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Camel Milk Production, Prevalence and Associated Risk Factors of Camel Mastitis Inaysaita Woreda Afar Regional State, North East Ethiopia

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Abstract: *The study was conducted with the objectives of assessing the current camel milk production, determining the prevalence, major Bacterial pathogens and associated risk factor of camel mastitis. For this study 100 households and 384 camels were selected randomly. Questionnaire survey was administered to camel holder households to collect data on management practices, knowledge of camel mastitis, treatment attempts and responses, extent of veterinary service delivery, and general information on production and reproduction performances of camels. Clinical examination, CMT and bacteriological culturing were performed to diagnose the occurrence of clinical and subclinical mastitis. Data collected was analyzed using descriptive statistics and univariate logistic regression. GLM (General Linear Model) were used to examine the effect of mastitis, parity, and stage of lactation in camel milk yield. Mean milking frequency and mean lactation length was (3.03±0.731) times a day and (13.8 ± 0.19) months respectively. Diagnosis result of mastitis and stage of lactation had significant effect in milk yield ($p<0.01$). However across parity there was no statistically significant difference. Daily mean milk yield was higher (3.6 ± 0.09) in non mastitic camel than the mastitic once (2.3 ± 0.10). The results of CMT and bacteriological culture revealed that Clinical and sub-clinical mastitis were prevalent in 19 (4.9%) and 96 (25%) of the studied animals respectively. This gives an overall CMT based mastitis prevalence of 29.9% (95%CI: 24.93, 34.06) at animal level and 9.4% at quarter level. Additionally, 9 (2.3 %) camels were found with blind teats. The most important pathogens isolated from clinical and subclinical mastitis cases were S. aureus (6.6%), St. dysgalactiae (2.9%), Escherichia coli (2.2%), and S. aureus38 (27.9%), St. Agalactiae16 (11.7%) Escherichia coli (8.1%), Bacillus spp (6.6%) respectively. The univariate logistic regression showed that, among risk factors considered tick infestation ($P<0.01$), using ant-suckling device ($P< 0.05$), stage of lactation ($P<0.01$), and parity number ($P<0.05$) had significant effect in prevalence of overall mastitis.*

Keywords: *Bacterial Pathogen Camelusdromedarius, California Mastitis Test (Cmt), Lactation Length, Milk Yield, Prevalence, Risk Factors*

1. INTRODUCTION

The dromedary camel *(Camelus dromedarius)* is a multipurpose animal adapted to the harsh environments of semiarid and arid zones, essentially kept for milk and meat production and transportation. It is also a financial reserve (asset) and security (drought-prone risk management) for pastoralists and plays an important role in social prestige and wealth. Because of the increasing desertification and recurrence of drought and famine in sub-Saharan Africa, particularly in East Africa, the camel plays a very significant role as a source of milk, meat and draft power (Woubit *et al.*, 2001).

According to Food and Agriculture Organization (FAO) of United Nations, approximately there are 25 million camels in the world where the global market for camel products has a potential of US$10 billion per year. The comparative advantages of the camel as a dairy animal over the other species in the same environment are difficult to quantify; however, in absolute terms, it is widely recognized that the camel produces more milk for a longer period of time than any other animal under the same condition (FAO, 2011).

In Ethiopia camels are kept in the arid and semiarid lowlands of Borena, Ogaden and Afar regions, which cover 50% of the pastoralist areas in the country. The major ethnic groups owning camels in Ethiopia are the Somali, Borena and

Afar. Milk of camel is one of the main components of the diet of the nomads in Ethiopia and is consumed in its raw or naturally processed (soured) form (Woubit *et al.*, 2001). According to Behnke (2010)as cited in (Abdi *et al.*, 2011) Ethiopia camel population was estimated to be 2.4 million distributed around the country. In which 458,760 are lactating camels each year with an annual milk production of 608, 315, 760 liters that roughly generates 3, 345, 736, 680 birr (Abdi *et al.*, 2011).

Despite the camel's considerable contribution to food security in semi dry and dry zones and its being a major component of the agro-pastoral systems in vast pastoral areas in Africa and Asia, little is known about its production potential and production systems compared to other domestic animals (Simenew *et al.*, 2013).

Like other dairy animals, dromedary camel could be affected by udder infection as mastitis, a complex disease occurring worldwide among dairy animals, with heavy economic losses largely due to clinical and subclinical mastitis. The last requires indirect means of diagnosis (Matofari *et al*., 2003). Evidence indicates that subclinical mastitis causes suffering of the animal, reduces milk yield, alters milk properties, impairs preservation and processing and is a public health concern for consumers of camel milk (Tibaryand Anouassi, 2000).

Bacterial infections are considered the primary cause of mastitis in domestic animals. The causative agents of bovine mastitis are well defined but as far as camels are concerned, there is paucity of information about the etiological agents associated with camel mastitis. Very little work is done concerning camel mastitis as the disease was thought to be uncommon in camels (Obeid *et al*., 1996; Almaw and Molla, 2000; Abdel, 2001). As camels has not been a subject of research, the epidemiology and pathogenesis of these mastitis pathogens remains unclear (Abdurahman, 2006). On the one hand, the disease is not usually treated in traditionally managed camels, hence takes a natural course to chronicity (Obeid *et al*., 1996). On the other hand, the traditional treatment attempts by herders are usually ineffective. These conditions may lead to chronic, often fibristic sequel resulting in permanent loss of milk production and early culling of the animals (Abera *et al.*, 2010).

Research conducted in camel in any of the disciplines is scant. May be due to the habitat of the camel which is inhospitable for researchers, lack of infrastructure and transportation and to the non-sedentary nature of the herds constantly moving in search for feed and water. In light of this the study was proposed to be undertaken in pastoral area of Ayssaitaworeda of the Afar National Regional State

Specific objectives:

1. To assess camel milk production
2. To determine the prevalence of mastitis in traditionally managed camels
3. To identify the major associated risk factors of camel mastitis in the study area
4. To identify the major bacterial pathogens cause mastitis in the woreda

2. Materials and Study Methods

2.1. Description of the Study Areas

Afar region is one of the four major pastoral regions in Ethiopia located in north eastern part of the country. The region is divided in to five administrative zones, which are further subdivided into 29 woredas. The regional population is estimated to be 1.2 million of which 90% are pastoralists and 10% agro-pastoralists. The majority of the land is rocky and the annual precipitation is low (150-500 mm/annum) which makes crop cultivation unsuitable. People in the region, therefore, depend mainly on live stock production for their livelihood. The livestock population in the region is estimated at 703,424 cattle, 1,003,000 heads of sheep, 2,014,418 heads of goats, 301,733 camels and 16,976 donkeys (LCNRDB, 2005).

The study was conducted in AyssaitaWoreda Zone 1 of the Afar Regional State (fig. 1). Asayita is bordered on the south by Afambo, on the west by Djiubti, on the north by the Awash River which separates it from Elidar, and on the east by Djibouti and 670 km far from Addis Ababa. The woreda consists of 13 Kebeles of which two are urban, five agro-pastora and and six pastoral kebeles. Livestock population of the woreda is estimated to be 115,171 animals; of these, cattle 71,383, goats 23,086, camels 16,943 and 482 equine are found in the area (Aysaita Agricultural office).

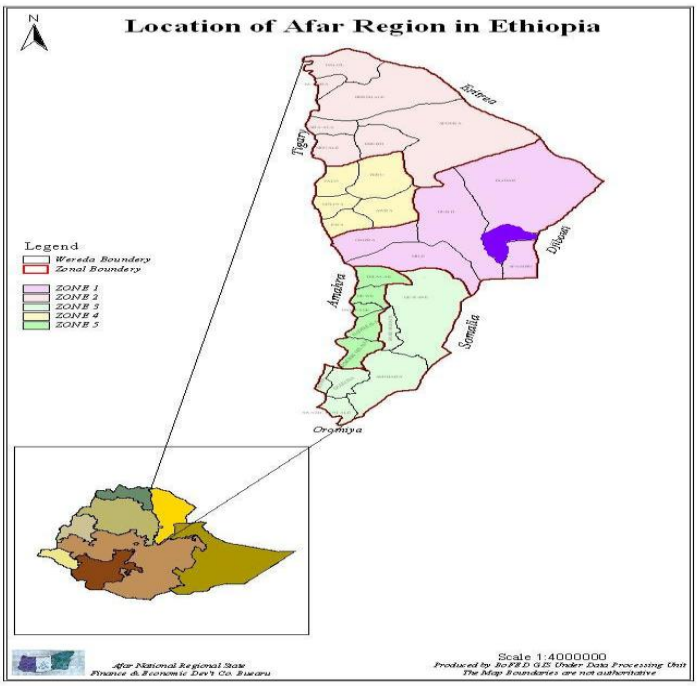

Figure1. *Afar regional map showing the study area*

2.2. Study Design, Study Animals and Sampling Procedure

A cross-sectional study design was conducted to asses camel milk production as well as prevalence of mastitis, and associated risk factors, and to isolate and characterize the major bacterial pathogens found in the milk of mastitic camels (*Camelus dromedarius)*. Five kebeles were selected purposively from 13 kebeles found in the woreda based on seasonal availability of camels with the assumption of 20 to 30 camels in one herd. Herds in 5 kebeles were taken as sampling frame. The sampling units were lactating camels in a herd. The number of camels that were sampled from a herd was determined proportionally based on the estimation of the camel population. Accordingly 384 lactating camels were selected randomly.

2.3. Sample Size Determination

Sample Size Determination for Questionnaire Survey

The sampling units were households keeping camels in the study area. The sample size required for the study was determined by the formula recommended by Arsham (2007) for survey studies as illustrated below:

$N=0.25/SE^2$

Where N= Sample size

SE= Standard Error

Hence, at 5% standard error, the total number of households selected was 100.

Sample Size Determination for Mastitis Prevalence

There is no previous investigation about the prevalence of camel mastitis in the study area. Hence, the average expected prevalence rate was assumed to be 50% for the area within 95 % Confidence Intervals (CI) at ± 5 % desired accuracy. Subsequently, the number of study animals was determined following the formula published in Thrusfield (1995).

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

Where

n= required sample size,

d= desired absolute precision,

P_{exp}= expected prevalence (50%)

2.4. Data Collection

Single Visit Formal Survey Methods were applied to collect data. Various techniques and tools such as questionnaires, record sheets and measurements were used to collect information from camel owner households and the camels.

Before milk sample collection questionnaires were administered for camel herders (n=100). Then the record sheets were filled, while taking the milk samples.

The information (questionnaire based) was collected in the villages and settlements before the animals were sent for browsing, or at watering points. The questionnaire and record sheets were pre-tested, and then modified on the

basis of the information obtained in the pre-tests. Local ethnic leaders who were known to the respondents were used to interpret and explain the questions in the course of individual interviews and discussions. These leaders were very helpful in communication between the researcher and the respondents.

The questionnaire has mainly focused on management practices, their knowledge of camel mastitis, treatment attempts and responses, extent of veterinary service delivery, and general information on production and reproduction performances of camels. Totally 100 camel owner households were involved in the questionnaire survey based on Arsham (2007) formula.

Whereas the record sheet mainly focuses in risk factors such as production system, age, parity, and milk yield, stage of lactation, tick infestation and type and application of anti-suckling devices were filled simultaneously while taking the milk sample.

Data about parity and lactation stage were gathered by interviewing the owners. The parity number record during the study was parity 1 to 9. The lactation stage 1 to 16 months, lactation stage classifies in to three categories as early (10 days to 2 months), middle (3 to 5 months), and late (>6 months) to observe whether there would be significant difference in the occurrence of mastitis during these stages.

2.5. Clinical Examination of Udder and California Mastitis Test

All udders were subjected to clinical examination for presence of swelling, lesions or anatomical malformations prior to sampling; the udder was washed, dried and the teat was disinfected with cotton moistened with 70% alcohol. After discarding the first few squirts of milk about 15 ml were collected in sterile universal bottles and kept in an icebox, and transported immediately to the laboratory for analysis (Samara Animal Health Regional Laboratory) where all the primary biochemical identification tests of the bacteria were accomplished up to genera level. The isolated bacteria were transported to Addis Ababa University College of Veterinary Medicine and Agriculture microbiology laboratory for further analysis (secondary biochemical tests).

The milk samples were examined for their consistency, color and other visible abnormalities. Clinical mastitis was recognized by abnormal milk, signs of udder infection and detection of mastitis pathogens by bacteriological culture; whereas subclinical mastitis was recognized by apparently normal milk and an increase in somatic cells as evidenced by CMT and positive culture results. CMT was used to give an indication of the number of somatic cells present in each of the milk samples.

All collected milk samples were examined for mastitis using California mastitis test. (CMT) was carried out using the method described in Quinn *et al. (*1994). Equal volumes (2 ml) of commercial CMT reagent (avatar rapid mastitis test Kit-Alvetera Gmbh-Germany) and quarter milk were mixed and the changes in milk fluidity and viscosity were observed. The interpretation of the result was done according to the method described by Quinn *et al.* (1994). Negative (0) and trace (+/-) were considered as negative and different intensities of positive (1, 2 and 3) were considered as positive (Appendix 2).

2.6. Bacteriological Isolation

The bacteriological culture was performed following the standard microbiological technique (Quinn *et al.*, 1994). One loop full of milk was streaked on 5% sheep blood agar and MacConkey agar to detect bacteria that could grow on this medium. MacConkey plates were used to detect *Enterococcus* species and any Gram-negative bacteria. Inoculated plates were incubated aerobically at 37°C for 24-48 h. Presumptive identification of bacterial isolates was made based on colonymorphologic features, Gram-stain reaction, hemolytic characteristics, catalase, oxidase and Oxidation fermentation (O-F) tests. *Staphylococci* and *Micrococci* were identified based on their growth characteristics on mannitol salt agar, coagulase production, catalase and oxidase tests. Isolates identified tentatively as *Streptococci* were evaluated according to CAMP reaction, growth characteristics on Edward's medium (Oxoid), hydrolysis of esculin and sodium hippurate, catalase production, and sugar fermentation tests. Gram-negative isolates were subcultured on MacConkey agar and further tested using triple sugar iron (TSI) agar (Merck), the IMViC test (indole, methyl red, Voges-Proskauerand citrate utilization tests), urea, lysine and ornithine decarboxylase and oxidase reactions.

2.7. Data Management and Statistical Analysis

Data on animal characteristics and herd management practices, including the results of the individual CMT result were recorded and transferred into MS-Excel spread sheet. Data

from all questionnaires were verified, rechecked and filtered. Variables with outliers and wide disparities were dropped to prevent bias in the analyses. All the collected data were stored in Microsoft excel spread sheet and transferred to SPSS version 16.0 for analysis.

The CMT screening test data obtained were analyzed to determine the prevalence (by dividing the number of CMT+ lactating camels to the total number of lactating camels tested) and distribution of disease in the lactating -camels of the study area (Thrusfield, 1995). P-value < 0.05 was considered significance.

Significance of risk factors on the prevalence of mastitis in camels were calculated through chi-square ($\chi 2$) technique to test the existence of association between CMT positive and risk factors like, parity, stage of lactation, tick infestation and anti-suckling device applied by the herders to prevent the calve from suckling the dam.

Variables those which have significant association as shown from the chi-square ($\chi 2$) and P-values with the outcome variable were selected and a logistic regression model was built to illustrate the magnitude of association between the selected factors and mastitis. This was done by delivering odds ratio, p-value and 95% confidence intervals of those selected risk factors when entered as explanatory variables a against the outcome variable (mastitis).

For the purpose of building the logistic regression model, a quarter was defined as CMT positive if it had a CMT score of 1+ or above. A lactating camels was defined as CMT positive if it had at least one quarter with a CMT score of 1+ or above, hence, all CMT scores of negative (−) were coded as 0 and all positive scores of +, ++, +++ were coded as 1. Similarly, all of the explanatory variables were coded appropriately before analysis.

GLM (General Linear Model) were used to examine the effect of mastitis, parity, and stage of lactation in camel milk yield. By computing milk yield as response variable and the diagnosis result presence and/or absence of mastitis, parity and stage of lactation were predictors. The interaction of predictor variables was assessed before computing the GLM there was no interaction effect, therefore the following model was formulated

$y_{ijk} = \mu + m_i + p_j + l_k + e_{ijk}$

Where

Yijk = Average daily milk yield (Response Variable)

μ = The overall mean

mi = Diagnosis of mastitis (positive=1, negative=0)

pj = parity (9)

lk = lactation month (3)

eijk = Error term

3. RESULTS

3.1. House Hold Characteristics

Description of household characteristics

Among the studied households, 91% were male –headed, while the remaining 9% were female headed (Table 1). The average age of the household head was 40.91 years and it range from 24 -70 years. Regarding to the age categories, 31.2% of the house hold members were in the age group between 21-45 years, 24.3% of the house hold members were age above 45 years while 17.3% of the house hold were between 11 – 20 years, whereas the remaining 27.4% of household members were less than 10 years old.

Table1. *Family size, age and sex structure of farm families of the respondents*

variable	N=100	(%)
House hold head		
Male	91	91
Female	9	9
Mean age (SE)/years	40.91(1.048)	
Age category of HH members		
≤10 years	179	27.4
11-20	113	17.3
21-45	204	31.2
>45	159	24.3
sex category of HH members		
Male	324	49.61
Female	329	50.38
AVF(SE)	6.53	0.215

AVF= Average Family Size, SE= Standard Error, HH= House Hold

3.2. Livestock Herd Composition

The livestock compositions of the sampled household in Aysaita woreda are presented in (Table 2). From the interviewed household, it was observed that the livestock species composition in the study area was cattle (16.9%), camel (40.6%), goats (41.7%), sheep (0.9%) and donkey (0.16). The mean of camel holding in the study area was 26.95 ± 2.06 heads per house hold.

Table2. *Livestock Herd Composition*

Type of herd	N= 100	Total Number	Mean ± SE	%
Cattle		1122	11.2 ± 1.08	16.9
Camel		2695	26.9 ± 2.06	40.6
Goat		2769	27.7 ± 1.69	41.7
Sheep		60	0 .6 ± 0.29	0.9
Donkey		11	0.1 ± .03	0.2
Total		6629	6.2 ± 2.7	100.0

SE= Standard Error

In (Table 3) commonly kept livestock species in the areas were including cattle, goats, sheep, camels and donkeys. Majority of the households were rear cattle, camel and goat simultaneously during wet season, goat and camel during dry season. According to the respondent's camel is preferred animal during dry season. Commonly kept livestock species in the areas were goats, camels, cattle, sheep, and donkeys in orders of preference. However, Majority of the households were rear Cattle, camel and goat simultaneously.

Table3. *Overall species distribution (%) in different kebeles of study area*

Species composition	Kebeles				
	Galifagi	Rumaitu	Hinile	Ghertu	Handeg
Camel only	43.5	7.1	10.0	6.9	10.0
Cattle and camel	11.0	7.1	18.5	13.4	33.3
Cattle, camel and goat	31.8	42.9	30.0	44.8	30.0
Camel, goat and sheep	3.0	2.0	2.0	3.8	3.0
Camel and goat	10.6	40.0	39.5	31.0	23.3
Total	100	100	100	100	100

3.3. Camel Herd Structure

Table 4 indicates total camel category in the herd and the dry camel consist maximum number 855 (31.72%) followed by heifer 703 (26.08%) milking camels 443(16.43%) female calves 338(12.54%), male calves 179 (6.6%) and camel bull the least number 177 (6.5). But the Afar pastoralists mainly depend on milk production. The percentage of lactating camel reported here is unbelievable!!

Table4. *Camel herd structure of the study area*

Herd type	Total	Mean ± SE
Milking camels	443(16.43%)	4.43 ± 0.24
Dry camels	855 (31.72%)	8.55 ±1.16
Female calves	338 (12.54%)	3.38 ±.22
Male calves	179 (6.64%)	1.79 ± .13
Bull	177 (6.56%)	1.77 ± .10
Heifer	703 (26.08%)	7.03 ± .60
Total	2695 (100%)	26.95± 2.05

SE: Standard Error

3.4. Milking Procedure and Milking Frequencies

Hand milking was the only ways of milking camels in the study area the owners prepare the milking vessel (*Amure*); as part of preparation for milking. During milking period allow the selected calf to come out from the enclosure where calves were kept separately to the open milking area where the dam was kept (not clear statement). Calf was allowed to suckle their dam for a few minutes to stimulate milk let down. Milking the camel was at a standing position with one knee raised to support the milking vessel on

his lap. While another man held the calf from suckling. Majority of the respondents (55%) milking were practiced in the morning (7:00 am) and afternoon (2:00-4:00 pm). When the dams goes far from the homestead for grazing during the day time and she back to home at afternoon. The other (45%) respondents milk their camel morning (6:00 am) and on the evening (5:30-6:30 pm).

Milking of camels is practiced in unhygienic environment which is full of dust and dung and without shade in the area. Only male members of the household are responsible for milking camels.

Milking frequency was three times per a day (3.03±0.731). As indicated in (Fig 2) Out of the total sampled camel owners (n=100), 21, 59, 16 and 4 percent of the respondents were indicated that camels are milked twice, thrice, forth and five times a day respectively. (Is that true? Why??)

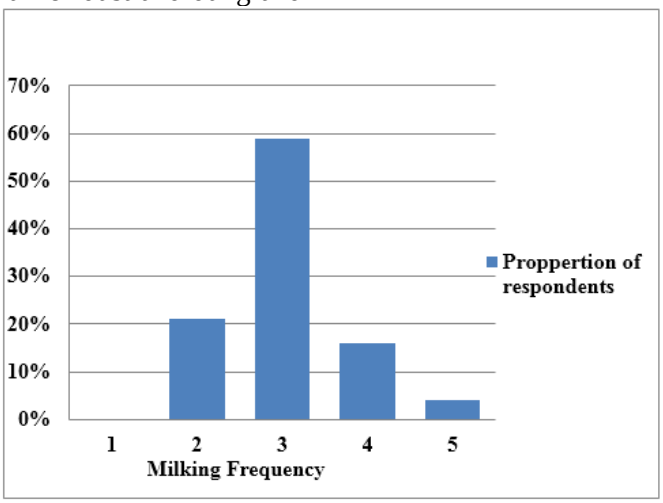

Figure2. *Average daily milk frequency of the study area*

Hygiene before and after milking was unsatisfactory, milking was accomplished in unhygienic environment, washing of the udder and teats of the dams before and after milking were not practiced. About 77% of the respondents have not an experience of washing hand before milking. Only the remaining 23 % respondents have an experience of washing hands when there is availability of water by assuming that clean hands during milking stimulate milk let down.

Table5. *Milking procedure in traditionally managed camels in Aysaita woreda of afar regional state, eastern Ethiopia (n= 100)*

Parameters	N (%)
Milking procedure	
Wash udder/teats before milking	4
Wash hands before milking	23
Let the calf to suckle before milking	95
Pre strep teats before milking as part of preparation	None

N = number of households interviewed

3.5. Camel Milk Yield

The estimated daily milk yield per camel at different stage of lactation, parity, and diagnosis result (presence and absence of mastitis) were analyzed. The result of univariate analysis of variance is summarized in (Table 7). The estimated mean daily milk yield (± SE) during early, mid and late stages of lactation was 3.3 ± 0.13, 3.0 ± 0.09 and 2.4 ± 0.14 respectively. The average lactation length of camels was between 9 – 16 months, with the average mean (± SE) of 13.8 ± 0.19 months. Daily mean milk yield was higher (3.6 ± 0.09) in non mastitic camel than the mastitic once (2.3 ± 0.10). Across parity average daily milk yield was no statistically significant association.

Table 6 Indicates diagnosis result of mastitis and stage of lactation had significant difference in milk yield ($p<0.01$). However across parity there was no significant difference.

Table6. *Variance analysis of factors affecting daily milk yield*

Source	Df	Mean Square	F	P-value
Parity	8	1.80	1.57	0.276
Mastitis	1	114.30	99.98	0.000**
Stage of lactation	2	13.80	12.02	0.000**
Error	374	1.14		
Total	384			

*** The difference was highly significant (p < 0.01).*

Table7. *Least square mean ± SE for the effect of mastitis, parity and stage of lactation on daily milk yield.*

Source	N	Mean ± SE	95% Confidence Interval	
mastitis			Lower Bound	Upper Bound
Positive	123	2.3 ± .10	2.08	2.49
Negative	261	3.6 ± .09	3.39	3.78
Parity				
1	51	3.3 ± 0.15	2.96	3.58
2	98	3.0 ± 0.12	2.81	3.28
3	78	2.7 ± 0.12	2.46	2.96
4	45	2.8± 0.16	2.50	3.14
5	38	2.9 ± 0.18	2.61	3.32
6	19	2.9 ± 0.25	2.42	3.40
7	27	2.7 ± 0.20	2.25	3.07
8	18	3.1 ± 0.25	2.25	3.67
9	10	2.8 ± 0.34	2.17	3.52
Stage of lactation				
Early lactation	78	3.3 ± 0.13	3.07	3.59
Mid lactation	244	3.0 ± 0.09	2.86	3.20
Late lactation	62	2.4 ± 0.14	2.16	2.72
Grand total	384	2.9 ± 0.08	2.78	3.08

N = number of samples, SE= Standard Error

3.6. Camel Herd Management

Distance Covered During Grazing

Livestock are congregated around rivers and cotton growing areas in the woreda which utilise dry season grazing areas Joanne *et al*. (2005). However, it is known that camels are mobile in nature and can cover over a great area for foraging than any other domestic animals. Although the area coverage during grazing depends on the season, availability of feed, adaptability and the knowledge of the area, a distance covered by the camel in searching of feed in the study area were ranges from 2-8 km during wet and extends up to 20 km in dry season. With the mean (±SE) distance of 11.6400 ±.58093

Migration

According to the information obtained from camel owners, livestock are migrated from Aysaita woreda to neighboring zones in different seasons. During *Karma* season (July-August) due to the recurrent occurrence of flooding livestock are migrate to Awra, Ewa, Teru, Chifra, Serdo, and Dichiotto. On the other hand, during *Sugum* season (March-April) livestock do not migrate out from Aysaita due to the abundance of Agricultural by-products such as crop residues which are mainly maize Stover (*Hafa*), cotton seed and availability of browse species. During the cooler *Hagay* season (Nov-Jan) pastoralist preferred to return to Aysaita, because during this time flooded water will dry up. Feed condition is better and also agricultural practices are predominantly held in the woreda.

Housing

Camels were housed in open and closed type of houses depending on age. All the respondents indicated that calves camel, and mature camel are housed separately. Mature camels were housed in the open camp around their home. Camel calves were housed in (*Gesso)* local name of enclosures made for the purpose of keeping calves separately from the rest of the herd. (*Gesso*) were constructed with wood (*Keselto*) and fencing by available piece of thorn wood (*Prosopisjuliflora*) and different bush plants. Thus types of house are constructed with the main objectives of protecting the calves from predators during night time and protect form suckling of dam. The rest of herds'were believed to protect themselves from predators.

3.7. Major Constraints of Camel Production

According to the results of interview supported with focus group discussions and field observations held in each of the study kebeles, the major constraint that hinder camel production in the woreda 47%, 35%, 11%, and 7% were listed as feed shortage, diseases, lack of market to sell camel milk products and other problems like the poor genetics of Afar camels for dairy purpose. Difficulty of road, predators, lack of transportation to transport milk from far remote areas to the market, very limited or no access to animal clinics common problems across the woreda.

Feed shortage was further constrained due to encroachment of grazing lands by inedible thorny

weeds, (Particularly *Prosopis juliflora*). Deforestation for the purpose of charcoal making,

3.8. Camel Disease

Disease is the second most important factor which hinders the livestock production in general and camel herders particularly in the study area. According to the respondents the type of diseases frequently occurred in the herds in their order of importance were Coughing (33%), Gastro intestinal disorder (24%), Skin problem (17%), Mastitis (*angubiak*) (13%), Silayto (7%) and other diseases (6%).

3.9. Mastitis Prevalence

In this study, 384 lactating camels were examined clinically as well as sub-clinically using CMT screening test with subsequent bacteriological examination. Clinical and sub-clinical mastitis were prevalent in 19 (4.9%) and 96 (25%) of the studied animals, respectively (Table 9). This gives an overall CMT base mastitis prevalence of 29.9% (95%CI: 24.93, 34.06) at animal level and 9.4% at quarter level. Additionally, 9 (2.3 %) camels were found with blind teats, and no samples were taken for CMT and culture. Hence, the animal level prevalence (32.2 %) is based on the CMT result excluding the 9 camels with blind teats. Similarly, of the total 1,536 examined teats, 11 (0.7 %) were considered as blind. Thus, milk samples were taken only from 1525 teats, out of which 155 (10.1%) teats were found to be positive for CMT.

Table8. *Major constraints affect camel production in the area*

Problems	N (%)
Feed	47 (47%)
Disease	35 (35%)
Market	11 (11%)
Others	7 (7%)

N = number of respondents

Table9. *Frequently occurred (%) diseases and their local treatments in study area*

Disease	N=100	Symptom	Traditional treatments
Coughing (*kahu)*	33	-Nasal discharge -couching -Weight loss	Restriction from water up to 7 days
Gastro intestinal disorder	24	-Abdominal pain -Diarrhea(Altered odder, color and viscosity)	-restricted consumption of lush plant species -providing with dry feeds
Skinproblem (mange)	17	-Removal of hair on the head, neck and shoulder region	-Apply oil -keep the camel in shade
Mastitis (*angubiak*)	13	-Swelling of teats -fever, unequal teats, -bloody and tangent milk secretion - hardening of teats and feel pain	- Soil form the depth mixed with water then smoothly massage the infected teat or the udder - applying roots of herb "*Ayro Weret*" in teats -udder cauterization
Silayto	7	Twists the head of camels and failed on the ground	-Drinking mixing of Pepper and salt
Other diseases	6	-	-
Total	100		

N= Number of respondents

Mastitis was prevailed in all study kebeles in different proportion Annex table (4). The higher prevalence was in Handeg (39.7%), Rumaitu (33.3%), Gehertu (31.1%) Galifagi (30.8%) and in hinile were prevailed 25.8% in descending order. However the overall prevalence of mastitis in all studied kebeles were not statically significant difference (P= 0.56, $\chi 2 = 11.274$)

3.10. Risk Factor Analysis

The association of tick infestation, anti-suckling device, stage of lactation, parity and production system with the prevalence of mastitis was showed in Table 11. Accordingly, majority of the tick infested camel udder (64.9%) and those used anti-suckling device (49.1%) were positive for mastitis. Hence, there was a higher likelihood of mastitis occurrence among camels which were tick infested (OR=14.3, 95%CI: 8.46, 24.13; P=0.000) than none infested camels. Likewise, higher likelihood of mastitis occurrence was observed in camels use anti-suckling device (OR=2.3, 95%CI: 1.33, 4.17; P= 0.003) than those not used. At early stage of lactation the occurrence of mastitis were higher likelihood (OR= 5.9, 95%CI: 3.41, 10.23; P=0.000) than mid stage of lactation. Concerning to parity, more or less prevalence of mastitis was in an increasing

manner with number of parities. The probability of acquiring mastitis infection was found to be higher in 9th parity (OR= 8.33, 95%CI: 2.08, 33.33; P=0.003), in 8th parity (OR=8.69, 95% CI: 2.90, 26.31; P=0.000) than the second parity.

Table10. *Prevalence of udder health problems at animal and quarter level*

Udder health problems	N=384	Animal level Positive (%)	N	Quarter level Positive (%)
Clinical mastitis	384	19 (4.9)	1525	29 (1.9)
Sub-clinical mastitis	384	96 (25)	1525	115 (7.5)
CMT based mastitis case	384	115 (29.9)	1525	144 (9.4)
Blind teat	384	9 (2.3)	1536	17 (1.1)
Total mastitis	384	124 (32.2)	1536	161 (10.5)

N= Number of sample

Table11. *Logistic regression on the prevalence of the overall mastitis with respect to exposure variables in studied lactating camels (N=384) univariate logistic regression*

Exposure variables	Mastitis No (%)	Non- mastitis No (%)	OR (95% CI)	P-value
Anti-suckling device				
No	95 (29.1)	232 (70.9)	1	-
Yes	28 (49.1)	29(50.9)	2.36 (1.33,4.17)	**
Tick infestation				
No	27 (11.4)	52 (35.1)	1	-
Yes	96 (64.9)	209 (88.6)	14.3 (8.46, 24.13)	**
Stage of lactation				
Early (0-2 month)	48 (61.5)	30 (38.5)	5.9 (3.41, 10.23)	**
Mid (3-5 months)	52(21.3)	192 (78.7)	1	-
Late >6 months	23 (37.1)	39 (62.9)	2.7 (1.36, 5.39)	**
Production system				
Pastoral	74 (33.9)	144 (66.1)	1.25 (0.80, 1.94)	NS
Agro-Pastoral	48 (29.1)	117 (70.9)	1	-
Parity				
1st	10(19.6)	41(80.4)	1.34 (0.55, 3.26)	NS
2nd	15 (15.3)	83 (84.7)	1	-
3rd	29 (37.2)	49 (62.8)	3.27(1.6, 6.71)	**
4th	14 (31.1)	31 (68.9)	2.50 (1.08, 5.78)	**
5th	17 (44.7)	21(55.3)	4.48 (1.92, 1.04)	**
6th	9 (47.4)	10 (52.6)	4.97(1.73, 14.28)	**
7th	12 (44.4)	15 (55.6)	4.42 (1.73, 11.3)	**
8th	11 (61.1)	7 (38.9)	8.69(2.90, 26.31)	**
9th	6 (60)	4 (40)	8.33(2.08, 33.33)	**

N= number of lactating camels.

*** The difference was highly significant (p < 0.01).*

NS= None significant

Except in parity two which have a least association and it had been considered as reference to compute the odds ratio. The result of the univariate logistic regression revealed that moreover, parity level had a significant effect on the prevalence of the overall mastitis cases. And no associations were observed between mastitis prevalence and the remaining risk factor (production system).

3.11. Bacterial Isolates

The list, number and proportion of the bacterial isolates from a total of 115 camels and 144 quarters are present in (Table12). Out of the total sample cultured 136 (94.4 %) gives bacterial growth, of which 20 (14.7%) were found from milk samples collected from clinically mastitic quarter. The dominant isolates from the clinically mastitic quarter were *Staphylococcus aureus, Streptococcus dysgalactiae, Escherichia coli, and Streptococcus agalactiae*. While 85.3% (n=116) of isolates were found from milk samples originating from camels with sub-clinical mastitis, *Staphylococcus aureus, Streptococcus dysgalactiae, Streptococcus. agalactiae, Staphylococcus hyicus, Escherichia coli and B.cereus* were commonly isolated bacterial species.

Table12. *Mastitis causing pathogens isolated from camels with clinical and subclinical mastitis*

Bacteria isolated	Num. of cases		
	Clinical	Sub -clinical	Total number (%)
Staphylococcus aureus	9 (6.6)	38 (27.9)	47 (34.5)
Staph. Hyicus	0	4(2.9)	4(2.9)
Staph. intermedius	0	6(4.4)	6(4.4)
Micrococcus spp	0	8(5.9)	8 (5.9)
Strept. Agalactiae	2 (1.5%)	16 (11.7)	18 (13.2)
Strept. Uberis	0	4(2.9)	4 (2.9)
Strept. dysgalactiae	4(2.9%)	6(4.4)	10 (7.3)
klebsiella pneumonia	2 (1.5%)	4(2.9)	6 (4.4)
Corynebacterium .bovis	0	7(5.1)	7 (5.1)
Actinomyces pyogenes	0	3(2.2)	3 (2.2)
Escherichia coli	3 (2.2%)	11(8.1)	14 (10.2)
Bacillus.cereus	0	9(6.6)	9 (6.6)
Total	20 (14.7)	116 (85.29)	136 (100)

Staphyl ococcus aureus was the most frequently recorded bacterial species accounting for (34.5 %) of all isolates, followed by *Streptococcus Agalactiae (13.2), Streptococcus dysgalactiae* (9.5), *Staphylococcus hyicus* (2.9%), Bacillus species (6.6%), *Escherichia coli* (10.2), *Micrococcus* spp *(5.9),Coryne bacterial species* (5.1%). *Staphylococcus intermidius* (4.4%), *klebsiella pneumonia (4.4), Strept. Uberis (2.9%), and Actinomycespyogenes accounted for (2.2%)* of the isolates.

Based on their origin 62.3%of the isolates from both clinical and subclinical cases were contagious pathogens (Fig3). While 37.7 % were environmental pathogens (Fig4).

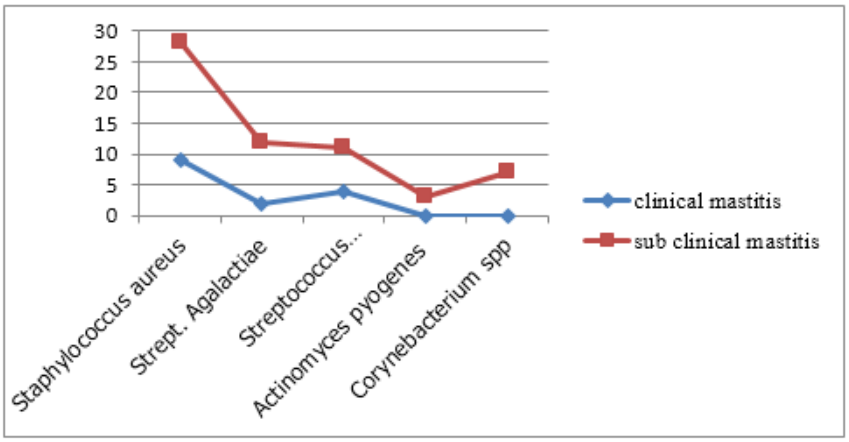

Figure3. *Prevalence of contagious pathogens in both clinical and sub clinical mastitis*

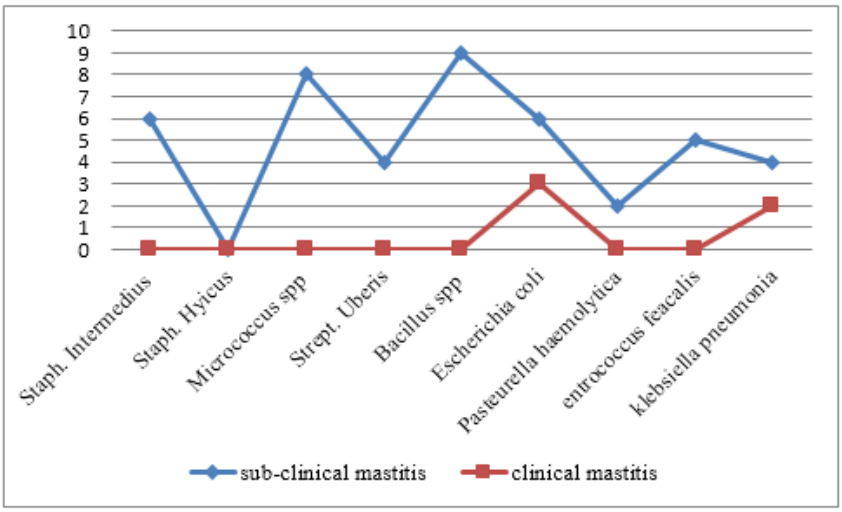

Figure4. *Prevalence of environmental pathogens in both clinical and sub clinical mastitis*

4. DISCUSSION

4.1. Livestock Herd Composition

As in most of other pastoral societies, livestock herding is the main activity of the pastoralists in the study area. The pastoralists in the area possess mixed livestock species, the composition of which varies depending on the availability of grazing pasture, browsing plants and climatic condition of the area. In terms of number, the predominant livestock species kept by the pastoralists was the goats (41.7%) followed by camel (40.6%), cattle (11%), sheep (0.6%) and donkey (0.1%) accordingly. The present result reveals to the findings of Simenew *et al*. (2013) who reported that Camel, goat, cattle, sheep and donkey are livestock species in the ranking order of their relative preference. In Afar pastoral area as is true in most of other pastoral systems camel is the best adapted animal because of its ability to resist drought and water deprivation because of their special physiological and anatomical adaptation mechanisms over other domestic livestock species.

The proportions of livestock type vary with the availability of grazing pasture and browsing species of plants. The pastoral kebele Galifagi, which were located around Aysaita Town near to the stream of Awash River and to the newly established sugar factory, was hold large number of cattle, camel and goats than the other kebeles. Whereas in Gehirtu Camels were the major livestock type found in the area since the area was dominated by bush and browsing shrubs. More over pastoralist were kept mixed herds in the study area. This result is similar to (Ramet, 1989) who noted that In Somalia pastoralists keep mixed herds with varying milking capabilities, thus assuring a continuous supply of milk throughout the year.

The pastoralists have an endogenous knowledge of risk minimization strategies which helps them to maintain their pastoral ways of life. Herd maximization and diversification are the most appropriate strategies in Afar pastoralist communities. Herd maximization provided a means for efficient utilization of available range resources. Most of the time in pastoral area there is spatiality of rainfalls as a result availability of vegetations is also highly variable from place to place. During such conditions herd maximization and diversification be coming in place to utilize the available resources.

This result is also consistent to the reported by (Kelemework, 2001) present as the different species have different feeding habits, severe degradation was avoided by maintaining a relatively low grazing density. Diversification was also economically advantageous because the different species were utilized for different purposes (Kelemework, 2001). An Afar pastoralist prefers not to sell camel, though it fetches much more market value than cattle and goats. Camels are sold only during times of crisis. Most of the time, they sold male camels. Gift of camel is a sign of high honor and is used to cement relationships between mutually dependent groups and individuals.

4.2. Camel Herd Structure

The mean camel herd size in the study area was 26.9 ± 2.06. This finding is incompatible with the previous finding of Bekelle (2010) who reported 18.4±1.8 in Borana plateau. However, this result is close to 25.2± 2.2 camels for Gabra pastoralist reported by the same author. This figure indicates how important camels to the pastoralists in the area.

From the total camel category in the herd, the dry camel consist maximum number 855 (31.7%) followed by heifer 703 (26.0%), milking camels 443 (16.4%), female calves 338 (12.5%), male calves 179 (6.6%) and camel bull the least number 177 (6.5%). Among the total number of camels owned by a given household, the number of female camels far exceeds that of male camels. The preference for more females than males is to ensure good supply of milk and reproductive potential.

The statement is also proved by majority of respondents' that milk production was major objectives of keeping camel and the strong interest to increase camel herd size and this is in agreement to reports of Yayneshet and Kelemework, (2004), Afar pastoralists have the tendency of maximize females while keeping males at the minimum number in herd structure to ensure effective breeding and food security through market exchange of livestock.

This result is also consistent with Megersa *et al*. (2008), and Getahun and Kassa (2002) in Ethiopia who reported most pastoral herds have higher proportion of breeding female 50%, and 51% respectively. Male camels are mainly used as a pack animal in the area. For the transport of people, goods and mobile houses of the pastoralists during their seasonal migration in

search of feed and water for their animals. Some respondents also rent their male camels for salt traders for transportation purpose.

4.3. Major Constraints of Camel Milk Production

Feed shortage, disease prevalence, lack of market and animal clinic were the major problems which hinders livestock production in order of importance in the study area.

This result reveals to the findings of (Alemayehu, 2001) who reported that, the major problems of camel production in (Afar and Kereyu) include disease, shortage of feed water, marketing problems and poor genetic potential of camels and it is also similar with the result reported by Ahmed (2002) noted that the major milk production constraint is lack of road infrastructure to transport milk from far remote areas to the market

4.4. Milking Procedure and Milk Yield

Hand milking was the only ways of milking camels in the study area. Before milking the calf was allowed to suckle its dam for a few minutes to stimulate milk ejection. After this, one man holds (protects) the calf while another man milks the camel at a standing position with one knee raised to support the milking vessel on his lap. Milking is practiced morning, afternoon, and evening, two to five times a day with the average mean of 3.03±0.731. This finding is consistent with Ahmed (2002) who stated that the gel-lab camel was milked on average 3.61 times a day.

Milking was practiced in an area which is fully exposed to environmental micro organisms which may contaminate milk. And only male members of the household are responsible for milking camels. This observation was strongly agreed with the findings of Eyasu (2009) who reported unlike the case in the highlands of Ethiopia where women are responsible for milking of dairy cows, in Borana usually male members of the household milk camels.

Sometimes the man washes his hand by mixing of soil and water in order to clean his hand before milking. Washing of the udder and teats of the dams before milking was not practiced. About 77% of the respondents have not an experience of washing hand before milking. Only the remaining 23 % respondents have an experience of washing hands when there is availability of water by assuming that clean hands stimulate milk let down. This result is in disagreement with findings of Eyassu (2009) who reported that**;** 39% of respondents from Borana were the experience of washing hands before milking. This difference could be due to; difference in awareness of herders about udder health problems and difference in availability and distribution of water.

The average daily milk yield per camel observed in this study (3.43 ± 0.18) is fairly in agreement with daily milk yield of Afar camel ranges from 2.01 to 12 liters per camel reported by Simenew *et al.* (2013). But the result is incompatible with the results reported by (Knoess, 1977) and Gebre-Mariarm (1987) who reported in Ethiopia camels produced about 8 liters of milk a day when milked twice a day, totaling 2,470 kg in 305 days and average daily milk yield of Somali camels ranged between 5 and 6 litres respectively. In this study, the estimated mean daily milk yield in early, mid and late stage of lactation were 4.13, 3.41 and 2.65 respectively which is much more lower than the findings of Yohanse *et al.* (2007) who reported that estimated mean daily milk yield during early, mid and late stages of lactation in Babilie and Kebribeyah was 6.41 and 5.01, 5.00 and 5.12 and 3.20 and 3.19 liters respectively. Similarly, the result of this study is lower than the previous finding reported by (Basmaeil and Bakkar, 1987) the average milk yield was 5.5 ± 1.5 litres.

The average lactation length of camels observed in this study (13.8 ± 0.19 months) was slightly higher than the values reported by Eyassu (2009) (382.7 days)**,** Bekele *et al.* (2002) (353 ± 14 days) and Kebebew and Baars (1998) (282 days) and much higher than Alemayehu (2001), which is 6 to 8 months for Afar and Kereyu camels of Ethiopia respectively. But in agreement with findings of Tezera (1998) who indicated 13 and 15 months for Shinile and Jijiga camels, respectively. The lactation length recorded in the present study is, however, shorter than the findings of Schwartz and Walsh (1992), who indicated it to be 15 to 18 months. This variation may originate from breed/type, agro-ecological and seasonal differences.

In general the great variation in camel milk production may be emanated from methods employed to determine yield, high genetic variation between individuals, breed, feeding and management conditions, type of work, milking frequency, and persistency of lactation, and stage of lactation.

4.5. Camel Feeding and Housing

Concerning to animal feed resource and camel housing in the woreda, the current observation were similar to Joanne *et al*. (2005) who reported that livestock feed comprises grazing and browsing of communally owned rain fed rangelands in Afar. The current result is also in concordance to the findings of Eyassu (2009) who noted that camels in Shinile and Jijiga zones, eastern Ethiopia were fed exclusively on natural browse; herded during the daytime on communal grazing lands and kept at night in traditional enclosures (Corral) made of thorny bushes and tree branches as protection from predators. This is similar to the Afar (*Gasso)* an enclosure where calves were kept separately from the herds, to protect suckling and to safe guard during night.

4.6. Attitude of Herders Towards Mastitis

From the field observation and questionnaire results the attitude of camel herders towards disease identification and treatment were good (they have endogenous knowledge in disease identification and treatments). Concerning to mastitis majority of the respondents (85%) was aware of mastitis as disease locally called *"angubiak"* for clinical mastitis which is higher than the findings reported by Alemayehu (2013) only 70.1% of respondents had awareness about camel mastitis in Borana. This could be due to the repeated exposure of occurrence of the disease in the study area. However 94% of respondents were not conscious of subclinical mastitis and the way of transmission and control mechanism of the disease. This result disagree with fidings of Alemayehu *et al*., (2013) who reported 57 % of respondents from Borana were do not have the awareness about the way of transmission of disease and its control This could be due to the nature of the disease which is not diagnosis directly through naked eye, loss were occurred without the knowledge of the farmers. As a result most of the herders were believed that a camel does not affected by udder disease. Rather they give more attention to diseases like coughing and gastro intestinal problems that shows clinical signs.

Therefore, the traditional hand milking and attitude of farmers towards mastitis contributes to the dissemination of mastitis and consequently milk loss in the study area. The major traditional treatments of camel mastitis (*angubiak)* in the area were deep soil from the surface and mix with water then smoothly massage the infected part and also use roots of herb "*AyroWeret*" to apply in the infected teat or udder. Cauterization of udder is also common practice in case of clinical mastitis.

4.7. Mastitis Prevalence

The overall prevalence of mastitis (32.50%) and 10.1% clinical mastitis are in agreement with Bekele (2010) who reported the overall mastitis at animal level in Borana, lowland of Ethiopia ranges from 28.6% to 37% and the clinical mastitis 10% respectively. But the overall prevalence of mastitis reported by Bekele and Molla (2001), Fasil *et al*. (2010), Eyassu, *et al*. (2010), Alemayehu *et al*. (2013) were 59.8%, 66%, 75.5, and 44.8 respectively which are greater than the findings of present study. Almaw and Molla (2000), and Abera *et al.* (2010) reported (2.1%) and 29% respectively of mastitis prevalence in lactating camels in north eastern Ethiopia. Prevalence rate of 4.9% for clinical mastitis, in this study was lower than the prevalences of 19.5%, 12.5%, and 8.3%, reported by Obeid *et al.* (1996) Bekele and Molla (2001), and Abera *et al*. (2010), respectively. On the other hand, lower clinical mastitis of 2.1% was reported by Woubit *et al.* (2001). According to Alemayehu *et al* (2013) the CMT-based quarter level prevalence of camel mastitis in Borana Zone, Oromia Regional State, Ethiopia was 22.3 % which is higher than the present prevalence.

The overall prevalence of camel mastitis observed at camel and quarter level was low compared to the results of previous studies in other parts of the country. This could be due to difference in breed used, management system employed and Agro-ecology Chafe *et al*. (2008). Occurrence of mastitis may be influenced by some heritable characteristics such as capacity of milk production, teat structure and udder conformation as well as genetic variation in disease resistance among breeds (Abdurahman, 1995).

4.8. Potential Risk Factors

In traditional husbandry practices of the study area, anti-suckling device, fibers from plants or strip of cloth are tied to the teat to prevent the calf from suckling the dam. The present finding is consistent with the findings of Almaw and Molla (2000) who reported that camel herders in the Afar tie the teats with soft bark to prevent the calf from suckling when calves began to herd together with their dams. It is also observed that they apply cattle dung in to udders of lactating camels

and put sticks in to the nostrils of calves to prevent suckling.

The udder is a predilection site for tick infestation which causes skin and teat lesions, facilitates bacterial entry and leaves behind permanent tissue damage (Woubit *et al.* 2001). In the present study the incidence of mastitis was higher in tick infested (64.9%) than non infested (11.4%) udders. This result is consistent with Obeid *et al.* (1996) who indicated that heavy tick infestation of the udder, harmful treatment of affected quarters by cauterization and use of anti-suckling device could be some of the factors, which predispose camel udders to bacterial infection. Similarly, Woubit *et al.* (2001) reported high prevalence of mastitis in dromedary camels in Borena. The apparently high prevalence of mastitis in the camel herds examined might be attributed to the high tick infestation rate.

The result of univariate analysis revealed that the parity level had a significant effect on the prevalence of the overall mastitis cases. This result is consistent with the findings of Abera *et al.* (2010) and Riyadh *et al.* (2011) who reported age and parity number affected mastitis prevalence, there was an increasing trend of mastitis prevalence with increasing parity number and the risk of subclinical mastitis increased significantly with parity and the early stage of lactation. The possible reasons could be as the age (parity) of the camels increase physiological defense mechanisms of the udder or the milk reduce, so that minor pathogens and opportunistic organisms get access to the glandular tissue and cause inflammation of mammary gland (Abera *et al*., 2010).

Moreover the treatments for the cure of the disease may not be effective, as a result the camels may persistently infected or diseases may persist up to next parity. The other possibility is that as the time of exposure to wards different risk factors increase the probability of having an infection is also increase.

The first stage of lactation could be associated with decreased resistance of mammary gland to infection as result of immune depression following the stresses and hormonal changes that occur around the time of parturition and onset of lactation may leads to high prevalence of subclinical mastitis (Sordillo, 2005; Burvenich *et al*., 2007).

Production system does not have significant effect in prevalence of mastitis in present study. This may be due to the similarity of camel husbandry practices. The management of the camel owner households was largely similar.

4.9. Bacterial Pathogens

Gram positive cocci were the main bacterial isolate in mastitis cases. *S. aureus,* was identified as the most common bacteria. The organism constitutes 47 (34.5%) of the total isolates. This finding is in line with that reported by Karmy (1990), Obeid *et al.* (1996), and Fasil *et al.* (2010), who reported (34.4%), (31.5%) and (28%) respectively. The result also agrees with the report of Abdurahman (1995) that CNS and *S. aureus* represented 61.1% and 38.9%, respectively of the total isolates and considered as the main organisms that cause mastitis in the Bactrian camel.

The high prevalence of S. aureus may be attributed to wide distribution of the organisms inside the mammary gland and the skin of teats and udder and its frequent colonization teats (McDonald, 1997). From the overall mastitis cases *Streptococcus* constitutes (25.4%) of which *St. dysgalactiae and St. Agalactiae* were prevailed 13.2 % *and 9.5%* isolates respectively. This finding agrees with that reported previously (Abdurahman, 1995; Woubit Salah *et al*., 2001). *St. agalactiae* and S. aureus were reported to be the most common causes of camel mastitis in eastern Sudan (Obied *et al*., 1996) and Kenya (Younan *et al*., 2001).

The commonly isolated genera of bacteria Staphylococcus, Streptococcus, Coryne bacterium, Bacillus, and Escherichia in this study agree with Sibtain *et al.* (2011), Bekele and Molla (2001), Sena *et al*. (2001), Younan *et al*. (2001), Matofari *et al*. (2005), Abdurrahman (2006), Kalla *et al*. (2008), and Abera *et al*. (2010) who found Staphylococcus, Streptococcus, and Escherichia as major mastitis causing pathogens.

The results of investigations carried out by Obied *et al*. (1996), Almaw & Molla (2000), Sena *et al*. (2000) and Abdel Gadir *et al*. (2005) showed that coagulase positive (CPS) and negative staphylococci (CNS) are the bacteria most frequently isolated from camels and can be considered as main reason for subclinical mastitis in dromedaries.

The gram negative bacteria constituted 14.6% of the isolates of which E.coli was 10.2% of the isolates. This result is consistent with findings of Fasil*et al.* (2010) who reported that, E.coli

represents 11.8% of isolates in mastitic camel milk.

Based on their origin 60.1%of the isolates from both clinical and subclinical cases were contagious pathogens. While 39.1 % were environmental pathogens. This could be due to unhygienic milking practice in the study area.

5. Conclusions and Recommendations

Feed shortage and disease prevalence were pre dominant factors which hinder livestock production and productivity. The livestock species which are commonly kept in the study area were goat, camel, cattle, sheep and donkey in descending order. Among them, camels were mainly kept for milk production and reproduction. It produces valuable amount of milk for long lactation length under harsh environment. This study reveals moderate to high prevalence of mastitis at camel and quarter level in the study area and mastitic camel was prone to daily milk yield reduction than the non mastitic once. The potential risk factors like tick infestation, anti-suckling device, parity and stage of lactation were highly associated with the overall mastitis cases. Gram positive cocci were the main bacterial isolates in mastitis cases. Staphylococcus and Streptococcus species were the dominant bacterial isolates in the study area.

Based on the above conclusion the following points are forwarded as recommendations

- ✓ Integration of livestock feeding with crop production and conventional feeds like Molasses Urea Block (MUB) from the recently established Sugar Factory (using by products as source of livestock feed) minimize feed shortage problems
- ✓ As in other pastoral parts of Ethiopia camel herders have no access to animal clinic in the study area. Thereforeit is further advocated that mobile animal clinic is necessary to improve udder health and camel milk production.
- ✓ To change and improve the livelihood of the pastoral and agro -pastoral communities by improving camel milk production, awareness creation on camel mastitis (particularly sub clinical mastitis) for herders, animal health workers and clan leaders through consistent training which centered on the indigenous knowledge should be practiced continuously.
- ✓ In order to reduce the high prevalence of contagious and environmental mastitis in the area, following mastitis control program, improved milking hygiene, prevention of skin lesions, culling of chronic mastitis carriers, and treating of clinically infected she-camels should be practiced.
- ✓ Further research should be done to investigate the performance of Afar camel as dairy animal, economic loss due to mastitis at animal level, moreover, investigation on mastitis causing pathogens at molecular level and their association with potential risk factors is necessary

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