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Mastitis and its Effect on Chemical Composition of Milk in and around Worabe Town, Siltie Zone, Ethiopia

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Abstract

The study was undertaken from October, 2011 to June, 2012 to estimate prevalence of mastitis, to identify potential risk factors, and to assess impact of mastitis on chemical composition of cattle milk in and around Worabe town, Ethiopia. The study was conducted using California Mastitis Test for screening of subclinical mastitis, clinical examination and ultramilker to analyze chemical composition of milk. A total of 1,097 quarter milk samples collected from 290 local zebu and Holestein-zebu cross breed cows were examined; and overall prevalence of 46.9 and 24.3% was observed at cow and quarter level, respectively. Clinical and subclinical mastitis were detected with prevalence of 9.7 and 37.2%, respectively. From observed risk factors breed, milk yield, housing and feeding show statistically significance difference ($p < 0.05$) in prevalence of mastitis. Of all parameters, chemical composition of milk, statistically significant difference ($P < 0.05$) was observed in the mean fat composition among different mastitic milk. In conclusion, prevalent occurrence of mastitis accompanied with different potential risk factors was an important problem affecting dairy production; therefore, integrated control measures and monitoring were suggested.

Key words: Worabe; mastitis; milk composition; risk factors; prevalence.

1. Introduction

In recent years, the demand for milk is increased tremendously worldwide due to increased population growth [23]. However, production of milk has been affected by various factors like mastitis [32].

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Mastitis is inflammation of mammary gland and costly production disease affecting dairy cattle industry worldwide [38]. It is often classified as subclinical or clinical depending on the severity of the disease or contagious and environmental based on the causative agents [4].The occurrence of mastitis depends on the interaction between microbial agent, host and environmental factors. The changes in composition of milk are one of the consequences of mastitis in dairy cows [16]. It leads to a reduction of yield, lactose and butter fat. Milk protein levels will increase slightly with mastitis, but the protein is of lower quality, with increased levels of globulin and decreased casein [4]. In Ethiopia, cows are the main source of milk and 42% of the total cattle herds for private holdings are milking cows [13]. Ethiopia's increasing human population and urbanization trends are leading to a substantial increase in the demand for milk and meat [7]. The activities of Ethiopia for self-sufficiency together with increase in milk demand leads to having a significant percentage of improved breeds of dairy cattle in the years to come, which are susceptible to most diseases including mastitis [26]. The level of different types of mastitis, potential risk factors and impact of mastitis on chemical composition of the milk were not studied. Therefore, the present study was undertaken to estimate prevalence of mastitis, to identify potential risk factors, and to assess impact of mastitis on chemical composition of cattle milk in and around Worabe town, Ethiopia.

2. Materials and methods

Study design, mastitis examination and sample collection

The study conducted on 290 lactating local zebu and Holstein-Zebu crossbred cows from October, 2011 to June, 2012 in and around Worabe town of Silte zone, Ethiopia. Breed, age, stage of lactation, parity, milk yield, tick infestation, housing and feeding of study animals were considered as risk factors to be tested for occurrence of mastitis. History about the udder and quarters was asked. The udder (including its symmetry, size, consistency and hotness) and milk (including its consistency and color change) were physically examined. Clinical mastitis was diagnosed on the basis of manifestation of visible signs of inflammation. A warm and swollen quarter which had pain upon palpation was considered to have acute clinical mastitis otherwise chronic mastitis when misshaped, atrophied, hard and fibrotic quarters were examined (International Dairy Federation [20]. A quarter was considered subclinically affected when clinical signs were not present and become positive by California Mastitis Test (CMT). A cow which had one or more positive quarters by CMT was considered positive for subclinical mastitis [34]. Milk samples were collected from clinically and subclinically affected non-blind quarters and additionally, normal quarters. For comparative study of chemical composition of milk, pooled sample was collected from normal quarters of non-mastitic cows; however, milk from cross and local breed cows were collected into separate bottles. After milking out and discarding the first two drops of milk, the milk was examined both for clinical and subclinical mastitis. Then, about 50 ml from each quarter was aseptically collected using sterile universal bottle. Finally, samples were transported in ice box to University of Hawassa Microbiology laboratory for analysis. Samples will be kept at 4°C not for more than18 h if immediate analysis is not convenient.

Milk analysis

Milk samples of both mastitic and non-mastitic quarters were analyzed separately according to their collection using ultramilker [17]. Samples had been warmed at 30°C if they were preserved at 4°C, and fat, solid not-fat (SNF), protein, lactose and ash were analyzed according to description of Hangzhou Ultrasun Technologies Co Ltd [17].

Data analysis

The data was entered and managed in Microsoft Excel spread sheet. Presence of difference in prevalence of mastitis between different groups of risk factors was tested by using chi-square test; Fisher's exact test was used when the numbers within categories were too small for the Chi-square test. Analysis of variance (ANOVA) was used to evaluate presence of significant difference in means of a specific milk composition of more than two means. Student t-test was used for two means and to identify categories of leading significant difference when it was found statistically significant by ANOVA. Multiple regression analysis was applied to see the confounding effects of breed and mastitis on chemical composition of milk. P-value less than 5% was considered statistically significant.

3. Results

Prevalence study

An overall prevalence of 46.9% (136 of 290 cattle) was observed. Of these 136 cows which were positive for mastitis, 108 (79.4%) was due to subclinical while the rest 28 (20.6%) was due to clinical mastitis (Table 1). When the prevalence of clinical and subclinical mastitis compared between local and cross breed cows, higher prevalence was observed in cross breed cows in both cases with prevalence of 12.9% ($\chi2 = 6.2728$, $P < 0.05$) and 47.3% ($\chi2 = 22.5048$, $P < 0.05$), respectively (Table 2).

Risk factors

Table 1: Prevalence of clinical and subclinical mastitis in cattle at cow and quarter level in and around Worabe.

Type of mastitis	No. of animals/quarters examined	Positive (%)
Cow level		
Subclinical	290	108 (37.2)
Clinical		28 (9.7)
Total		136 (46.9)
Quarter level		
Subclinical	1097	236 (21.5)
Clinical		31 (2.8)
Total		267 (24.3)

Breed, stage of lactation, milk yield, housing, feed, tick infestation, age and parity were evaluated as risk factors for prevalence of mastitis; of which breed, milk yield, housing and feeding show statistically significance difference (P < 0.05) in prevalence (Table 3).

Table 2: Prevalence of clinical and subclinical mastitis between local and cross breed cattle.

Breed					
Type of mastitis	**Cross (%)**	**Local (%)**	**Total (%)**	**χ2 or Fisher's exact**	**p-value**
Total no. of animals examined	186	104	290	-	-
Clinical	24(12.9)	4(3.8)	28(9.7)	6.2728	0.012
Subclinical	88 (47.3)	20 (19.2)	108 (37.2)	22.5048	0.000
Total	112 (60.2)	24 (23.1)	136 (46.9)	-	-

Chemical composition of milk

Table 4 shows results of milk composition of clinical, subclinical and normal milk of cross and local breeds. The calculated means of types of mastitis was analyzed and statistically significant difference was observed between types of mastitis in bringing effects on fat in cross breeds (F = 19.45, P < 0.05). The mean of the fat showed significant difference between normal (non-mastitic) and clinical mastitis (t = 3.9644, P < 0.05) and between subclinical and clinical mastitis (t = 4.3891, P < 0.05). There were also some alteration in chemical composition of milk and this showed different degrees of increment or decrement with respect to types of mastitis from the normal (non-mastitic) cows in the study area. Breed was not found as confounding factor affecting fat composition.

4. Discussion

Prevalence study

The prevalence of mastitis at cow and quarter level was observed. At cow level, overall prevalence of 46.9% (136 of 290 cows) mastitis was observed. The observed prevalence in this study was in agreement with work of Workineh [40] who reported mastitis with prevalence of 45.4% in their study on prevalence and etiology of mastitis in cows from two major Ethiopian dairies. It was higher than previous reports of mastitis in some parts of Ethiopia. As [11, 15] reported mastitis with prevalence of 24.9 and 28.2% in their respective studies in Selalle, and Bahir Dar, respectively. Similarly, Reference [24] in Malawi reported cattle mastitis with prevalence of 17.19%. However, it was lower than the works of [25, 28] who reported mastitis with prevalence of 52.78, 65.6 and 71.0% in their respective studies. The observed difference in the prevalence of mastitis among these studies could be due to difference in managemental system [3]. At quarter level, overall prevalence of 24.3% was observed. It was in close agreement with the work of [3] in their study of bovine mastitis on smallholder dairy farms (22.8%) in Bahir Dar, and [14] in large scale dairy farms (27.57%) in Thuringia-Germany.The quarter level mastitis observed in this study was higher than the work of [15] from their study (10.61%) in Selalle. According to [34] occurrence of mastitis depends on the interaction between microbial agent, host and environmental factors.

Table 3: Prevalence of mastitis compared between/among risk factors.

Risk factor	Animals examined	Positive (%)	χ2 or Fisher's exact	P-value
Breed				
Cross	186	112 (60.2)	36.9424	0.000
Local	104	24 (23.1)		
Stage of lactation				
Early	91	41 (45.1)	0.1958	0.907
Middle	137	65 (47.4)		
Late	62	30 (48.4)		
Milk yield				
Low	91	28 (30.7)	14.4892	0.001
Medium	101	52 (51.5)		
High	98	56 (57.1)		
Housing				
Poor	121	40 (33.1)	29.17	0.000
Fair	69	34 (49.3)		
Good	72	37 (51.4)		
Very good	27	24 (88.9)		
Feed				
Mixed	219	115 (52.5)	11.3240	0.001
Pasture	71	21 (29.6)		
Tick infestation				
Absent	260	118 (45.4)	2.3070	0.129
Present	30	18 (60)		
Age				
Young	16	4 (25)	0.214	0.214
Adult	223	108 (48.4)		
Old	51	24 (47.1)		
Parity				
1 and 2	132	53 (40.2)		
3 and 4	112	65 (58)	0.023	0.310
5 and 6	41	16 (39)		
7 and 8	5	2 (40)		
Total for each	290	136		

Therefore, the difference in the prevalence of mastitis both at cow and quarter level might be associated with difference in interaction among host, agent and environment in the different study areas. Clinical mastitis was observed at prevalence of 9.7 and 2.8% at cow and quarter level, respectively. Prevalence of clinical mastitis at cow and quarter level in the current study was higher than work [15] who reported clinical mastitis with prevalence of 1.8 and 0.51% at cow and quarter level, respectively. The cow level prevalence observed in this study was higher than prevalence of 4.4, 3.6 and 3% reported by respective studies.

Table 4

.	**Cross breed**					**Local breed**			
	No. of observations = 74						**No. of observations = 24**		
Component of milk (%)	**N**	**C**	**S**	**P-value**	**F-test**	**N**	**S**	**P-value**	**F-test**
Fat	6.024615	2.53375	6.0665	0.0000	19.45	5.676	5.377143	0.7458	0.11
SNF	9.274615	8.64875	8.99225	0.5475	0.61	9.493	9.195	0.7413	0.11
Protein	3.510769	6.59875	3.3135	0.1441	1.99	3.514	3.742857	0.8161	0.06
Lactose	5.173077	4.76125	4.91175	0.8396	0.18	5.297	4.981429	0.9542	0.00
Ash	0.6984	0.6425	0.6535	0.4013	0.92	0.713	.6871429	0.8301	0.05

N = Non-mastitic, C = clinical mastitis, S = subclinical.

Of [34] in different study areas. However, it was lower than the work of [25, 28] who reported clinical mastitis with prevalence of 26.5 and 22.4%, respectively. Subclinical mastitis was observed with prevalence of 37.2% at cow level. It was in close agreement with prevalence of 34.6, 36.7 and 38.1% reported by [1, 25]. The authors [2, 15] also reported subclinical mastitis but with prevalence of 25.22 and 22.3%, respectively. At quarter level, subclinical mastitis was observed with prevalence of 21.5% in the present study. The result of current study was in line of agreement with the work of [2] who reported quarter level subclinical mastitis with prevalence of 22.8%. [8] reported quarter level subclinical mastitis with prevalence of 44.17% from Pakistan; therefore, this was lower when compared with the report from Pakistan. However, it was more than two fold when compared with work of [15]) who reported subclinical mastitis with prevalence of 10.1% at quarter level. The higher prevalence of subclinical mastitis both at cow and quarter level in Ethiopia is due to the little attention given for subclinical form of mastitis than clinical mastitis, and efforts have been concentrated on the treatment of clinical cases [19] while the high economic loss could come from subclinical mastitis.

Risk factors

Breed

The higher prevalence of mastitis (60.2%) observed in cross breed cows than in local breeds (23.1%) was in line with the report of author [2] which might be due to difference in anatomical structure of the teats and difference in genetic resistance to disease (Radostits and his colleagues2007). When prevalence of clinical mastitis was compared between cross and local breed cows, the prevalence was 12.9 and 3.8% in cross and local breeds, respectively. In line with prevalence of mastitis between breeds in the current study, author [2] reported occurrence of clinical mastitis in cross breed cows (3.9%) but none in the local breed cows. This can also be associated with difference in milk yield as cows with high milk yield have gene which makes them more susceptible to mastitis author [35].

Stage of lactation

Highest prevalence of mastitis (48.4%) was observed in cows at later stage of lactation. It was in agreement with work of author [22], and [31] who reported higher prevalence of sub-clinical mastitis for cows in mid and late stage of lactation. However, [9, 29] reported higher prevalence of mastitis in early stage of lactation. The variations in the effect of stages of lactation among different studies could be related probably to disparities in age, parity and breed of the sampled animals as indicated by author [15].

Milk yield

Mastitis was observed at highest prevalence (57.14%) in high yielding cows followed by medium yielding (51.49%) and less prevalent in low yielding (30.77%). The result in the current study was in agreement with the work of authors [25,37] who reported highest prevalence of mastitis in high milk-yielding cows in Asella. The similarity in prevalence of mastitis taking milk yield as a risk factor might be associated with the fact that higher-yielding cows have been found more susceptible to mastitis owing to position of teat and udder susceptible genes making them prone to mastitis author [35], and due to less efficacy of phagocytic cells in higher yielding cows associated to dilution author [36].

Housing and feeding

The current study indicated that housing system had significant effect on prevalence of mastitis. The highest prevalence (88.9%) was observed in cows kept in very good housing condition and prevalence decreases when the housing condition was getting poor. It was in line with the work of author [14] who reported higher prevalence of mastitis in tie-stall housed cows in Thuringia, Germany. However, author [15] reported higher prevalence in cows living in poor housing system. Feed had also got significant effect on prevalence of mastitis with more prevalence in cows fed with mixed feeds of different types (52.5%) than cows fed with pasture and hay. Generally, cows in good housing system have less chance to get their udder contaminated and to get mastitis. However, the result in this study might be due to management practice applied to different breeds of cattle. Cross breeds are kept mostly for dairy purpose and are more susceptible; so desire better management, feeding and housing. Therefore, the higher prevalence of mastitis might be due to confounding effect in the managemental practices given for different breeds.

Tick infestation

Higher prevalence was observed in cows infested with tick; but there was no statistically significant difference in prevalence of mastitis between the two groups of cattle. This might be due to seasonal occurrence of ticks in the study area. However, according to author [25], prevalence of mastitis can be affected by tick infestation of the udder.

Parity

In the current study, as parity increases it had a tendency towards increasing prevalence of mastitis. This is in agreement with the work of authors [22, 29], that of authors [15,25]. The author [34] has also stated that older cows, especially after four lactations, are more susceptible to mastitis.

Chemical composition of milk

Of all parameters, especially in chemical composition of milk, statistically significant difference ($P < 0.05$) was observed in the mean fat composition among the different mastitic milk. The result of the current study in fat concentration was according to [4] who described mastitis as a cause for decrease in fat composition. The author [12] also reported altered fatty acid composition of raw milk due to elevation of somatic cell count of milk caused by mastitis. However, Reference [32] indicated that fat content of milk can vary even between milking of the same cow whether diseased or not. Whether the difference in mean fat composition can be affected by breed was tested; breed was not found as confounding factor affecting fat composition. However, according to [27,2] and author [35]composition of milk can be affected by breed.Alteration in chemical composition of milk and different degrees of increment or decrement with respect to types of mastitis from the milk collected from normal cows (non-mastitic cows) in the present study is in agreement with different works. It is generally accepted that during mastitis, there is an increase in milk proteins [5] that has been attributed to the influx of blood-borne proteins (such as serum albumin, immunoglobulins) T [4,5] the minor serum proteins, transferring a-macroglobulin [5] into the milk coupled with a decrease in caseins [18]. The author [5]reported a decrease in fat concentration, but the majority of the authors recorded an increase in total fat content of mastitic milk [33]. It is well accepted that mastitis causes a decrease in the concentration of milk lactose [4, 5]. The ionic content of milk varies markedly from that of extracellular fluid which batches the acini of the mammary gland. Milk contains a high concentration of potassium relative to sodium, the later being actively removed from the secretary cells by an energy dependant ATPase, which is located at the baso-lateral surface of the cell [18].

5. Conclusion

Our study showed mastitis as important disease for the infant dairy industry in the study area. Breed, milk yield, housing and feeding was important risk factors precipitating occurrence of mastitis. Of the two types of mastitis, subclinical mastitis was observed at higher prevalence. Mastitis was not as such an important cause for deterioration of chemical composition of milk in the study area. Therefore, individuals, and governmental and nongovernmental institutes working on dairy production should give emphasis on control of mastitis. Furthermore, improvement of milk production by providing crossbred heifers with systemic mastitis control and prevention is very important. Even though the current and previous studies showed importance of mastitis, the economic impact is not well addressed; therefore, further study involving different risk factors, economic impact and ways to improve milk production of local breeds by overcoming risk factors other than breed should be conducted in the study area.

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