtained the results were classified as negative (no gel formation), trace 1,2,3 reaction in which one and above results are considered positive [10]. Cows were considered positive for CMT when at least one quarter turned out to be positive for CMT. A herd was considered positive for CMT when at least one cow in a herd was tested positive with CMT.

### Data management and analysis

All the information collected throughout the study period was entered into Microsoft Excel data sheet and then statistical analysis was done by SPSS Version 20 statistical software. The variations between different factors were analyzed using chi-square ( $\chi^2$ ) test. A P-value<0.05 was considered to be statistically significant.

### Results

From the total of 138 lactating cows examined using CMT screening the overall prevalence of mastitis was 68.1% and 48.8% at cow and quarter level respectively where 16.67% and 51.4%, cows were found with clinical and subclinical mastitis, respectively. Out of the 552 quarters examined, (41.12%) quarters were found to be positive for subclinical mastitis and (5.25%) for clinical mastitis (Table 1).

In this study 17.64% clinical and 23.52% sub clinical and 17.30% clinical and 61.53% sub clinical prevalence at cow base and 5.46% clinical and 10.93% subclinical and 5.80% clinical and 53.03% subclinical prevalence at quarter base were observed from local borena and exotic breeds respectively (Table 2).

Prevalence of mastitis associated to assumed factors was determined by the total animal examined to positive cows. Breed, parity, and production status showed significant variation on the occurrence of bovine mastitis ( $p<0.05$ ). Exotic HF cows had prevalence of 61.51%. A higher prevalence (100%) was recorded in cow calved more than 6 times followed by cow calved 5-6 times (77.77%) as compared to cows calved 2, and 3-4 times and cows that gave more production had (>450 liters) higher prevalence (100%) of mastitis (Table 3).

### Discussion

The result of current study showed that an overall prevalence of mastitis was 68.11%. The finding was similar with Nibret et al. [15], Mekonnen et al. [16] and Tesfaheywet and Gerema, [17], who reported prevalence of 60.9%, 62.9%, and 64.3% respectively, and comparable with the result of 71% around Holeta town [18], 59.1% in Borana [19], 56.5% in Batu and its surrounding [11,20], 56.16% in West Algeria [21], and 50.03% in the districts of North Showa and Borana zones of pastoral area [22]. However, the current study is different from the result of 75.22% in Jimma town [23], 74.3% in Addis Ababa area [24], 53.25% in Dire Dawa town [25], 52.78% in and around Sebeta [26],

Types of mastitis	Total examined cows	Total number affected cows (%)	Total examined quarter	Total number affected (%)
Clinical	138	23 (16.67)	552	29 (5.25)
Subclinical	138	71 (51.44)	552	227 (41.12)
Total	138	94 (68.11)	552	256 (46.37)

Table 1: The overall prevalence of mastitis at cow and quarter levels.

Level	Types of Mastitis	Local borana (n=34)	Exotics (n=104)
		Prevalence, N (%)	Prevalence, N (%)
Cow level	Clinical	6 (17.64)	18 (17.30)
	Subclinical	8 (23.52)	64 (61.53)
Quarter level	Clinical	7 (5.46)	23 (5.80)
	Subclinical	14 (10.93)	210 (53.03)

**Table 2:** Prevalence of mastitis in local Borana and exotic breed at cow base and quarter level.

Risk factor	Examined animal	positive animals	Prevalence (%)	$\chi^2$	p value
<b>Age</b>					
3-5 years	91	42	46.15	6.59	0.086
6-8 years	23	11	47.82		
9-11years	15	9	60.0		
>11years	9	8	88.88		
<b>Breed</b>					
Local Borana	34	6	17.64	19.74	0.001
Exotic HF	104	64	61.51		
<b>Parity</b>					
Calved up to 2	92	42	45.65	9.034	0.029
Calved 3-4 times	28	13	46.42		
Calved 5-6 times	9	7	77.77		
Calved>6	4	4	100.0		
<b>Stage of lactation</b>					
Early	55	25	45.45	5.406	0.067
Mid	42	18	42.85		
Late	41	27	65.85		
<b>Production status</b>					
<150 liter	45	13	28.88	15.537	0.001
150-300 liter	67	41	61.19		
300-450 liter	22	12	54.54		
>450 liter	4	4	100.0		

Keys: HF: Holstein Friesian; MY/LP: Milk Yield/Lactation Period

**Table 3:** The prevalence of both clinical and subclinical mastitis in milking cows based on assumed risk factors.

46.7% in Adama town [27], 44.1% around Holeta areas [28], 32.6% in and around Gondar [15], 28.2% in Bahir Dar and its surroundings [29], and 34.9% in Southern Ethiopia [30]. The variation in these studies could be due to the disparity in the breed, management system, and the epidemiological status [31].

The present study also confirmed that prevalence of 16.67% for clinical mastitis that was similar with the report of 19.6% in Addis Ababa [24], and 16.11% in and around Sebeta [26] and comparable to the reports of 9.09% in Dire Dawa town [25], 10.0% in Adama town [27], 10.3% at Asella [32], 10.3% around Holeta town [28], and 11.9% in Bahir Dar and its surroundings [29] and 10.7% Eastern harrarghe zone [17] and 9.5% in North Showa and Borana zones of pastoral area [22]. However, the result of the current study was much higher than the findings of 0.93% in and around Gondar [15], 5.3% in Batu and its surroundings [20] and lower than the reports of 22.4% around Holeta town [18], Animals, pathogen, and environment were the most important determining factors which influence the occurrence of clinical mastitis that could contribute for variation in the prevalence of mastitis [31].

The present study also confirmed that prevalence of subclinical mastitis was 51.44% this result was in line with the result of 51.8% in Eastern harrarghe zone [17] and also in close harmony with the result of 55.1% in Addis Ababa [24], 55.8% in Asella [19], 44.6% around Holeta town. The finding of the present study was comparable with earlier findings such as the findings of 40.6% in Batu and its surroundings [20],

40.7% in North showa and Borana zones of pastoral area [22], 33.8% around Holeta areas [28]. However lower than the finding of 36.67% in and around Sebeta [26], 31.67% in and around Gondar [15], and 23.0% in Bahir Dar and its environments [29]. The prevalence of subclinical mastitis varies in dairy cows this might be due environmental factors that play an important role in the occurrence of the disease [31].

The current finding confirmed that lower prevalence of clinical mastitis compared with the subclinical mastitis. Other studies also shared similar observations [17,22-24,33,34]. This could be attributed to the indistinguishable and silent character of subclinical mastitis in most of the time that gives little concentration by the farms and veterinary professionals during treatment unlike that of the clinical mastitis which have given more emphasis in the treatment and control efforts of the disease [17,28,35].

The prevalence of mastitis with regard to lactation stage was studied and the result showed an increase in early and late stages of lactation with a prevalence rate of 45.45% and 65.85%, respectively. This observation was similar with the previous result of Nesru [36], Mungube et al. [37], and Biffa et al. [30] in Ethiopia. The former two authors reported a high prevalence of subclinical mastitis for cows in the late stage of lactation while the late two reported higher prevalence in the early stage of lactation this is associated with most new infection occurs in the first two month of lactation especially the environmental infection probably due to stress and following weakening of immunity. In the late lactation stage the chance of the cow picking up the infection

would be high and this result in an increase in prevalence of mastitis in early and late stage of lactation [38].

The higher prevalence of mastitis observed in exotic breed lactating cows (61.51%) than local borana breed (17.64%) was considerably associated with variation in certain physiological and anatomical characteristics between the breeds. This is similar with Lakew et al. [32] who found significant difference between crosses and local Arsi breed and Biffa et al. [30] found a significant difference between local zebu, Holstein Friesian, and Jersey breeds. Exotic breed cows have been found more vulnerable to mastitis due to the position of teat, udder, and anatomy of teat canal. Differences in the genetic structure of teat canal sphincter muscle, keratin in the teat canal or shape of teat end where pointed end are prone to injury which induces infection. [31].

The study showed that there were significant statistical associations ( $p < 0.05$ ) the prevalence of mastitis with the parity number of animals, cows with many numbers of calves were with higher prevalence of mastitis and the risk of subclinical mastitis increases with increasing parity number in this study agrees with the finding of Busato and Schallibaum [39] and Bitew et al. [29]; Girma [28]; Nibret et al. [15] who found that the risk of clinical and subclinical mastitis increase significantly with increasing parity number of the cow. The higher prevalence in cows at three and above calved could be due to increase ease of penetration of the teat duct by pathogens and accumulated previous infection [7]. It is postulated that younger animal is less susceptible; through a more effective host defense mechanism. Older cows, especially after four calving are more prone to mastitis [40].

The study showed that there were significant statistical associations ( $p < 0.05$ ) between the different production status of the cow. Prevalence of mastitis was higher in high yielding cows than that produce low milk yield per lactation period. Radostits et al. [7] stated that high yielding cows are more susceptible to mastitis than low yielding. This could be due to the ease with which injuries are sustained in large udders so that foci for the entrance of pathogens are created, and stress associated with a high milk yield may upset the defense system of the cow. It has been shown that genotype favorable for milk yield are more susceptible to mastitis [41]. The long-term selection pressure for milk production may have had a negative effect on polymorphism of gene linked to major histocompatibility complex (Bola) in dairy breeds [42,43]. Once inside teat cistern pathogens encounter a group of nonspecific bacteriostatic and bactericidal factors. When these fail, phagocytic cell aided by Immunoglobulins are called into action. Variation among cows has been observed in most of mechanisms, apportion of which is attributable to heredity [41].

## Conclusions

The finding of this study confirmed that a total prevalence of 68.11%, which could indicate that mastitis, was the main important health constraints of dairy cows in the study farm which decreases the output of dairy business and thus which urges the need of serious concentration for the disease. Occurrence of subclinical mastitis was more prevalent in the study farm (51.44%) which might indicate dairy farm owners, managers and veterinary professionals give due attention for clinical mastitis than subclinical infection which gives very little emphasis for the status of the subclinical mastitis. Furthermore, regular testing for the detection of subclinical mastitis and proper treatment of the clinical cases together with the appropriate treatment of cows during dry and lactation period should be practiced.

## References

1. Sire C, Seinfeld H, Goenewold T (1996) World livestock system. Current status, issue and trends. Animal production and health paper, No: 127, FAO, Rome pp: 81.
2. World Bank technical paper (1991) Dairy development in Sub Sahara Africa: A study of issues and options. Africa technical department series Washington DC, the World Bank.
3. Williams TO, Derosa A, Badiane O (1995) Macroeconomic, International trade and sect oral economic policies in livestock development: A with particular reference to low income countries ILRI, Addis Ababa Ethiopia, pp. 45-68.
4. Asfaw W (1997) Livestock development policy in Ethiopia In: CTA, OAU/IBAR, Ministry of agriculture and cooperatives, Swaziland (editors). Livestock development policies in eastern and southern Africa paper presented in a seminar held in Mbabane, Swaziland, 28 July-August 1997.
5. Seegers H, Fourichon C, Beaudeau F (2003) Production effects related to mastitis and mastitis economics in dairy cattle herds. *Vet Res* 34: 475-491.
6. Sumathi BR, Veeregowda BM, Mitha RA (2008) Prevalence and anti biogram profile of bacterial isolates from clinical bovine mastitis. *Vet World* 1: 237-338.
7. Radostits OM, Gay CC, Hinch, KW (2002) Mastitis Veterinary Medicine. A text book of disease of cattle, sheep, pigs, goats and horses 9th (ed). WB Saunders, London, UK, pp. 603-700.
8. Dupreeze JH (2000) Bovine mastitis therapy and why it fails. *J S Afr Vet Assoc* 71: 201-208.
9. Quinn PJ, Carter ME, Markey B, Carter GR (2004) Clinical Veterinary Microbiology. Mosby Publishing, London, UK, pp. 43-55.
10. Quinn PJ, Carter, ME, Markley B, carter GR (2002) Clinical Veterinary microbiology. Wolf publishing, London, UK, pp. 405-420.
11. Bishi AB (1998) Cross-sectional and longitudinal prospective study of Bovine clinical, sub clinical mastitis in peri urban and urban dairy production system in Addis Ababa region. MSc Thesis Addis Ababa University, Faculty of Veterinary Medicine, Debre-Zeit, Ethiopia.
12. Mekonnen H, Workinesh S, Baylyegne M, Moges A, Tadele K (2005) Antimicrobial susceptibility profile of mastitis isolate from cow in three major Ethiopian dairies. *Revue Med Vet* 150: 391-394.
13. CSA (2008) Federal Democratic Republic of Ethiopia. Central statistical Agency, Agricultural sample survey report on livestock and livestock characteristics. Volume II, Addis Ababa Ethiopia.
14. Thrusfield M (2005) Veterinary Epidemiology. Blackwell science Ltd, Oxford, UK.
15. Nibret M, Yilikal A, Kelay B (2011) A cross sectional study on the prevalence of sub clinical mastitis and associated risk factors in and around Gondar, Northern Ethiopia. *Int J Anim Vet Adv* 3: 455-459.
16. Mekonnen L, Tesfu K, Azage T (2012) Clinically manifested major health problem of cross breed dairy herds in urban and peri-urban production system in central highlands of Ethiopia. *Trop Anim Health Prod* 33: 85-93.
17. Tesfaheywet Z, Gerema A (2017) Prevalence and Bacterial Isolates of Mastitis in Dairy Farms in Selected Districts of Eastern Harrarghe Zone, Eastern Ethiopia. *J Vet Med: ID* 6498618, 7 pages.
18. Mekibib B, Furgasa M, Abunna F, Megersa B, Regassa A (2010) Bovine mastitis: prevalence, risk factors and major pathogens in dairy farms of Holeta town, central Ethiopia. *Vet World* 3: 397-403.
19. Bedane A, Kasim G, Yohannis T, Habtamu T, Asseged B, et al. (2012) Study on prevalence and risk factors of bovine mastitis in Borana pastoral and agro-pastoral settings of Yabello District, Borana Zone, Southern Ethiopia. *American-Eurasian J Agricult Environ Sci* 12: 1274-1281.
20. Bedacha BW, Mengistu HT (2011) Study on prevalence of mastitis and its associated risk factors in lactating dairy cows in Batu and its environments, Ethiopia. *Global Veterinaria* 7: 632-637.
21. Benhamed N, Moulay M, Aggad H, Henni JE, Kihal M (2011) Prevalence of mastitis infection and identification of causing bacteria in cattle in the oran region West Algeria. *J Anim Vet Adv* 10: 3002-3005.
22. Dinaol B, Yimer M, Adem H, Nateneal T, Tadesse K, et al. (2016) Prevalence, Isolation of Bacteria and Risk Factors of Mastitis of Dairy Cattle in Selected

- Zones of Oromia Regional States, Ethiopia. *Global J Med Res: C Microbiol Pathol* 16: 39-45.
23. Sori T, Hussien J, Bitew M, (2011) Prevalence and susceptibility assay of *Staphylococcus aureus* isolated from bovine mastitis in dairy farms of Jimma town, South West Ethiopia. *J Anim Vet Adv* 10: 745-749.
  24. Zeryehun T, Aya T, Bayecha R (2013) Study on prevalence, bacterial pathogens and associated risk factors of bovine mastitis in small holder dairy farms in and around Addis Ababa, Ethiopia. *J Anim Plant Sci* 23: 50-55.
  25. Biniam T, Rediet T, Yonus A (2015) Prevalence and potential risk factors of bovine mastitis in selected dairy farms of Dire Dawa Town, Eastern Ethiopia. *Appl J Hygiene* 4: 06-11.
  26. Sori H, Zerihun A, Abdicho S (2005) Dairy cattle mastitis in and around Sebeta, Ethiopia. *Int J Appl Res Vet Med* 3: 332-338.
  27. Abera M, Demie B, Aragaw K, Regassa F, Regassa A (2010) Isolation and identification of *Staphylococcus aureus* from bovine mastitic milk and their drug resistance patterns in Adama Town, Ethiopia. *J Vet Med Anim Health* 2: 29-34.
  28. Girma D (2010) Study on prevalence of dairy cows around Holeta Areas, West Shewa Zone of Oromia Region, Ethiopia. *Global Veterinaria* 5: 318-323.
  29. Bitew M, Tafere A, Tolossa T (2010) Study on bovine mastitis in dairy farms of Bahir Dar and its environments. *J Vet Anim Adv* 9: 2912-2917.
  30. Biffa D, Debela E, Beyene F (2005) Prevalence and risk factors of Mastitis in lactating dairy cow in southern Ethiopia. *Int J Appl Res Vet Med* 3: 189-198.
  31. Radostits OM, Gay KW, Hinchcliff C, Constable PD (2007) Mastitis: in *Veterinary Medicine: A Text Book of Disease of Cattle, Sheep, Pigs, Goats, and Horses* (10th ed). Bailliere Tindall, London, UK, pp. 674-762.
  32. Lakew M, Tolosa T, Tigre W (2009) Prevalence and major bacterial causes of bovine mastitis in Asella, South Eastern Ethiopia. *Trop Anim Health Prod* 41: 1525-1530.
  33. Workineh S, Bayleyegn M, Mekonnen H, Potgieter LN (2002) Prevalence and aetiology of Mastitis in cows from two major Ethiopian dairies. *Trop Anim Health Prod* 34: 19-25.
  34. Dego OK, Tareke F (200) Bovine mastitis in selected areas of southern Ethiopia. *Trop Anim Health Prod* 35: 197-205.
  35. Karimuribo ED, Fitzpatrick JL, Bell CE (2006) Clinical and subclinical mastitis in smallholder dairy farms in Tanzania: risk, intervention and knowledge transfer. *Prev Vet Med* 74: 84-98.
  36. Nesru H (1999) A cross sectional and longitudinal study of bovine mastitis in urban and peri urban dairy system in the Addis Ababa region. MSc. Thesis. Free University Berlin and Addis Ababa University, Ethiopia.
  37. Mungube EO, Tenhagen BA, Regassa F, kyule MN, Shiferaw Y, et al. (2005) Reduced milk production in udder quarters with sub clinical mastitis and associated economic losses in cross bred dairy cows in Ethiopia. *Trop Anim Health Prod* 37: 1573-7438.
  38. Schalm DW, Carroll EJ, Jain C (1971) *Bovine Mastitis*. Lea and Fibiger, Philadelphia, Pa, USA.
  39. Busato A, Trachsel P, Schalibaum M, Blum JW (2000) Udder health and Risk factor for sub clinical mastitis in organic dairy farm in Switzerland. *Prev Vet Med* 44: 205-220.
  40. Dullin AM, Paape MJ, Nickerson SC (1988) Comparison of phagocytosis and chemiluminescence's by blood and mammary gland neutrophils from multi parous cows. *Am J Vet Res* 49: 172-177.
  41. Shook GE (1989) Selection for disease resistance. *J Dairy Sci* 72: 1349-1362.
  42. Lewin H (1989) Disease resistance and immune response genes in cattle: Strategies for their detection. *J Dairy Sci* 72: 1334-1348.
  43. Lipman LJ (1995) *Escherichia coli and Staphylococcus aureus mastitis: Epidemiology and pathogenesis*. PhD Thesis, University Utrecht, Netherlands.