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Prevalence of Bovine Mastitis in Lactating Cows and its Public Health Implications in Selected Commercial Dairy Farms of Addis Ababa

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Abstract- A cross sectional study was conducted in Addis Ababa from October 2011 to May 2012 to determine prevalence of bovine mastitis and discuss its public health implications. A total of 444 systematically selected lactating cows of different cattle breed from thirty seven (37) dairy farms were investigated. The herds were visited and the farmers interviewed about the management, housing, feed and feeding, and milking conditions. California Mastitis Test (CMT) was applied on milk samples collected from 1776 individual quarters. The overall prevalence of bovine mastitis was 68.0% (302/444) of which sub-clinical mastitis accounted for 46.8% (208/444) while 21.2% (94/444) were found to be clinical forms. There was significant difference ($P < 0.05$) in the prevalence of mastitis among the different breeds, age groups, parity and lactation stage. Relatively higher number of farmers interviewed (20.8%) replied that they do not withhold milk from cows treated for mastitis and continue to avail it to the public without interruption. As it is economically damaging, the need to establish diagnostic facility to enable early detection for screening large number of samples was emphasized. Further work on identification of the causative agents and conducting public awareness creation about major zoonotic diseases were also recommended.

Keywords: *california mastitis test, interview, prevalence, mastitis, zoonotic.*

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Abstract- A cross sectional study was conducted in Addis Ababa from October 2011 to May 2012 to determine prevalence of bovine mastitis and discuss its public health implications. A total of 444 systematically selected lactating cows of different cattle breed from thirty seven (37) dairy farms were investigated. The herds were visited and the farmers interviewed about the management, housing, feed and feeding, and milking conditions. California Mastitis Test (CMT) was applied on milk samples collected from 1776 individual quarters. The overall prevalence of bovine mastitis was 68.0% (302/444) of which sub-clinical mastitis accounted for 46.8% (208/444) while 21.2% (94/444) were found to be clinical forms. There was significant difference ($P < 0.05$) in the prevalence of mastitis among the different breeds, age groups, parity and lactation stage. Relatively higher number of farmers interviewed (20.8%) replied that they do not withhold milk from cows treated for mastitis and continue to avail it to the public without interruption. As it is economically damaging, the need to establish diagnostic facility to enable early detection for screening large number of samples was emphasized. Further work on identification of the causative agents and conducting public awareness creation about major zoonotic diseases were also recommended.

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I. INTRODUCTION

Despite many years of research, mastitis subclinical remains the most economically damaging and zoonotic potential disease for dairy industry and consumers worldwide irrespective of species of animal (Ojo *et al.*, 2009). Economic losses caused by mastitis include value of discarded milk (Radostits *et al.*, 2007). Bacterial contamination of milk from affected cows may render unsuitable for human consumption by causing food poisoning or interference with manufacturing process or in rare cases provides mechanism of spread of disease to humans. Zoonotic diseases potentially transmitted by raw cow milk include brucellosis, caseous lymphadenitis, leptospirosis, listeriosis, melioidosis, Q-Fever, Staphylococcal food poisoning, toxoplasmosis and tuberculosis (Mungube *et al.*, 2005; Radostits *et al.*, 2007).

The prevalence of subclinical mastitis in dairy herds is often surprising to producers, moreover, sub-

clinically infected udder quarters can develop clinical mastitis and the rate of new infections can be high (Zdunczyk *et al.*, 2003). Previous studies conducted in different countries indicate the distribution and economic importance of the disease. Contreras *et al.* (1997) from Spain; Moshi *et al.* (1998) from Tanzania; Ameh and Tari (2000) from Nigeria; Ndegwa *et al.* (2000) from Kenya and Kozacinski *et al.* (2002) from Croatia reported different prevalence rates of mastitis in dairy cattle. The disease has been reported by several authors in different parts of the Ethiopian country (Mungube *et al.*, 2005; Lakew *et al.*, 2009; Gebreyohannes *et al.*, 2010; Megersa *et al.*, 2010). Several of these studies have been shown the occurrence a range of mastitis causing bacteria indicating *Staphylococcus*, *Escherichia coli* and *Streptococcus* as dominant and pathogenic species. Some authors (Mungube *et al.*, 2005) reported a substantial economic loss in Ethiopian highland crossbred dairy cows due to subclinical mastitis.

Subclinical mastitis can be recognized indirectly by several diagnostic method including the California mastitis test (CMT), the Modified White Side test, Somatic cell count, pH, and catalase tests. These tests are preferred to be screening tests for subclinical mastitis as they can be used easily, yielding rapid as well as satisfied results (Joshi and Gokhale, 2006).

In some parts of Ethiopia, the disease is insufficiently investigated and information relating to its magnitude, distribution and risk factors is scant. Such information is important to envisage when designing appropriate strategies that would help to reduce its prevalence and effects (Mekebib *et al.*, 2009; Megersa *et al.*, 2010).

This study aimed (i) to evaluate the prevalence of subclinical mastitis in apparently healthy dairy cows in Holeta district, (ii) to determine the most frequency of intramammary infection, causative agents, and (iii) to evaluate associated risk factors affecting on subclinical mastitis.

II. MATERIALS AND METHODS

a) Study area

The study was conducted in Addis Ababa city administration, the capital of the Federal Democratic

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Republic of Ethiopia. The city covers an area of 530.14 km² and is sub divided into ten sub-cities namely, Arada, Bole, Addis Ketema, Nefas Silk Lafto, Kolfe Keranio, Akaki Kality, Yeka, Lideta, Kirkos and Gulele sub-cities. Addis Ababa lies at an altitude of 2000-3000 meters above sea level and is a grass land biome located between 9.03 North latitude and 38.74 East longitudes. The city has alternating dry and rainy seasons with the long rainy season that extends from June to September and short rainy season that lasts from March to May. The mean annual minimum and maximum temperatures range between 14°C and 21°C respectively with an overall overage of 17°C. The mean relative humidity is 61.3% (CSA, 2003).

b) Study Animals and Sample Size Determination

The study was conducted on 444 lactating cows (local, Holstein-Friesian, Jersey and cross breeds) from 37 dairy farms in Addis Ababa. The farms were purposively selected based on the availability of lactating cows within the farm and the owners' willingness. Systematic random sampling method was applied for the selection of individual animals (lactating cows) in the farms. The sample size was determined by the formula given by Thrusfield (2007) considering an expected prevalence of 71% (Mekibib *et al.*, 2009), 95% confidence level and 5% desired precision. Adding a few more samples to improve on the accuracy, a total of 444 lactating cows were considered for the study.

c) Study Design

A Cross sectional study was conducted. Three dairy farms were purposively selected for their ease accessibility. Simple random sampling technique was followed to select the study animal and the desired sample size was calculated according to the formula given by Thrusfield (2007).

The study was carried out from November 2011 to April 2012 by collection of events associated with mastitis in lactating cows from 37 small holder's dairy farms in Addis Ababa.

d) Study Methodology

i. Clinical inspection of udder

The udder was first examined visually and then by palpation to detect possible fibrosis, inflammatory swellings, visible injury, tick infestation, atrophy of the tissue and swellings of supra mammary lymph nodes. The teat condition (color changes, swelling at or near the teat base, swelling or firmness at or near the teat end, openness of the teat orifice, teat skin condition, signs of vascular damage like petechial hemorrhage, etc.) was evaluated during clinical examination (More, 1989). Upon palpation, one can feel hot, painful swelling on udder and ventral abdomen and was manifested by loss of appetite, depression, recumbence and blood mixed milk in acute mastitis. In chronic mastitis, continuous or intermittent discharge of pus, clots, flakes

or watery secretion will be seen from the udder (Chauhan and Agarwal, 2006).

e) California mastitis test (CMT)

The California Mastitis Test (CMT) was performed according to the manufacturer's instruction. In brief, a small sample of milk (approximately ½ teaspoon) was collected from each quarter into a plastic paddle that has 4 shallow cups marked A, B, C and D. An equal amount of CMT reagent was added to the milk and the paddle rotated to mix the contents. After approximately 10 seconds, the score was read while continuing to rotate the paddle. Results were recorded as T (trace), 1, 2 or 3 based on the level of precipitation (coagulation) (Mellenberger and Carol, 2000).

i. Risk factor assessment

Information on animal and farm-based risk factors was collected in two separate pre-designed questionnaires, by observation, and by interviewing of the different farm attendants and owners. A check-list was used to record such information as the cows' age, breed, parity, lactation stage, and body condition, problems of leaking milk and previous history of mastitis. Farm-based risk factors considered were teat drying, teat cleaning, floor types, teat dipping, milkers, bedding and treatment history.

ii. Assessment of public health risks

This was done by asking respondents whether they adapt the behavior of boiling milk before consumption, stripping of the foremilk at the start of milking, and by asking them the time duration of time they withheld milk before distribution to the public if the animals were treated for mastitis.

f) Statistical analysis

The data was compiled and analyzed with SPSS statistical package version 17. Prevalence estimation of commonly isolated pathogens in Holeta town dairy farms was determined using standard formulae (i.e., the number of positive animals/samples divided by the total number of animals/samples examined). Descriptive statistics such as percentages and frequency distributions was used to describe/present the nature and the characteristics of the data.

III. RESULTS

a) Prevalence of Mastitis at Individual Cow and Quarter Level

Three hundred forty three Holstein-Friesian (HF), 20 Jersey, 15 local and 32 cross (HF X Local) breeds were included in the study. Of the total 444 lactating cows, 302 (68%) were found to be affected with clinical or sub clinical mastitis based on clinical examination of the udder and CMT results. From these, 94 (21.2%) was clinical and 208 (46.8%) was sub-clinical mastitis (Table 1). Out of 1776 quarters examined, clinical, non-functional and sub-clinical abnormalities

were found in 288 (16.2%), 55 (3.1%), 456 (25.7%) quarters respectively.

Table 1 : Prevalence of mastitis

Types of mastitis	Total number examined	Positive (%)	χ^2	P- Value
Clinical	444	94 (21.20)	52.078	0.000
Subclinical	444	208 (46.80)		
Total	444	302 (68.00)		

b) Prevalence of Bovine Mastitis across Different Categories of Cows

Breed, age, parity and lactation stages have significant influence ($P < 0.05$) on the prevalence of bovine mastitis. There was a significant difference in prevalence between animals of different age categories ($P < 0.05$). The highest prevalence (86.5%) was found in lactating cows of ages 7-10 years, followed by cows of ages 11-13 years (81.8%), and the lowest prevalence (59.1%) was recorded in cows of ages 3-6 years. Higher prevalence (90.8%) was recorded in cows which gave birth to 4-7 calves and the lower prevalence (61.6%) was recorded in cows that gave birth to 1-3 calves. The difference was statistically significant ($P < 0.05$) (Table 3).

The effect of lactation stage on the current prevalence of mastitis was studied and analyzed and

the result revealed that lactation stage had significant effect ($P < 0.05$) on the prevalence of mastitis. Higher prevalence (89.3%) of mastitis was observed and recorded in cows of late lactation stage (9-14 month) followed by cows in mid (83.65%) lactation (5-8 month) and early lactation stage (3 week-4 month) that had a prevalence of 50.7%. The effect of breed on the prevalence of mastitis was also studied and analyzed and the result revealed that breed had significant effect ($P < 0.05$).

Among the different breeds studied, the highest mastitis prevalence was observed in Holstein-Friesian breeds (71.8%) followed by Jersey (70.0%), local (66.7%), and cross (48.5%) breeds (Table 3).

Table 3 : The prevalence of bovine mastitis in association with potential predisposing factors

Variables	No. examined	Positive (%)	χ^2	P-Value
Breed				
Holstein-Friesian (HF)	343	246 (71.7)	13.786	.003
Jersey	20	14 (70.0)		
Cross (local x HF)	66	32 (48.5)		
Local	15	10 (66.7)		
Total	444	302 (68)		
Age				
3-6 years	296	175 (59.1)	32.497	.000
7-10 years	126	109 (86.5)		
11-13 years	22	18 (81.8)		
Total	444	302 (68)		
Parity				
1-3	346	213 (61.6)	30.048	.000
4-7	98	89 (90.8)		
Total	444	302 (68)		
Lactation stage				
3 week-4 month	223	113 (50.7)	62.722	.000
5-8 month	146	122 (83.65)		
9-14 month	75	67 (89.3)		
Total	444	302 (68)		

c) Questionnaires Survey, Observation and Interviewing

Questionnaires were distributed to 24 farms among the 37 farms included in the study. One questionnaire per farm owner/attendant was distributed. The entire farms included in the study followed manual

milking (hand milking) system and most (80%) of the milkers were males. No specific sequence is followed during milking in many (87.5%) of the farms. Rather, it depends on the placement of the animal in the shed. Fifty four percent of the farm owners were educated to

high school level while 12.5% were educated up to university level. The remaining (33.5%) attended elementary schools. Overall, educated people had better know how about the zoonotic implications of consuming raw milk, predisposing factors for mastitis and drug residue effect post treatment of mastitic animals. A few (12.5%) farmers emphasized the need to milk healthy cows first and the diseased cows later to prevent transmission of disease. Most (66.7%) of the milkers used disinfectant before milking only while 8 (33.3%) milkers said that they use disinfectant both before and after milking. Tap water is the primary source of water to clean teats and hands in many (91.7%) of the farms while few (8.3%) milkers use river water for teats and hands cleansing.

Eighteen (75%) farms strip the foremilk first while few undertake direct milking to the material used for milking. Among the 24 farms, 8 (33.3%) used individual towels, 10 (41.7%) communal towel and 6 (25%) did not use towel for drying of teats before or after milking. Among the 24 farms, 14 (58.3%) milkers disinfect their hands before proceeding to milk the next cow while 10 (41.4%) milkers disinfect their hands only at the beginning of milking. Most (75%) of the farmers boil milk before consumption while few (25%) milkers consume raw milk. In almost all of the farms, animals were previously treated for mastitis while few animals (heifers that gave the first and second calf) were not treated for mastitis cases. Few (20.8%) farms distribute the milk for public consumption starting from the same day the animals were treated while most (79.2%) withhold the milk depending on the withdrawal period of the drug as prescribed by veterinarians. The management (housing, bedding, feeding, etc.) and the degree of sanitation were also observed. Among the 24 farms, there were leakage of urine, feces and milk during milking in 7 (29.2%) while in the remaining (14 farms), the bedding, housing and other degree of sanitary measures like milking procedures, use of disinfectant etc. were good.

IV. DISCUSSION

A total of 444 dairy cows, from which 343 HF, 20 Jersey, 66 cross (HF x local), and 15 local breeds from Addis Ababa were investigated in a cross sectional study conducted between November 2011 and April 2012. The current prevalence of mastitis was 68.0%. The finding in this study is greater than that of Girma (2010), who reported 44.1% and Nibret *et al.* (2011), who reported 32.6% in different parts of Ethiopia. The high prevalence of sub-clinical mastitis may be attributed to improper milking hygiene, lack of post milking teat dipping and contact labors used, absence of order in milking cows of different ages and milking of mastitic animals before the healthy ones all of which might have increased the prevalence (Radostits *et al.*, 2007). The

quarter level prevalence was 41.9% (744/1776). This finding was greater than that of Benta *et al.* (2011), who reported 31.4% (349/1112). This difference in the observed prevalence of mastitis among studies may be attributed to various factors like management, environmental, animal risk factors and causative agents (Radostits *et al.*, 2007).

This study revealed a higher prevalence of sub-clinical mastitis (46.8%) than clinical mastitis (21.2%). A similar result was found by Mekibib *et al.* (2009) who reported 22.4% and 48.6% for clinical and sub-clinical mastitis respectively, in dairy farms of Holeta town, central Ethiopia. In case of sub-clinical mastitis, the cow-level prevalence (46.8%) obtained in this study was greater than the finding by Girma (2010) and Nibret *et al.* (2011) who reported 33.8% and 31.67%, respectively, in different parts of Ethiopia. However, it was lower than that reported by a study carried out in Sudan (88.1%) (Abdelrahim *et al.*, 1989). This may be attributed to the difficulty of detecting sub-clinical mastitis by the owners compared to the easily detectable clinical cases which prompt owners seek treatment for their animals (Radostits *et al.*, 2007).

Increasing age, lactation stage, parity and poor management increased the risk of mastitis. This is line with previous reports on mastitis in Ethiopia (Kerro Dego and Tareke, 2003) and industrialized countries (Schukken *et al.*, 1989). Stage of lactation was a risk factor for mastitis (Mungube *et al.*, 2004). In late lactation the risk of mastitis increased. Two reports on Ethiopian conditions found higher prevalence of mastitis during early lactation than late lactation (Hussien, 1999). The reason may be due to excluding of lactating cows below 3 weeks to avoid false positive result since SCC increases during early lactation (Tesfu *et al.*, 1999).

Manual milking methods in the entire farms that included in this study was the major predisposing factors to increase the prevalence of mastitis. Most of employed milkers have little educational background and have limited knowledge about the mechanism/s of disease transmission. Often, they do not disinfect their hands and teats during and between milking of different cows, use of communal towel for drying of teats and also, they have no special preference between tape and river water. This study also noted a high prevalence of mastitis in farms that use river water for sanitation. Sequence of milking cows also seemed to have a role on the prevalence of mastitis. For example, in farm A which employ a specific sequence (first milk healthy heifers, healthy cows and last diseased cows), the prevalence was lower as compared to the other farms in which they apply random milking procedures in the placement of cows in the shed.

In this study, 33.3% of the farm attendants reported to consume raw milk. This practice can be said as risky as raw milk can contain a variety of disease-causing pathogens, as demonstrated by numerous

scientific studies. These studies, along with numerous milk borne out breaks, clearly demonstrated the risk associated with drinking raw milk. For instance, in the US alone, there were 85 reported outbreaks of human infections over the years 1998-2008 due to the consumption of contaminated milk, 1614 illness, 187 hospitalizations and two deaths (Thorne, 2011).

There is also concern that small amounts of certain antimicrobial agents (residue) may significantly shift the resistance patterns in the microbial population in human intestinal tract, allergy from residue of penicillin etc. (Jones, 1999). The present study also found reluctance in 79.2% of the farm owner's to withhold milk from mastitic cows after treatment. Pasteurization effectively kills raw milk pathogens without any significant impact on milk nutritional quality. Stripping of the foremilk is also necessary as it contains many microbes that affect human health negatively.

V. CONCLUSION AND RECOMMENDATIONS

In a spite of a large research efforts aimed to gain prevalence and to develop a new control tools for mastitis, the subclinical occurrence of the mastitis remains a substantial problem for dairy producers. The result of the present study indicated a relatively high prevalence of subclinical mastitis in dairy cattle of the study area. The relatively high prevalence reported in this study was clearly indicated lack of strategic control measures against the disease as well as poor surveillance measures. Lack of maintenance of strict hygiene and good sanitary environment may be contributory factors in the cause of subclinical mastitis. It is therefore important that farmers should ensure strict personal hygiene and that of animals and general sanitary condition of the farms should be improved and maintained. Furthermore, all dairy producers know that early detection of intramammary infection is important for selecting and implementing proper therapy. Unfortunately, most infections are not detected until they become clinical, and by then extensive and costly damage can result. Routine milk cultures should be an ongoing part of any mastitis control program. The sampling strategies for any ongoing program require the input of the herd veterinarian as well as herd management.

Conflict of Interest

The authors have no declared any conflict of interest

VI. ACKNOWLEDGEMENTS

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