# INTRODUCTION

Milk is an ideal food for human being irrespective of ages and undoubtedly the most important one among the foods of animal origin. Goat milk is highly nutritious and has a similar nutritional profile to those of human's breast milk (Islam *et al*., 2011). Milk is a very nutritious food that is rich in carbohydrate, proteins, fats, vitamins and minerals. However, health risk to consumers can be associated with milk, due to the presence of zoonotic pathogens and antimicrobial drug residues. The quality of milk may be lowered by a number of factors such as adulteration, contamination during and after milking and the presence of udder infections (Abera *et al*., 2010).

Mastitis, which is an inflammation of the mammary gland, is among the most important diseases in the dairy animals. Mastitis in dairy goats, like mastitis in dairy cows, is a disease of considerable economic importance Worldwide (Ali *et al*., 2010).

Several pathogens have been reported to cause mastitis in goats while Staphylococcus spp. is the most frequently diagnosed causal microorganisms. Other pathogens such as *Streptococcus spp.*, *Enterobacteriaceae*, *Pseudomonas aeruginosa*, *Mannheimia haemolytica*, *Corynebacteria*, and fungi can produce intra-mammary infection (Megersa *et al*., 2010).

Contagious mastitis can be divided into three groups:

1- Clinical mastitis

2- Sub-clinical mastitis

3- Chronic mastitis

**1- Clinical mastitis:-**

Characterized by the presence of gross inflammation signs (swelling, heat, redness, pain). Three types of clinical mastitis exist (Otto *et al.*, 2007).

**1.1- Per- acute mastitis**

It is characterized by gross inflammation, disrupted functions (reduction in milk yield, changes in milk composition) and systemic signs (fever, depression, shivering, loss of appetite and loss of weight).

**1.2- Acute mastitis**

It is similar to per acute mastitis, but with lesser systemic signs (fever and mild depression).

**1.3- Sub-acute mastitis**

In this type of mastitis, the mammary gland inflammation signs are minimal and no visible systemic signs.

**2- Sub-clinical mastitis:-**

This form of mastitis is characterized by change in milk composition with no signs of gross inflammation or milk abnormalities. Changes in milk composition can be detected by special diagnostic tests (Otto *et al.*, 2007).

3- **Chronic mastitis:-**

This inflammatory process exists for months and may continue from one lactation to another. Chronic mastitis for the most part exists as sub-clinical or acute form, which last for a short period (Otto *et al.*, 2007).

Diagnostic methods have been developed to check the quality of the milk through detection of mammary gland inflammation and diagnosis of

the infection and its causative pathogens. Currently, assays often used include measurement of SCCs, enzymatic analysis, California Mastitis Test (CMT), Bromo Thymol Blue (BTB), modified whiteside test, trypsin inhibition test, milk pH, and electric conductivity. colourimetric and fluorometric assays have been developed for measuring the concentrations of enzymes elevated in milk during mastitis (e.g. NAGase or LDH). Use of culturing techniques signal for the detection of mastitis-causing microorganisms is still the gold standard, although it is very labor-intensive and therefore expensive. Ethidium bromide ]penetrates and intercalates with nuclear DNA, and the fluoresecent generated is used to estimate the SCC in milk. It is rapid and automated. The device is expensive and complex to use (Awale *et al.*,2012).

Poor management and sanitary conditions, lack of therapeutics and control measures like pre and post milking teat dipping are some major factors which play vital role in the development of this disease in goats. Owing to immense importance of dairy goat milk, it is imperative to provide disease free -wholesome milk to the consumers. Though in developed countries proper strategies of disease monitoring and control have been developed (Ali *et al*., 2010).

Mastitis causes significant loss to dairy farmers as a result of decreased milk production, decreased milk quality, and increased culling rate of animal and the substantial cost of treating affected animal (Kwanashie *et al.*, 2012).

Milk and milk products have the potential to transmit pathogenic organisms to humans. All the nutritional components that make milk and milk products an important part of the human diet also support the growth of pathogenic organisms. Milk can transmit tuberculosis, brucellosis,

diphtheria, scarlet fever, and Q fever to humans. Fortunately, over the decades, the threat of these diseases and the incidence of outbreaks involving milk and milk products have been greatly reduced due to improved sanitary of the milk production practices and pasteurization technique. However, a variety of microorganisms still contribute to illnesses and disease outbreaks (Abdelhameed *et al*., 2006).

In the Sudan cows and goats are the most important species involved in milk production; together they provide nearly 90% of the milk output. Disease prevention has to be adjusted to the management system and the disease pattern in the herd. The farming system by itself is a major factor determining the health problems of dairy cattle and other aspects of their welfare, partly through housing and equipment and partly through management and handling practices, inadequate ventilation is highly ranked in the case of indoor systems but values of risk are very different and much higher in the case of tie-stalls. Light level and duration have a very low risk probability and magnitude values when compared with other hazards. Poor air quality was rated as a hazard with a large magnitude of the adverse effect in all types of indoor housing and the risk or hazards associated with housing/environment conditions have much lower magnitude of the adverse effect than for cows housed indoors. The largest risk estimates for cows at pasture for behavioral problems were associated with inappropriate temperature and humidity (Salih *et al.*, 2010).

## The objectives of this study were:-

1. To estimate the prevalence of sub clinical and clinical mastitis in goats in Khartoum state

2. To investigate the potential risk factors which are associated with the disease in goats in Khartoum state.

# Chapter one

# 1. LITERATURE REVIEW

1.1. Definition:-

Mastitis is the inflammation of mammary glands with physical, chemical and microbiological changes characterized by an increase in somatic cells, especially leukocytes in the milk and by the pathological changes in the mammary tissue. Generally, mastitis occurs in two forms which includes clinical (overt) and sub-clinical (inadvertent). In the clinical mastitis all the five cardinal signs of udder inflammation (redness, heat, swelling, pain and loss of milk production) are present, while the sub-clinical form is bereft of any obvious manifestation of inflammation. Mastitis is recognized as the most important and costly disease of dairy animals worldwide but also posses the risk for the transmission of milk borne zoonotic diseases (Sarker and Samad , 2011).

The nutritional components that make milk an important part of the human diet also support the growth of pathogenic micro organisms coming from milk contamination or from animal infections. Mastitis is the total or partial inflammation of the mammary gland provoked by one or more pathogenic microorganisms, which can appear either in clinical or subclinical forms. The subclinical one is a form of the disease in which there is neither detectable change in the udder nor observable abnormalities in milk. However, the presence of microorganisms in milk usually can be demonstrated by microbial culture, and inflammatory changes in the milk can be detected by special methodologies such as somatic cell count. Staphylococcus spp. are the most frequently diagnosed microorganisms responsible for intra mammary

Infection in goats and sheep (Santos *et al.*, 2009).

Mastitis pathogens have been classified as either contagious or environmental. In essence, the contagious pathogens can be considered as organisms adapted to survive within the mammary gland, and can establish infections to trigger inflammatory response, which are typically manifest as an elevation in the somatic cell count of milk from the affected quarter. In contrast, the environmental pathogens are best described as opportunistic invaders of the mammary gland, not adapted to survival within the host; typically they "invade" the udder when the teat orifice is open, e.g. at or soon after milking or after teat damage (Deleless *et al*., 2010).

Mastitis is a serious concern to both meat and milk producers since the infection can lead to considerable economic losses due to reduction in milk yield, decreased milk quality and treatment costs (Nathawat *et al.*, 2013).

## 1.2. Epidemiology:-

A cross-sectional study on mastitis in lactating goats was undertaken to estimate the prevalence, associating bacterial pathogens, and their antimicrobial resistance patterns in the Southern Rift Valley Region of Ethiopia. Of the 340 lactating goats physically examined, 8 (2.4%) showed clinical mastitis. Among the 680 milk samples collected from the 340 lactating goats, 278 (40.9%) were California mastitis test positive, and on culturing, 250 (89.9%) yielded bacterial growth. The main bacterial pathogens isolated were coagulase-negative *staphylococci* (CNS) (9.6%), *Staphylococcus aureus* (12.8%), and *Bacillus* (13.8%) and *Corynebacterium* (10.9%) spp. Other bacteria isolated include *Streptococcus agalactiae, Streptococcus dysgalactiae, Klebsiella pneumoniae, Enterobacter aerogenes, Escherichia coli, Pasteurella*

(Mannheimia) *haemolytica*, and *Micrococcus spp*. (Wakwoya *et al.*, 2006).

In the study to investigate the periodic prevalence, etiology and some epidemiological features of sub-clinical mastitis in ewes in the Tabriz region, milk samples from 260 lactating ewes were aseptically collected for bacterial and California mastitis test (CMT). An association was observed between the occurrence of subclinical mastitis and the age of ewe. The periodic prevalence rate of SCM was 9.23%. *Staphylococci* were the most prevalent bacteria, representing 88.4% of the isolates. Coagulase-negative *staphylococci* (CNS) (69.2%), was the most prevalent species followed by *staphylococcus aureus* (19.2%). Escherichia coli and *Corynebacterium bovis* was the second bacterial group in importance according with the distribution among flocks representing 8% and 8% of the isolates (Beshti *et al*., 2010). Another study was conducted to investigate the factors that influence the udder health status of dairy cows in Thuringia-Germany. A total of 64542 udder quarter and whole milk samples of which 56950 were udder quarter samples and 7592 were whole milk samples, from 10741 dairy cows in 48 dairy farms in the state of Thuringia were collected and subjected to microbiological investigations. The prevalence of infection was 27.57% of the quarters and 49.59% of the whole milk samples. *Staphylococcus aureus* and Coagulase Negative *Staphylococci* (CNS) were the most frequently isolated contagious pathogens. Whereas, *Streptococcus dysgalactiae* and Esculin Positive *Streptococci* (EPS,environmental pathogens), showed a prevalence in the udder and udder quarter samples of 12.90/13.90% and 9.0/10.60% respectively (Fadlelmoula *et al*., 2007).

Also a study was conducted at Kafta Humera and Tanqua Abergelle Districts from April to June, 2011 to assess the prevalence of subclinical

mastitis in lactating small ruminants and identify bacterial causative agents (Gebrewahid *et al*., 2012). A total of 390 lactating animals comprising 255 goats and 135 sheep were randomly selected from population and screened for evidence of subclinical mastitis. The overall prevalence of subclinical mastitis was found to be 18.03% (46/255) and 28.14% (38/135) in goats and sheep, respectively. California mastitis test (CMT) positive milk samples were subjected to bacteriological examination and the following bacteria were isolated; coagulase negative *Staphylococcus* (44.7%), *Staphylococcus aureus* (27.7%), *Escherchia coli* (17.0%) and *Streptococci* (10.63%).

Another study was carried out to investigate the presence of pathogenic bacteria in raw goat milk by using *Staphylococcus spp*. as indicator bacteria, and also to evaluate the potential risk factors associated with them. Information regarding potential risk factors was collected by questionnaire. The conventional bacteriological method for bacterial isolation and the indirect test (California Mastitis Test (CMT)) for determining udder inflammation status were employed. A sample size of 300 udder halves milk samples from three commercial dairy goat farms in the Bogor District, West Java Province, Indonesia were investigated for counts and prevalence of indicator bacteria. Ten potential risk factors were also evaluated in relation to counts and prevalence of indicator bacteria. The results showed that the median value of indicator bacterial count from overall udder-half milk samples was 3.00 log cfu/ml. The indicator bacterial count from udder-half milk samples was significantly different ($P<0.05$) among farms. Overall prevalence of *Staphylococcus spp*. was 78.7%. As one of potential risk factors, udder inflammation status was found to be risk factor for *Staphylococcus spp*. contamination in milk. Udders with inflammation had significant association and a higher chance of having contaminated samples by

*Staphylococcus spp.* as compared to udders without inflammation. Additionally, according to these study results, CMT can be used as an effective, reliable, cheap and "farm and farmer friendly test" for test of intramammary infection (IMI) or sub clinical mastitis in dairy goats (Taufik *et al*., 2008).

Also in another study, a total of 230 dairy cows in Tanzania were designed with the aim of elucidating the prevalence and cause of bovine intra mammary infections (Kivaria *et al* 2006). The most important microorganisms detected from quarter samples were *Staphylococcus aureus* (48%), *Streptococcus agalactiae* (17.6%), *Candida albicans* (7.2%), *Streptococcus pyogenes* (7.2%), *Escherichia coli* (4.1%), *Arcanobacterium pyogenes* (3.6%) and *Pseudomonas aeruginosa* (3.0%).

A cross-sectional study was designed to find the prevalence of sub clinical mastitis in goats in Kohat (Pakistan). Based on Surf Field Mastitis Test and California Mastitis Test, it was observed that prevalence of mastitis were higher in goat having age 2-4 or more than 4 years and had completed 3 or more than 3 lactations. On the basis of milking technique, prevalence of mastitis was higher in folded thumb method as compared to whole hand method. Teddy and Desi breeds were found to be more susceptible than Beetle breed. Based on sanitation, mastitis prevalence was higher where sanitary conditions were poor. Similarly, prevalence was high in those cases where teat injury was present in goats (Ali *et al.*, 2010).

Another study was conducted to determine prevalence of bovine mastitis, identify predominant bacteria responsible for mastitis infection and assess potential risk factors associated with the disease. A total of 460 lactating Boran breed cows from both pastoral and agro-pastoral set up of the district were included in the study. California Mastitis Test

(CMT), clinical examination of udder and teats and bacteriological examination were employed during the study period. The overall prevalence of mastitis at a cow level was 59.1% (272/460), from which 21.1% (97/460) and 38.0% (175/460) were clinical and subclinical, respectively. The quarter level prevalence of the disease was also 38.7% (712/1840) from which 13.4% (246/1840) and 25.3% (466/1840) were clinical and subclinical form, respectively. Among the cause of bovine mastitis in the study area *Staphylococcus* species, *Streptococcus* species and *E. coli* were leading infectious causes with relative percentage of 29.2%, 22.5% and 11.4%, respectively. All the potential risk factors considered in this study namely, parity ( $^2$ = 83.6, p = 0.00001), age ( $^2$= 16.4, p = 0.0003) and stage of lactation ( $^2$ = 14.1, p = 0.0009) showed very highly significant effects on prevalence of mastitis in the present study. Thus, high prevalence was observed in older cows >10 years and cows with parity >7 calves. In general, management practices and hygiene of dairy environment in all studied pastoral associations were very poor. Adequate sanitation of dairy environment, proper attention to health of mammary gland, regular screening tests and awareness of the people of the area about the disease should get emphases as control strategies and antimicrobial sensitivity tests for the isolated bacterial species were recommended for further study (Adane *et al*., 2012).

A study was undertaken to determine the udder-halve-wise comparative prevalence of clinical and sub-clinical caprine mastitis with their associated bacterial pathogens during the period from January to May 2010 (Sarker *et al.*, 2011). The teat and udder of a lactating population of 1025 Black Bengal goats maintained under rural (village) condition in two different districts (Joypurhat and Mymensingh) of Bangladesh were physically examined, of which 54 (5.27%) goats had

clinical mastitis which constituted as experimental animals for this study. Of the 54 selected goats, 59 (54.63%) udder-halves were affected with clinical mastitis whereas the remaining 49 (45.37%) udder-halves of the selected goats were found physically normal. Out of 59 udder-halves, 49 (90.74%) were unilaterally and 5 (9.26%) were bilaterally affected with clinical mastitis. The prevalence of clinical mastitis was found significantly ($p < 0.01$) higher in left udder-haves (H = 47; 79.66%) in comparison to the right (H = 12; 20.34%) udder-halves. Milk samples collected from all the 108 udder-halves were examined bacteriologically, of which 102 (94.44%) udder-halves had bacterial infection. No significant differences were observed on the status of bacterial pathogens between clinically (H = 55; 93.22%) and sub-clinically (H = 47; 95.92%) affected udder-halves, and between the single (CH = 45; 76.27% and SCH = 35; 71.43%) and mixed (CH = 10; 16.95% and SCH = 12; 24.49%) bacterial infections in both the clinical and sub-clinical mastitis udder-halves.

In Australia, a study of sub-clinical mastitis and associated risk factors on dairy farm in New South Wales found that the average herd prevalence of SCM among the 189 respondents was 29%. Farmers who had herds with a low prevalence (20%) cows with individual somatic cell count (ISCC)  105 cells/mL) more frequently wore gloves during milking (26% vs 62%), used individual paper towels for udder preparation (16% vs 62%), and fed cows directly after milking(47% vs 87%) and more frequently treated cows with high ISCC(69% vs 80%) than farmers who had herds with a high prevalence of SCM (30% cows with ISCC  105 cells/mL). The latter more often used selective dry cow therapy (52% vs 24%), compared with low prevalence herds ( Plozza *et al.*, 2011).

A cross- sectional study was conducted from November 2008 to April 2009 in Hawassa town, southern Ethiopia to determine the overall mastitis prevalence and identify the role of potential risk factors in 183 randomly selected small holder lactating dairy cows of 53 high grade xHolstein Friesian, 113 Holstein-indigenous zebu cross and 17 indigenous zebu breeds (Moges *et al.*, 2012). Of the total 183 lactating smallholder dairy cows examined for bovine mastitis 9(4.9%) had clinical mastitis, while 56(30.6%) subclinical mastitis. Out of 9 (4.9%) clinical mastitis, 9.43 and 3.53% occurred in high grade Holstein and Holstein-indigenous zebu, respectively but indigenous zebu breeds was found not affected. Among the potential risk factors considered, breed ( 2= 17.3, P< 0.05), presence of teat lesion and/or tick infestation ( 2= 7.73, P< 0.05), stage of' lactation ( 2=l3.8, P< 0.05) and parity number ( 2= l9.4, P< 0.05) had significant effect on the prevalence of subclinical mastitis.

Another cross sectional study was carried out from April, 2009 till the end of November, 2011 to estimate prevalence of mastitis and its risk indicators in private dairy herd in Beni-suef region (Elbably *et al.*, 2013). A total of 233 Holstein milking cows were tested using California Mastitis Test (CMT). Prevalence of mastitis at cow level was 42.92 % (100/233), out of which 9.87% (23/233) and 33.05% (77/233) were clinical and subclinical mastitis, respectively. The quarter level prevalence was 29.08 (272/929); from this the clinical and subclinical forms were 5.81 (54/929) and 23.47 % (218/929), respectively. Risk factors such as age difference, stage of lactation, parity, tick infestation, previous history of clinical mastitis, and farm hygiene were highly significant in the mastitis prevalence (P < 0.01). On the other hand, strong relationship was found between milk production and occurrence of bovine mastitis as, prevalence was higher in adult cows (X2= 9.50, P<

0.05), hence the risk of developing mastitis significantly increase (P< 0.003) in lactating cow at ages (3-5 years) , at early lactation stage , with parity number (2-4) and during summer months, than those corresponding animals. In conclusion, the potential risk factors associated with mastitis prevalence and severity includes cow's itself and their surrounding environment particularly farm and milking hygiene procedure. Moreover, veterinary supervision, and tick infestation are among the potential risk factors predispose and increase severity of mastitis problem in dairy farm.

In previous study on the prevalence and etiology of subclinical mastitis a bacteriological survey on 16 Awassi dairy sheep flocks in southern Turkey was conducted. A total of 1458 milk samples from 729 Awassi ewes in mid-lactation were tested with the California mastitis test (CMT). Samples from 170 (11.7%) glands and 135 (18.5%) sheep had positive CMT results. Bacteria were isolated from 93 (6.4%) udder halves and 82 (11.2%) ewes. Positive CMT and bacteriological results were combined to define subclinical mastitis. The prevalence of subclinical mastitis and positive CMT samples among the different flocks ranged from 1.9% to 11.5% and 2.8% to 21.9% of the glands, and 3.8% to 19% and 5.7% to 31.3% of the ewes, respectively, with averages of 6.4% and 11.7% of the glands, and 11.2% and 18.5% of the ewes, respectively (Ergun *et al.*, 2009).

A retrospective analysis using records of lactating Bulgarian Murrah buffaloes subjected to the California Mastitis Test in a herd in Nueva Ecija, Philippines was done to determine the prevalence of sub-clinical mastitis (SCM) and to identify risk factors that may influence its occurrence and recurrence (Salvador *et al.*, 2012). Results showed that SCM prevalence was 42.76%, whereas its recurrence was 75.03%. Age and lactation length influenced the occurrence of SCM. Younger buffalo cows were more susceptible compared with those at least 6 yr old. Dams

younger than 3 yr have a 76% probability, whereas those age 3 yr have an 82% probability of having SCM.

A cross- sectional study was conducted on 322 local (n = 57) and crossbred (n = 265) lactating hand milked small holder cows in and around Gondar ( Nibret *et al*.,2011). The objective of the study was to determine prevalence of clinical and sub clinical mastitis and the associated risk factors by clinical examination and using California mastitis test. Bacterial culture was also conducted to determine the casual agents of mastitis. The prevalence of clinical and sub clinical mastitis in the study area was 0.93 and 31.67%, respectively with an overall prevalence of 32.6%. Out of 1288 quarters examined 164 were infected while 39 were blind. The number of clinically and sub clinically infected quarters were 7 and 157, respectively. Among the risk factors considered, breed, age, parity and stage of lactation have been shown statistically significant ($p<0.05$) difference in the prevalence of mastitis. Sub clinical mastitis in both breeds has been reported to be higher than clinical mastitis. The odds of occurrence of mastitis were two times more likely in crossbreds compared to local zebu. All the risk factors considered were significant effect on the prevalence of mastitis.

Another cross- sectional study was carried out from November 2008 to April 2009 to estimate prevalence of mastitis and to see associated bacterial pathogens in lactating dairy cows in Holeta town (Mekibib *et al*.,2010). A total of 107 cross bred milking cows were tested using California Mastitis Test (CMT). Prevalence of mastitis at cow level was 71.0% (76/107), out of which 22.4% (24/107) and 48.6% (52/107) were clinical and subclinical, respectively. The quarter level prevalence was 44.9% (192/428); from this the clinical and subclinical forms were 10.0% (43/428) and 34.8% (149/428), respectively. Out of the 43 quarters with

clinical cases, 31 had blind teats while 12 of them revealed active cases of mastitis. Samples from all 12 active clinical cases and 90.0% (134/149) of the CMT positive subclinical quarters were found to be culture positive. Risk factors analysis revealed that prevalence significantly differed with the age ($P < 0.05$), parity ($P < 0.05$) and udder hygiene condition ($P < 0.03$). Thus, prevalence was relatively higher in adult cows (OR = 2.0;95% CI = 1.15, 3.64), cows with moderate calves (OR = 2.4;95% CI = 1.6, 3.6), cows with injured teat (OR = 7.7, 95%CI = 0.9, 64.1) and cows with unwashed udder (OR = 2.3, 95% CI = 0.8, 6.4) than those corresponding animals.

## 1.3. Diagnosis:-

Clinical findings like abnormalities of secretions, abnormalities of size, consistency and temperature of mammary gland were examined by visual inspection and palpation. Pain reaction upon palpation, changes in the milk (blood tinged milk, watery secretions, clots, pus), and change in consistency of udder were considered as indications of the presence of clinical mastitis. However, a large proportion of mastitis glands are not ready detected by manual palpation or by visual examination as a result, the diagnosis of mastitis depends largely on indirect test (Gebrekrustos *et al.*, 2012).

The udder was first examined visually and then through palpation to detect possible fibrosis, inflammatory swellings, visible injury, atrophy of the tissue, and swelling of supra mammary lymph nodes. The size and consistency of mammary quarters were inspected for the presence of any abnormalities, such as disproportional symmetry, swelling, firmness, and blindness. Viscosity and appearance of milk secretion from each mammary quarter were examined for the presence of clots, flakes, blood,

and watery secretions. Clinical mastitis was detected based on results of clinical inspection of udder and signs of systemic involvement. Sub-clinical mastitis was diagnosed based on results of indirect tests and the nature of coagulation and viscosity of the mixture, which show the presence and severity of the infection, respectively (Islam *et al.*, 2011). The following indirect tests were used for detection of subclinical mastitis:

### 1.3.1. White Side Test (WST)

The WST was performed as per procedure described by Kahir (2006). In brief, 50 µl (five drops) of milk were placed on a glass slide with a dark background by micropipette. And then 20 µl of WST reagent (4% NaOH) were added to the milk sample and the mixture was stirred rapidly with a toothpick for 20-25 seconds. A breaking up of milk in flakes, shreds and viscid mass was indicative of positive reaction. On the other hand, milky and opaque and entirely free of precipitant was indicative of negative reaction.

### 1.3.2. Surf Field Mastitis Test (SFMT)

This test was performed and scored following the method described by (Muhammad et. al., 1995). In brief, 2 ml milk was drawn into the cup and 2 ml reagent (4% solution of Surf Excel®, Uniliver, Bangladesh) was squirted from a polyethylene wash bottle. Mixing was accomplished by gentle circular motion of the paddle in a horizontal plane for few seconds. The reaction developed almost immediately with milk containing a high concentration of somatic cells.

### 1.3.3. California Mastitis Test (CMT)

The CMT kit was used for screening of milk samples for subclinical mastitis. The procedure of CMT was performed as per manufacturer's instruction, in brief; 2 ml milk was drawn into the cup and an estimated equal volume of CMT reagent was squirted from a polyethylene wash bottle. Mixing was accomplished by gentle circular motion of the paddle in a horizontal plane for few seconds. The reaction developed almost immediately with milk containing a high concentration of somatic cells. (Islam *et al*., 2011).

### 1.3.4. Milk Color

Milk color changes during clinical mastitis and physical damage of the udder as blood constituents leaks from the vessels. A sensor measuring reflected light intensity can be used to measure milk color and detect abnormal milk and blood in the milk. This color sensor analyzed a continuous flow of milk in automatic milking and detected blood in the milk at concentrations as low as 0.1%. The conventional visual method using a black strip cup, detected only minimum of 2.0% of blood in the milk. Green and blue colors were the best indicators for abnormal milk and clinical mastitis, although they did not correlate well with the appearance of the milk.

### 1.3.5. pH Test

The rise in milk pH, due to mastitis, is detected using bromothymol blue. It is user friendly, cost effective and rapid. It is not as sensitive as other tests.

### 1.3.6. Immunoassays

Numerous immunoassays have been developed for the detection of pathogens in milk and are used for monitoring milk quality. More than

one hundred known organisms can be responsible for causing mastitis, but ELISAs have only been developed for some of the most prevalent pathogens, such as *S. aureus, E. coli* and *Listeria monocytogenes*. Multiplex PCR and 'real-time' PCR assays that can simultaneously detect different mastitis-causing organisms in milk samples have been described and the most recently developed assay is capable of detecting 11 of the major mastitis-associated pathogens, including *E. coli, S. aureus, Streptococcus agalactiae* and *Streptococcus uberis.* (Awale *et al*., 2012).

### 1.3.7. Culture Tests

Laboratory-based tests use selective culture to identify different microorganisms involved in causing mastitis. It identifies specific pathogens causing mastitis. It cannot be used 'on-site' and the waiting time for results can be days (Awale *et al*., 2012).

### 1.3.8. Somatic Cell Count (SCC

The use of the somatic cell count is one of the most established methods for the diagnosis of udder health in cows .unfortunately, SCC could yet not be established as a proven marker for SCM in goats. Factors like parity, stage of lactation, estrus and breed contribute to significant changes of SCC in milk of dairy goats. SCC is also affected by the nature of infection with minor or major pathogens. Furthermore, *mycoplasmal* infections can lead to highly increased SCC in goat milk. In contrast, lentiviral infections by Caprine Arthritis Encephalitis Virus (CAE) may also lead to higher SCC, but seem to be a minor contributor to SCC in cases of persistent SCM. Thus, so far no reliable thresholds values could yet be defined for SCC in goat milk. Some authors even state that SCC can be viewed as not suitable for the monitoring of caprine mastitis .depending on the individual study, goat milk has a significantly higher

cell count than milk from cows and higher variability in SCC. While the health of udder quarters of cows are confirmed by SCC up to 100 103 cells ml. the maximum SCC for goats range from of 200 103 cells ml-1 up to a few million cells ml (Stuhr *et al*., 2010).

## 1.4. Treatment:-

Treatment of mastitis should be based on bacteriological diagnosis and take national and international guidelines on prudent use of antimicrobials into account. In acute mastitis, where bacteriological diagnosis is not available, treatment should be initiated based on herd data and personal experience. Rapid bacteriological diagnosis would facilitate the proper selection of the antimicrobial. Treating subclinical mastitis with antimicrobials during lactation is seldom economical, because of high treatment costs and generally poor efficacy. All mastitis treatment should be evidence-based the efficacy of each product and treatment length should be demonstrated by scientific studies. Use of on-farm written protocols for mastitis treatment promotes a judicious use of antimicrobials and reduces the use of antimicrobials (Pyörälä *et al*., 2009).

The SCM-infected animals were treated with the antibiotic to which the bacteria cultured from the milk were most sensitive based on antibiotic sensitivity tests. Animals were treated with antibiotic i.m. for 3 days. The total bacterial count (TBC) of the milk samples from sheep and goats was estimated before and after antibiotic treatment. Milk samples were cultured on plates. Milk production was recorded on days 0, 7, and 15 after the start of antibiotic treatment (Islam *et al*., 2012).

The use of antibiotics is one of the most commonly used therapies to reduce the intra mammary infections caused by pathogens in herds, and

the most common reason for treatment was mastitis therapy .Several antibiotics are employed in food animals, among others, lactams, tetracyclines, aminoglycosides, macrolides, and sulfonamides. However, the uncontrolled use of these agents has led to appearance of microbial strains more resistant to classic antimicrobials along with residual antibiotics in milk that are hazardous to public health and interfere with production of dairy products (Santos *et al.*, 2009).

One of the important reasons for failure of treatment is assumed to be indiscriminate use of antibiotics without testing in vitro sensitivity of causal organisms. This practice at one hand increases economic losses and on other results in development of resistance to commonly used antimicrobials .for suitable antibiotic therapy bacterial isolation and antibiotic sensitivity studies are, always essentials. Mastitis is considered as one of the major causes for use of antibiotics in dairy animals major cause for use of antibiotics in dairy animals veterinarian in selecting the most appropriate antimicrobial agent for treatment of intra mammary infection (IMI) caused by *Staphylococcus* species ( Kaliwal *et al*.,2011).

An investigation which was run in some villages in Assiut governance during summer 2007 to diagnose acute clinical mastitis in different animal species and to apply different lines of treatment for evaluating which treatment line of choice giving cure, aiming to another goal by preventing the conversion of acute mastitis towards the chronic one which is difficult to be treated and the dairy animal will be excluded. Therefore, 2150 animals were clinically examined in 5 villages located north to Assiut city, Egypt, including 400 cows, 950 ewes and 800 she goats, and the incidence of acute clinical mastitis was 22.50%, 2.63% and 4.63%, respectively. Then applying different lines of treatment, all diseased animals were classified into 3 groups: 1st group received local

treatment by intra-mammary infusion antibiotic. 2nd group received systematic treatment by intra-muscular (I/M) injection of both antibiotic and anti-inflammatory drugs. While, 3rd group received combination of both local and systematic treatment lines together. Cure% was achieved as 50% for 1st group, 90% for 2nd group, while 3rd group gave complete cure by 100%. It was noticed that the incidence of acute clinical mastitis among examined cows was worrisome and can be considered as indicator of the epidemiology of the disease. While, spreading of the disease among ewes and she goats was somewhat low in comparison with that of cows. In conclusion, combination of both local and systematic treatment lines together should be advised in treatment of acute clinical mastitis to ensure complete cure. The obtained results highlighted the focus towards the spreading of acute clinical mastitis among cows lived in some Assiut governorate villages (Sayed *and* Abdel rady , 2008).

## 1.5. Prevention and Control:-

Perhaps the single biggest advance in dairy health in the last 25 yr has been the paradigm shift to focus on disease prevention, rather than treatment. The key contributors to progress in health management in the last generation include using epidemiology to better study the determinants of disease, integration of the disciplines of veterinary medicine and animal science, and renewed focus on using science to advance health and husbandry. Major advances have been made in the last 25 yr in the prevention of contagious mastitis, and severe coli form mastitis. There is an ongoing challenge for prevention of many diseases; although there is still much to learn, information already exists to substantially reduce or prevent the disease altogether—the challenge is in effectively and consistently implementing the required management practices. Ever-better understanding of epidemiology and physiology will

not in itself reduce the incidence of disease. The ability to translate emerging knowledge into on farm application and actual prevention of problems requires understanding of the farm as an integrated system, a major component of which is educating and motivating humans to implement well designed practices understanding and accomplishing (Leblanc *et al.*,2006).

Developed countries like United Kingdom give consideration on the following points for controlling mastitis; i) Treatment all cases of clinical mastitis promptly with an effective remedy to limit exposure and reduce duration. ii) Use of a longer acing antibiotic on all quarters of all cows at the end of the lactation to eliminate persisting infections and prevent new infections in the dry period to reduce duration and minimize exposure. iii) Culling all cows suffering from recurrent infection. iv) Dipping teats of all cows in an effective disinfectant after every milking to reduce exposure. In addition to above, the following recommendations (Sharif and Muhammad , 2009).

Vaccines against clinical gangrenous mastitis, that are available on the market for small ruminants, are widely used when there is a high incidence of clinical gangrenous mastitis. However, owing to the reported different effectiveness of these vaccines for dairy cows and sheep, and their inability to prevent new infections, it has been suggested that vaccines should be used in dairy herds with a high prevalence of *S. aureus* IMI to reduce clinical symptoms. The effectiveness of vaccination programs against mastitis caused by *S. aureus* has been reported for sheep but not for goats. The efficacy of a vaccine preventing mastitis by *S. aureus* and *S. simulans* was assessed in field conditions. The results indicated a reduced prevalence of clinical mastitis but not of subclinical infections. At present, vaccination studies have failed to find this tool

decisive for controlling mastitis in small ruminants, and more immunization studies are needed to improve this strategy (Contreras *et al.*, 2007).

# Chapter Two

# 2. MATERIALS and METHODS

## 2.1. Study Area

As it is well known, Khartoum is the political capital of the Sudan where offices of the state, governmental institutions, ministries, embassies and international and regional organizations are located. There is also the main air port.

The state lies between longitudes 31.5 and 34 east and latitude 15-16 north in an area about 28.165 square kilometers. It is bordered to the north and the east side by the River Nile State, to North Western on the Northern State, and to the east and south-eastern by the states of Kassala, Gedaref and Gezira (Adel, and Omer 1999).

### 2.1.1. Climate (rainfall-temperature): -

Most of the Khartoum state lies in the climatic semi-desert region. The climate of the state is ranging from hot to very hot. The weather is rainy in summers, cold and dry in winters, average rainfall reaches 100-200 mm in the north-eastern areas and 300-200 mm in the North Western areas. Temperature ranges in summer between 25-40$^{o}$c in the period from April to June, and 20-35$^{o}$c in the period from July to October. In winter, however, temperatures continue to decline between Novembers to March from 25-15$^{o}$c degrees (Adel, and Omer 1999).

### 2.1.2. Geography of Khartoum state: -

A / first block: it starts from the Mugran, i.e. the confluence of the two rivers (the blue and white Niles), this block extends southwards to the boundaries of the Gezira state. Administratively, it is divided into two

localities, Khartoum and Gabal Owlia localities. The block is characterized by Sundus and Soba agricultural schemes in both Gabal Owlia and Khartoum localities respectively, along with a number of livestock, poultry, fishing projects, besides farms of vegetables and fruits and fodder production projects. B/ second block: it is the Northern block, which is limited between the Blue Nile and the River Nile. It includes the localities of Khartoum North and East of the Nile, where the town of Khartoum North represents a largest one of the towns of this block. In this block, there are many agricultural projects such as the Soba East and Seleit agricultural project. It also includes the largest dairy projects in the state, namely Kuku village project. The block has also the largest industrial areas of Sudan.

C / third block: namely, the one located west of the White Nile and the River Nile and includes three localities, which are: Omdurman, Um Badda and Karari localities. However, the city of Omdurman is the largest one among them, found, the area west to Omdurman is characterized by the natural hunting in the state (Adel, and Omer 1999).

### 2.1.3. Population and their activities:-

As to the activity of the population of Khartoum state, it can be said that most of the population are workers and personnel in the State chambers, the private sector and banks. Also, there is a large segment of capitalists dealing in trade and another segment represented by migrants and displaced people working in marginal activities. As to countrymen, they are engaged in agriculture and grazing. There are also some residents who live on the banks of the river engaged in the river-related works such as pottery, brick and fishing.

## 2.2. Study animals:-

The following table shows the number of the livestock population in Khartoum state for the year 2008:-

**Table 2.2.1:**

| Camels | Sheep | Goats | Cattle | Total |
|---|---|---|---|---|
| 7000 | 513000 | 624000 | 240000 | 1384000 |

## 2.3. Study Design:-

The study involved a cross-sectional observation to estimate the prevalence of caprine mastitis, and to investigate the risk factors associated with the disease by going to the field one time to collect samples and data by using a questionnaire. Using the probability sampling methods to select the animals, first we used the simple random sampling method from Bahri locality; Khartoum locality and Omdurman locality to selected the farms, then, animals were selected by using cluster random sampling from each farm. The prevalence was calculated using the formula described by (Martin, *et al*., 1987) as follow:

**Prevalence rate = No. of goats with mastitis * 100**

**Total no. of goats at a particular point in time**

## 2.4. Sample size determination:-

The sample size was calculated by the formula:-

$$N = \frac{4*P*Q}{L2}$$

**Where:**

N= sample size

P= expected prevalence

L= desired absolute precision\

Q= (1-P). (Martin, *et al*., 1987.)

The expected prevalence was estimated according to the study on prevalence of caprine mastitis and related risk factors in Borona, southern Ethiopia *(*Bekel,*et al.,* 2011*)*, which was estimated as 15.5%, then the sample size was calculated as follow :-

$$N = \frac{4*(0.155)*(0.845)}{(0.0025)} = 209 \text{ animals}$$

## 2.5. Assessment of clinical and sub-clinical mastitis:-

Clinical mastitis was assessed by palpation and visualization of the udder, and diagnosed if the udder was red, hard, or hot to touch. Mild CM was judged visually by slight or moderate swelling, and a visibly abnormal secretion. In severe CM, the udder was swollen and milk secretion was grossly abnormal. Animals sometimes had an increased body temperature, loss of appetite, depression, and nearly complete cessation of milk secretion.

Sub-clinical mastitis was assessed by the California mastitis test. CMT was done according to manufacturer's instructions. Briefly, in each well of the test plate, 2 ml of milk was stripped from individual teats and an equal amount (2 ml) of 10% Teepol was added to the milk. A circular motion was made with the plate for 10 seconds to mix the reagent and milk, and after 20 seconds, changes in the milk were observed.

## 2.6. Questionnaire execution;

Structured questionnaire with the objective of elucidating the multifactorial background of caprine mastitis was conducted in an interactive manner at every selected farm. All animals in each farm were examined and filled by asking the owners. The goat attributes included breed, age, parity, stage of lactation, previous history of mastitis, teat lesion, body condition, and infection with other disease. The farm attributes included herd size, farm hygiene. The general management factors included bedding, housing, bedding replacement and barn size, parturition, water source, feeding and drinking equipment, presence of flies and ticks, methods of treatment of mastitis.

## 2.7. Statistical analysis;

All data which will be collected were entered into Microsoft excel spreadsheet. for analysis of the data SPSS version 17 was used. Data were analyzed descriptively in the first step, using the frequency table and cross tabulation. The prevalence was calculated using the formula described by Martin *et al*., (1987) as follow:

**Prevalence rate =** $\frac{\text{No. of goat with mastitis * 100}}{\text{Total no. of goat at a particular point in time}}$

Then the association of the different variables with the prevalence of caprine mastitis at the goat level was analyzed using a Chi-square test. The level of significance was set at $P<0.25$. For the investigation of the association between the probabilities of occurrence of mastitis in response to potential individual, management and hygienic risk factors, multivariate analysis was performed in which logistic regression model

was used. The strength of association between the risk factors and the prevalence of caprine mastitis was analyzed using the odds ratio (EXP B) and the level of significance was set at $P<0.05$.

# Chapter three

# 3. RESULTS

## 3.1-Descriptive statistical analysis frequency table, cross tabulation and association table between the disease and risk factors:

A total of 209 lactating goat randomly selected and screened using California Mastitis Test (CMT) for sub-clinical mastitis and clinically examined for clinical mastitis. The study was conducted in Khartoum state, Sudan, during the period May – July, 2013. One hundred forty six animals were positive (69.8%) and 63 animals were negative (30.14%), 125 animals were sub-clinical (59.8%) and 21 animals (10.04%) were clinically affected (table 3.1.1).

The overall prevalence rate was 69.8% (10% clinical and 59.8% sub-clinical) in Khartoum state.

**Table 3.1.1: prevalence of clinical and sub-clinical mastitis in 209 goats in Khartoum state**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Negative | 63 | 30.14 | 30.14 | 30.14 |
| | Sub-clinical | 125 | 59.8 | 59.8 | 89.94 |
| | Clinical | 21 | 10.04 | 10.04 | 100.0 |
| | Total | 209 | 100.0 | 100.0 | |

## 3.2- Summary of the results of analysis of the association of different potential risk factors with the occurrence of clinical mastitis:

### 3.2.1. Locality:

The results showed that 77 (36.8%) examined animals were from Bahri, 75 (35.9%) from Omdurman, 57 (27.3%) from Khartoum (table 3.1.2). The prevalence of clinical mastitis in localities was 11.68% in Bahri, 5.26% in Khartoum and 9.33% in Omdurman (table 3.1.3). No significant association (P-value = 0.43, $x^2$ = 1.64) was observed between locality and clinical mastitis (table 3.1.5).

### 3.2.2. Herd size:

The result showed that 152 (72.7%) of examined animals in large herd size while 57 (27.3%) in small herd size (table 3.1.2). The prevalence of clinical mastitis in large herd size was 11.18% and in small herd size was 3.5%. (table 3.1.3). A significant association (P-value = 0.08, $x^2$ =2.9) was observed between herd size and clinical mastitis (table 3.1.5).

### 3.2.3. Cleaning of barn:

The result showed that 111 (46.9%) of examined animals were in clean barn while 98 (53.1%) in dirty barn (table 3.1.2). The prevalence of clinical mastitis within animals in the clean barn was 7.14%and within dirty bran was 10.18% (table 3.1.3).No significant association (P-value = 0.35, $x^2$ = 0.84) was observed between clean of barn and clinical mastitis (table 3.1.5).

### 3.2.4. Bedding:

The result showed that 151 (72.2%) of examined animals in the farm floors with bedding while 58 (27.8%) of animals in the farm floors was soil without bedding (table 3.1.2). The prevalence of clinical mastitis in animals in the farm floors with bedding was 9.27% and in animals in the farm floors without bedding was 8.62% (table 3.1.3). No significant association (P-value = 0.88, $x^2$ = 0.02) was observed between bedding and clinical mastitis (table 3.1.5).

### 3.2.5. Bedding replacement:

The result showed that 72 (34.4%) of examined animals in the farm floors with bedding frequently removed while 137 (65.6%) of animals in the farm floors with bedding not removed (table 3.1.2). The prevalence of clinical mastitis in animals in the farm floors with bedding removed was 5.55% and in animal in the farm floors with bedding not removed was 10.94% (table 3.1.3). A significant association (P-value = 0.197, $x^2$ = 01.66) was observed between bedding replacement and clinical mastitis (table 3.1.5).

### 3.2.6. Age:

The results showed that 133(63.6%) of examined animals were old while 76 (36.4%) were young (table 3.1.2).The prevalence of clinical mastitis in old animals was 11.27% and in young animals was 5.26% (table 3.1.3). A significant association (P-value = 0.14, $x^2$ = 2.11) was observed between age and clinical mastitis (table 3.1.5).

### 3.2.7. Parity:

The results showed that 58(27.8%) of examined animals had>4 parity ,79 (37.8%) of animals had 3-4 parity and72(34.4%) had 1-2 parity (table 3.1.2).The prevalence of clinical mastitis in animals had >4 parity was 17.24%and in animals had 3-4 parity was 6.32%while in animal had 1-2 parity was 5.55% (table 3.1.3). A significant association (P-value = 0.03, $x^2 = 6.48$) was observed between parity and clinical mastitis (table 3.1.5).

### 3.2.8. Body condition:

The results showed that 176 (84.2%) of examined animals found in good condition while 33 (15.8%)of animals found in bad condition (table 3.1.2).The prevalence of clinical mastitis in good body condition animal was3.97%and in bad body condition animals was 36.36% (table 3.1.3). A significant association (P-value = 0.00, $x^2 = 35.26$) was observed between body condition and clinical mastitis (table 3.1.5).

### 3.2.9. Breed:

The results showed that 50 (23.9%) of examined animals were local breed, 83 (39.7%) were cross breed while 76 (36.4%) were foreign (table 3.1.2).The prevalence of clinical mastitis in local breed was2%and in cross breed was 9.63% and in foreign was 13.15% (table 3.1.3). A significant association (P-value = 0.101, $x^2 = 4.5$) was observed between breed and clinical mastitis (table 3.1.5).

### 3.2.10. Lesion in the teat:

The results showed that 38 (18.2%) of examined animals had lesion in the teat while 171 (81.8%) has not had lesion in the teat (table 3.1.2).The prevalence of clinical mastitis in the animals had lesion in the teat was

26.31% and in animals has not had lesion in the teat was 5.26% (table 3.1.3). A significant association (P-value = 0.00, $x^2$ = 16.67) was observed between lesion in the teat and clinical mastitis (table 3.1.5).

### 3.2.11. Type of udder:

The result showed that the udder in 67 (32.11%) of examined animals were pendulous while in 142 (67.9) were not pendulous (table 3.1.2).The prevalence of clinical mastitis in the pendulous udder animals was 17.91% and in not pendulous udder animals was 4.92% (table 3.1.3). A significant association (P-value = 0.002, $x^2$ = 9.2) was observed between type of udder and clinical mastitis (table 3.1.5).

### 3.2.12. Lactation stage:

The results showed that 96 (45.9%) of examined animals were in early stage of lactation while 113 (54.1%) were in late stage of lactation (table 3.1.2).The prevalence of clinical mastitis in animals in early stage of lactation was 11.45%and in animals in late stage of lactation was 7.07% (table 3.1.3). No significant association (P-value = 0.0.27, $x^2$ = 1.2) was observed between lactation stage and clinical mastitis (table 3.1.5).

### 3.2.13. Wash of hands

The result showed that all farmers in the study did not wash their hands before milking (table 3.1.2). No significant association (P-value = 0.75, $x^2$ = 0.1) was observed between wash of hands and clinical mastitis (table 3.1.5).

### 3.2.14. Wash of udder:

The result showed that all farmers in the study did not wash the udder before milking (table 3.1.2). No significant association (P-value = 0.75, $x^2 = 0.1$) was observed between wash of udder and clinical mastitis (table 3.1.5).

### 3.2.15. Previous mastitis:

The results showed that 35 (16.7%) of examined animals had previous mastitis while 174 (83.3%) has not had previous mastitis (table 3.1.2).The prevalence of clinical mastitis in animals which had previous mastitis was 4.42%and in animals has not had previous mastitis was 8.62% (table 3.1.3). No significant association (P-value = 0.598, $x^2 = 0.27$) was observed between previous mastitis and clinical mastitis (table 3.1.5).

## 3.3- Summary of the results of analysis of the association of different potential risk factors with the occurrence of sub-clinical mastitis:

### 3.3.1. Locality:

The results showed that 77 (36.8%) examined animals were from Bahri, 75 (35.9%) from Omdurman and 57 (27.3%) from Khartoum (table 3.1.2). The prevalence of sub- clinical mastitis in localities was 40.25% in Bahri, 49.33% in Omdurman and 66.66% in Khartoum (table 3.1.4). A significant association (P-value = 0.01, $x^2$ = 9.2) was observed between locality and sub-clinical mastitis (table 3.1.6).

### 3.3.2. Herd size:

The result showed that 152 (72.7%) of examined animals in large herd size while 57 (27.3%) in small herd size (table 3.1.2). The prevalence of sub- clinical mastitis in large herd size was 46.71% and in small herd size was 61.40% (table 3.1.4). A significant association (P-value = 0.05, $x^2$ =3.5) was observed between herd size and sub- clinical mastitis (table 3.1.6).

### 3.3.3. Clean of barn:

The result showed that 98 (46.9%) of examined animals in clean barn while 111 (53.1%) in dirty barn (table 3.1.2). The prevalence of sub-clinical mastitis within animals in the clean barn was 41.83%and within dirty barn was 58.55% (table 3.1.4).A significant association (P-value = 0.016 , $x^2$ = 5.8) was observed between clean of bran and sub- clinical mastitis (table 3.1.6).

### 3.3.4. Bedding:

The result showed that 151 (72.2%) of examined animals in the farm floors with bedding while 58 (27.8%) of animals in the farm floors were soil without bedding (table 3.1.2). The prevalence of sub- clinical mastitis in animals in the farm floors with bedding was 45.03% and in animals in the farm floors without bedding was 65.51% (table 3.1.4). A significant association (P-value = 0.008, $x^2$ = 07.03) was observed between bedding and sub- clinical mastitis (table 3.1.6).

### 3.3.5. Bedding replacement:

The result showed that 72 (34.4%) of examined animals in the farm floors with bedding frequently removed while 137(65.6%), of animals in the farm floors with bedding not removed (table 3.1.2). The prevalence of sub clinical mastitis in animals in the farm floors with bedding removed was 36.11% and in animal in the farm floors with bedding not removed was 58.39% (table 3.1.4). A significant association (P-value = 0.0.002, $x^2$ = 9.3) was observed between bedding replacement and sub- clinical mastitis (table 3.1.6).

#### 3.3.6. Age:

The results showed that 133(63.6%) of examined animals were old while 76(36.4%) were young (table 3.1.2).The prevalence of sub clinical mastitis in old animals was 51.87%and in young animals was 48.68% (table 3.1.4). No significant association (P-value = 0.65, $x^2$ = 0.19) was observed between age and sub- clinical mastitis (table 3.1.6).

#### 3.3.7. Parity:

The results showed that 58 (27.8%) of the examined animals had >4 parity, 79 (37.8%) of animals had 3-4 parity and 72 (34.4%) had 1-2

parity (table 3.1.2).The prevalence of sub- clinical mastitis in animals that had >4 parity was 48.27%and in animals that had 3-4 parity was (54.43%) while in animals that had 1-2 parity was 48.61% (table 3.1.4). No significant association (P-value = 0.704, $x^2$ = 0.702) was observed between parity and sub- clinical mastitis (table 3.1.6).

### 3.3.8. Body condition:

The results showed that 176 (84.2%) of examined animals were found in good condition while 33 (15.8%) of animals were found in bad condition (table 3.1.2).The prevalence of sub- clinical mastitis in good body condition animals was (53.4%) and in bad body condition animals was (36.36%) (table 3.1.4). A significant association (P-value = 0.07, $x^2$ = 1) was observed between body condition and sub- clinical mastitis (table 3.1.6).

### 3.3.9. Breed:

The results showed that 50 (23.9%) of examined animals were local breed, 83 (39.7%) were cross breed while 76 (36.4%) were foreign (table 3.1.2).The prevalence of sub- clinical mastitis in local breed was 40%and in cross breed was 53% and in foreign was 55.2% (table 3.1.4). A significant association (P-value = 0.21, $x^2$ = 3.1) was observed between breed and sub-clinical mastitis (table 3.1.6).

### 3.3.10. Lesion in the teat:

The results showed that 38 (18.2%) of examined animals had lesion in the teat while 171(81.8%) were not having lesion in the teat (table 3.1.2).The prevalence of sub- clinical mastitis in the animals that had lesion in the teat was 39.47% and in animals that had not lesion in the teat was 53.2%

(table 3.1.4). A significant association (P-value = 0.125, $x^2$ = 2.34) was observed between lesion in the teat and sub- clinical mastitis (table 3.1.6).

### 3.3.11. Type of udder:

The result showed that the udder in 67 (32.11%) of examined animals were pendulous while in142 (67.9 %) were not pendulous (table 3.1.2).The prevalence of sub clinical mastitis in the pendulous udder animals was 52.2% and in no pendulous udder animals was 50% (table 3.1.4). No significant association (P-value = 0.76, $x^2$ = 0.09) was observed between type of udder and sub- clinical mastitis (table 3.1.6).

### 3.3.12. Lactation stage:

The results showed that 96 (45.9%) of examined animals were in early stage of lactation while 113 (54.1%) were in late stage of lactation (table 3.1.2).The prevalence of sub- clinical mastitis in animals in early stage of lactation was 47.91%and in animals in late stage of lactation was 53.09% (table 3.1.4). No significant association (P-value = 0.44, $x^2$ = 0.55) was observed between lactation stage and sub- clinical mastitis (table 3.1.6).

### 3.3.13. Wash of hands

The result showed that all farmers in the study did not wash their hands before milking (table 3.1.2). No significant association (P-value = 0.32, $x^2$ = 0.97) was observed between wash of hands and sub- clinical mastitis (table 3.1.6).

### 3.3.14. Wash of udder:

The result showed that all farmers in the study did not wash their udder before milking (table 3.1.2). No significant association (P-value = 0.32,

$x^2$ = 0.97) was observed between wash of udder and sub- clinical mastitis (table 3.1.6).

## 3.3.15. Previous mastitis:

The results showed that 35 (16.7%) of examined animals had previous mastitis while 174 (83.3%) has not had previous mastitis (table 3.1.2).The prevalence of sub- clinical mastitis in animals had previous mastitis was 40%and in animal has not had previous mastitis was 52.87% (table 3.1.4). No significant association (P-value = 0.16, $x^2$ = 1.9) was observed between previous of mastitis and sub- clinical mastitis (table 3.1.6).

**Table 3.1.2: Summary frequency table of clinical, subclinical mastitis and risk factors investigated for association with caprine mastitis in Khartoum state, Sudan.**

| Risk Factor | Frequency | Percent | Cumulative percent |
|---|---|---|---|
| Locality | | | |
| Bahri | 77 | 36.8 | 36.8 |
| Omdurman | 75 | 35.9 | 72.7 |
| Khartoum | 57 | 27.3 | 100.0 |
| Herd size | | | |
| Large | 152 | 72.2 | 72.7 |
| Small | 57 | 27.3 | 100.0 |
| Clean of barn | | | |
| No | 111 | 53.1 | 53.1 |
| Yes | 98 | 46.9 | 100.0 |
| Bedding | | | |
| No | 58 | 37.8 | 27.8 |
| Yes | 151 | 72.2 | 100.0 |
| Bedding replacement | | | |
| No | 137 | 65.6 | 65.6 |
| Yes | 72 | 34.4 | 100.0 |
| Age | | | |
| Old | 133 | 63.6 | 63.6 |
| Young | 76 | 36 | 100.0 |

**Table 3.1.2 continued**

| Risk Factor | Frequency | Percent | Cumulative percent |
|---|---|---|---|
| Parity | | | |
| >4 | 58 | 27.8 | 27.8 |
| 3-4 | 79 | 37.8 | 65.6 |
| 1-2 | 72 | 34.4 | 100.0 |
| Body condition | | | |
| Bad | 33 | 15.8 | 15.8 |
| Good | 176 | 84.2 | 100.0 |
| Breed | | | |
| Local | 50 | 23.9 | 23.9 |
| Cross | 83 | 39.9 | 63.6 |
| Foreign | 76 | 36.4 | 100.0 |
| Lesion in the teat | | | |
| Yes | 38 | 18.2 | 18.2 |
| No | 171 | 81.8 | 100.0 |
| Type of udder | | | |
| Pendulous | 67 | 32.1 | 32.1 |
| Not pendulous | 142 | 67.9 | 100.0 |
| Lactation stage | | | |
| Late | 113 | 54.1 | 54.1 |
| Early | 96 | 45.9 | 100.1 |
| Washing of hand | | | |
| No | 208 | 99.5 | 99.5 |
| Yes | 0 | o.5 | 100.0 |

**Table 3.1.2 continued**

| Risk Factor | Frequency | Percent | Cumulative percent |
|---|---|---|---|
| Washing of udder | | | |
| No | 208 | 99.5 | 99.5 |
| Yes | 0 | 0.5 | 100.0 |
| Previous mastitis | | | |
| Yes | 35 | 16.7 | 16.7 |
| No | 174 | 83.3 | 100.0 |
| Subclinical mastitis | | | |
| Yes | 125 | 59.8 | 59.8 |
| No | 84 | 40.2 | 100.0 |
| Clinical mastitis | | | |
| Yes | 21 | 10.0 | 10.0 |
| No | 188 | 90.0 | 100.0 |

**Table 3.1.3: Summary of cross tabulation for potential risk factors association with clinical carpine mastitis in Khartoum state, Sudan.**

| Risk Factor | No. Tested | No. positive | No. Positive % |
|---|---|---|---|
| Locality | | | |
| Bahri | 77 | 9 | 11.68 |
| Omdurman | 75 | 7 | 9.33 |
| Khartoum | 57 | 3 | 5.26 |
| Herd size | | | |
| Large | 152 | 17 | 11.18 |
| Small | 57 | 2 | 3.5 |
| Clean of barn | | | |
| No | 111 | 12 | 10.18 |
| Yes | 98 | 7 | 7.14 |
| Bedding | | | |
| No | 58 | 5 | 8.62 |
| Yes | 151 | 14 | 9.27 |
| Bedding replacement | | | |
| No | 137 | 15 | 10.94 |
| Yes | 72 | 4 | 5.55 |
| Age | | | |
| Old | 133 | 15 | 11.27 |
| Young | 76 | 4 | 5.26 |

**Table 3.1.3 continued**

| Risk Factor | No. tested | No. positive | No. Positive % |
|---|---|---|---|
| Parity | | | |
| >4 | 58 | 10 | 17.2 |
| 3-4 | 79 | 5 | 6.32 |
| 1-2 | 72 | 4 | 5.55 |
| Body condition | | | |
| Bad | 33 | 12 | 36.36 |
| Good | 176 | 7 | 3.97 |
| Breed | | | |
| Local | 50 | 1 | 2 |
| Cross | 83 | 8 | 9.63 |
| Foreign | 76 | 10 | 13.15 |
| Lesion in the teat | | | |
| Yes | 38 | 10 | 26.31 |
| No | 171 | 9 | 5.26 |
| Type of udder | | | |
| Pendulous | 67 | 12 | 17.9 |
| Not pendulous | 142 | 7 | 4.92 |
| Lactation stage | | | |
| Late | 113 | 8 | 7.07 |
| Early | 96 | 11 | 4.45 |
| Washing of hand | | | |
| No | 208 | 19 | 9.13 |
| Yes | 0 | 0 | 0.00 |

**Table 3.1.3 continued**

| Risk Factor | No. tested | No. positive | No. Positive % |
|---|---|---|---|
| Washing of udder | | | |
| No | 208 | 19 | 19.13 |
| Yes | 0 | 0 | 0.00 |
| Previous mastitis | | | |
| Yes | 35 | 4 | 11.42 |
| No | 174 | 15 | 8.68 |

**Table3.1.4: Summary of cross tabulation for potential risk factors association with sub-clinical caprine mastitis in Khartoum state, Sudan.**

| Risk Factor | No. tested | No. positive | No. Positive % |
|---|---|---|---|
| Locality | | | |
| Bahri | 77 | 31 | 40.25 |
| Omdurman | 75 | 37 | 49.33 |
| Khartoum | 57 | 38 | 66.6 |
| Herd size | | | |
| Large | 152 | 71 | 46.7 |
| Small | 57 | 35 | 61.4 |
| Clean of barn | | | |
| No | 111 | 65 | 58.55 |
| Yes | 98 | 41 | 41.83 |
| Bedding | | | |
| No | 58 | 38 | 65.5 |
| Yes | 151 | 68 | 45.03 |
| Bedding replacement | | | |
| No | 137 | 80 | 58.30 |
| Yes | 72 | 26 | 36.10 |
| Age | | | |
| Old | 133 | 69 | 51.80 |
| Young | 76 | 37 | 48.68 |
| Parity | | | |
| >4 | 58 | 28 | 48.27 |
| 3-4 | 79 | 43 | 54.40 |
| 1-2 | 72 | 35 | 48.60 |

**Table 3.1.4 continued**

| Risk Factor | No. Tested | No. positive | No. Positive % |
|---|---|---|---|
| Body condition | | | |
| Bad | 33 | 12 | 36.30 |
| Good | 176 | 94 | 53.40 |
| Breed | | | |
| Local | 50 | 20 | 40.00 |
| Cross | 83 | 44 | 53.01 |
| Foreign | 76 | 42 | 53.2 |
| Lesion in the teat | | | |
| Yes | 38 | 15 | 39.47 |
| No | 171 | 91 | 53.20 |
| Type of udder | | | |
| 1Pendulous | 67 | 35 | 52.23 |
| Not pendulous | 142 | 71 | 50.00 |
| Lactation stage | | | |
| Late | 113 | 60 | 53.09 |
| Early | 96 | 46 | 47.90 |
| Washing of hand | | | |
| No | 208 | 105 | 50.48 |
| Yes | 0 | 1 | 1.00 |
| Washing of udder | | | |
| No | 208 | 105 | 50.48 |
| Yes | 0 | 1 | 1.00 |

**Table 3.1.4 continued**

| Risk Factor | No. Tested | No. positive | No. Positive % |
|---|---|---|---|
| Previous mastitis | | | |
| 1-Yes | 35 | 14 | 40.00 |
| 2-No | 174 | 92 | 52.87 |

**Table 3.1.5: Univariate analysis of the association of different potential risk factors with the occurrence of clinical mastitis in Khartoum state, Sudan.**

| Risk Factor | Total No. | No. Positive | No. positive % | D.F. | $X^2$ | p-value |
|---|---|---|---|---|---|---|
| Locality | | | | 2 | 1.644 | 0.439 |
| 1-Bahri | 77 | 9 | 11.68 | | | |
| Omdurman | 75 | 7 | 9.33 | | | |
| Khartoum | 57 | 3 | 5.26 | | | |
| Herd size | | | | 1 | 2.955 | 0.086 |
| Large | 152 | 17 | 11.18 | | | |
| Small | 57 | 2 | 3.5 | | | |
| Clean of barn | | | | 1 | 0.847 | 0.357 |
| No | 111 | 12 | 10.81 | | | |
| Yes | 98 | 7 | 7.14 | | | |
| Bedding | | | | 1 | 0.021 | 0.883 |
| No | 58 | 5 | 8.62 | | | |
| Yes | 151 | 14 | 9.27 | | | |
| Bedding replacement | | | | 1 | 1.660 | 0.197 |
| No | 137 | 15 | 10.94 | | | |
| Yes | 72 | 4 | 5.55 | | | |
| Age | | | | 1 | 2.117 | 0.146 |
| Old | 133 | 15 | 11.27 | | | |
| Young | 76 | 4 | 5.26 | | | |

## Table 3.1.5 continued

| Risk Factor | Total No. | No. Positive | No. Positive % | D.F. | $x^2$ | p-value |
|---|---|---|---|---|---|---|
| Parity | | | | 2 | 6.48 | 0.039 |
| >4 | 58 | 10 | 17.2 | | | |
| 3-4 | 79 | 5 | 6.32 | | | |
| 1-2 | 72 | 4 | 5.55 | | | |
| Body condition | | | | 1 | 35.26 | 0.000 |
| Bad | 33 | 12 | 36.36 | | | |
| Good | 176 | 7 | 3.97 | | | |
| Breed | | | | 2 | 4.593 | 0.101 |
| Local | 50 | 1 | 2.00 | | | |
| Cross | 83 | 8 | 9.63 | | | |
| Foreign | 76 | 10 | 13.15 | | | |
| Lesion in the teat | | | | 1 | 16.67 | 0.000 |
| Yes | | | | | | |
| No | 38 | 10 | 26.31 | | | |
| | 171 | 9 | 5.26 | | | |
| Type of udder | | | | 1 | 9.281 | 0.002 |
| Pendulous | 67 | 12 | 17.90 | | | |
| Not pendulous | 142 | 7 | 4.92 | | | |
| Lactation stage | | | | 1 | 1.204 | 0.272 |
| Late | 113 | 8 | 7.07 | | | |
| Early | 96 | 11 | 11.45 | | | |

**Table 3.1.5 continued**

| Risk Factor | Total No. | No. Positive | No. positive % | D.F. | $x^2$ | p-value |
|---|---|---|---|---|---|---|
| Washing of hand | | | | 1 | 0.100 | 0.751 |
| No | | | | | | |
| Yes | 208 | 19 | 9.13 | | | |
| | 0 | 0 | 0 | | | |
| Washing of udder | | | | 1 | 0.100 | 0.751 |
| No | | | | | | |
| Yes | 208 | 19 | 9.13 | | | |
| | 0 | 0 | O | | | |
| Previous mastitis | | | | 1 | 0.278 | 0.598 |
| Yes | 35 | 4 | 11.42 | | | |
| No | 174 | 5 | 8.62 | | | |

**Table 3.1.6: Univariate analysis of the association of different potential risk factors with the occurrence of sub-clinical mastitis in Khartoum state, Sudan.**

| Risk Factor | Total No. | No. Positive | No. positive % | D.F. | $X^2$ | p-value |
|---|---|---|---|---|---|---|
| Locality | | | | 2 | 9.22 | 0.010 |
| Bahri | 77 | 31 | 40.25 | | | |
| Omdurman | 75 | 37 | 49.33 | | | |
| Khartoum | 57 | 38 | 66.6 | | | |
| Herd size | | | | 1 | 3.52 | 0.058 |
| Large | 152 | 71 | 46.7 | | | |
| Small | 57 | 35 | 61.4 | | | |
| Clean of barn | | | | 1 | 5.823 | 0.016 |
| No | 111 | 65 | 58.55 | | | |
| Yes | 98 | 41 | 41.83 | | | |
| Bedding | | | | 1 | 7.035 | 0.008 |
| No | 58 | 38 | 65.5 | | | |
| Yes | 151 | 68 | 45.03 | | | |
| Bedding replacement | | | | 1 | 9.370 | 0.002 |
| No | | | | | | |
| Yes | 137 | 80 | 58.30 | | | |
| | 72 | 26 | 36.10 | | | |
| Age | | | | 1 | 0.198 | 0.657 |
| Old | 133 | 69 | 51.80 | | | |
| Young | 76 | 37 | 48.68 | | | |

## Table 3.1.6 continued

| Risk Factor | Total No. | No. Positive | No. positive % | D.F. | $X^2$ | p-value |
|---|---|---|---|---|---|---|
| Parity | | | | 2 | 0.702 | 0.704 |
| >4 | 58 | 28 | 48.27 | | | |
| 3-4 | 79 | 43 | 54.40 | | | |
| 1-2 | 72 | 35 | 48.60 | | | |
| Body condition | | | | 1 | 3.23 | 0.072 |
| Bad | 33 | 12 | 36.3 | | | |
| Good | 176 | 94 | 53.40 | | | |
| Breed | | | | 2 | 3.101 | 0.212 |
| Local | 50 | 20 | 40.00 | | | |
| Cross | 83 | 44 | 53.01 | | | |
| 3-Foreign | 76 | 42 | 55.20 | | | |
| Lesion in the teat | | | | 1 | 2.349 | 0.125 |
| Yes | 38 | 15 | 39.47 | | | |
| No | 171 | 91 | 53.20 | | | |
| Type of udder | | | | 1 | 0.091 | 0.763 |
| Pendulous | 67 | 35 | 52.23 | | | |
| Not pendulous | 142 | 71 | 50.00 | | | |
| Lactation stage | | | | 1 | 0.557 | 0.455 |
| Late | 113 | 60 | 53.09 | | | |
| Early | 96 | 46 | 47.90 | | | |

## Table 3.1.6 continued

| Risk Factor | Total No. | No. Positive | No. positive % | D.F. | $X^2$ | p-value |
|---|---|---|---|---|---|---|
| Washing of hand | | | | 1 | 0.979 | 0.323 |
| No | | | | | | |
| Yes | 208 | 105 | 50.48 | | | |
| | 0 | 1 | 100.00 | | | |
| Washing of udder | | | | 1 | 0.976 | 0.323 |
| No | | | | | | |
| Yes | 208 | 105 | 50.48 | | | |
| | 0 | 1 | 100.00 | | | |
| Previous mastitis | | | | 1 | 1.932 | 0.165 |
| Yes | 35 | 14 | 40.00 | | | |
| No | 174 | 92 | 52.87 | | | |

## 3.4 Multivariate analysis:

These risk factors which had a significant effect in univariate analysis were fitted in multivariate logistic regression model under a significant level < 0.05. The result showed that body condition (P-value = 0.000), lesion in the teat (P-value = 0.000), type of the udder (P-value = 0.002) table(3.1.7), bedding (P-value = 0.008) and bedding replacement (P-value =0.002) (table 3.1.8) had statistical significant association with mastitis.

**Table 3.1.7: Multivariate analysis of the association of different potential risk factors with the occurrence of clinical mastitis in caprine in Khartoum state, Sudan.**

| Risk Factor | Positive % | Exp (B) | 95% Confidence interval | p-value |
|---|---|---|---|---|
| Herd size | | | | |
| Large | 11.18 | 2.88 | 0.474-17.8 | 0.09 |
| Small | 3.5 | Ref. | | |
| Bedding replacement | | | | |
| No | 10.94 | 1.16 | 0.277-4.91 | 0.197 |
| Yes | 5.55 | Ref. | | |
| Age | | | | |
| Old | 11.27 | 4.26 | 000 | 0.146 |
| Young | 5.26 | Ref. | | |
| Parity | | | | 0.039 |
| >4 | 17.2 | 1.36 | 0.331-5.66 | 0.279 |
| 3-4 | 6.32 | 000 | 0.00 | 0.197 |
| 1-2 | 5.55 | Ref. | | |
| Body condition | | | | |
| Bad | 36.36 | 8.84 | 2.6-29.6 | 0.00 |
| Good | 3.97 | Ref. | | |
| Breed | | | | 0.101 |
| Local | 2.00 | Ref. | | |
| Cross | 9.63 | 0.162 | 0.015-1.76 | o.823 |
| Foreign | 13.5 | 0.191 | 0.019-2.05 | 0.122 |

**Table 3.1.7 continued**

| Risk Factor | % Positive | Exp (B) | 95% Confidence interval | p-value |
|---|---|---|---|---|
| Lesion in the teat | | | | |
| Yes | 26.31 | 3.32 | 1.14-30-96 | 0.00 |
| No | 5.26 | Ref. | | |
| Type of udder | | | | |
| Pendulous | 17.9 | 3.32 | 1.005-10.99 | 0.002 |
| Not pendulous | 4.92 | Ref. | | |

**Table 3.1.8: Multivariate analysis of the association of different potential risk factors with the occurrence of sub-clinical mastitis in caprine in Khartoum state, Sudan.**

| Risk Factor | Positive % | Exp (B) | 95% Confidence interval | p-value |
|---|---|---|---|---|
| Herd size | | | | |
| Large | 46.7 | Ref. | | |
| Small | 61.4 | 0.779 | 0.32-1.86 | 0.058 |
| Bedding replacement | | | | |
| No | 58.3 | 1.3 | 0.52-3.55 | 0.002 |
| Yes | 36.1 | Ref. | | |
| Lesion in the teat | | | | 0.125 |
| Yes | 39.47 | Ref. | | |
| No | 53.2 | 0.6 | 0.268-1.35 | |
| Locality | | | | 0.01 |
| Bahri | 40.25 | Ref. | | |
| Omdurman | 49.33 | 0.889 | 0.42-1.80 | 0.765 |
| Khartoum | 66.60 | 0.300 | 0.13-0.68 | 0.005 |
| Breed | | | | 0.212 |
| Local | 40.00 | Ref. | | |
| Cross | 53.01 | 0.52 | 0.22-1.21 | 0.59 |
| Foreign | 55.20 | 0.45 | 0.19-1.07 | 0.32 |
| Body condition | | | | 0.072 |
| Bad | 36.3 | Ref. | | |
| Good | 53.4 | 0.37 | 0.15-0.90 | |

**Table3.1.8 continued**

| Risk Factor | Positive % | Exp (B) | 95% Confidence interval | p-value |
|---|---|---|---|---|
| Clean of barn | | | | 0.016 |
| No | 58.55 | 1.6 | 0.71-3.6 | |
| Yes | 41.83 | Ref. | | |
| Bedding | | | | 0.008 |
| No | 65.5 | 1.7 | 0.63-4.5 | |
| Yes | 45.03 | Ref. | | |
| Previous mastitis | 40.00 | Ref. | | 0.165 |
| Yes | 52.87 | 0.58 | 0.25-1.33 | |
| No | | | | |

# Chapter Four

# DISCUSSION

Mastitis is one of the most important disease causing economic losses due to reduction in milk yield, decreased milk quality and treatment costs. This disease is the outcome of the interaction of many risk factors associated with host and environment. This study was conducted to determine the clinical and subclinical mastitis prevalence and to investigate possible potential risk factors. This study would help the farmers, veterinarian and others concerned authorities in the control of this disease.

In this study the prevalence of sub-clinical mastitis is higher than that of clinical mastitis. This could be due to the reason that in khartoum state sub-clinical mastitis receives little attention and efforts have been concentrated only on the treatment of clinical cases.

The prevalence of clinical and sub-clinical mastitis was 10% and 59.8% respectively, with an overall prevalence 69.8%.

The high prevalence of sub-clinical mastitis (59.8%) and low prevalence of clinical mastitis (10%) are in agreement with previous observations which reported that sub-clinical mastitis is more prevalent than clinical mastitis with rate of 38.0% and 21.1% of sub-clinical and clinical mastitis respectively in Boran, Ethiopia (Adane *et al*., 2012) , 30.6% and 4.9% in Hawass town southern Ethiopia (Niberet *et al*., 2011) , 33.05% and 9.8% in Beni-suef region (Elbably *et al*., 2013) and 48.6% and 22.4% in Holeta town (Mekibib *et al*., 2010).

The overall prevalence in the present study is lower than those reported in some previous studies by Tadesse and Chanie (2012) in Addis Ababa

which was 65.3% and by Matios *et al* (2009) in Asella, Ethiopia, which was 64.5%. However, it is higher prevalence than previous studies conducted by Sori *et al* (2005) in Sebata Ethiopia, which were 52.7% and Hashemi *et al* (2011) in Fars province which was 44.7%.

The difference in prevalence of mastitis in the present study and other reports could probably be due to difference in management practices, breed , geographic location and study methods (Radostits *et al* .,2000).

The following risk factors show significant associations with mastitis in the univariate analysis under significant level of < 0.25: locality (P-value = 0.01), herd size (P-value = 0.08), bedding (P-value = 0.008), bedding replacement (P-value = 0.19), age (P-value = 0.14), parity (P-value = 0.039), body condition (P-value = 0.000), breed (P-value = 0.101), lesion in the teat (P-value = 0.000), type of udder (P-value = 0.002) and previous mastitis (P-value = 0.165) . These risk factors which had a significant effect in univariate analysis were fitted in multivariate logistic regression model under a significant level < 0.05, the result showed that body condition (P-value = 0.000), lesion in the teat (P-value = 0.000), type of the udder (P-value = 0.002), bedding (P-value = 0.008) and bedding replacement (P-value =0.002) had statistical significant association with mastitis.

Body condition was based on palpation of back bones and lumber processes. In our study body score showed a significant statistical association with mastitis (P-value = 0.000), this result is in agreement with the finding of previous work conducted in Tanzania by Kivira *et al*.,(2006), (P-value = 0.02), and by Uddin *et al*., (2009) in Mymunsingh, Bangaladish (P-value = 0.05). In most previous studies , significant statistical association with mastitis was not fully explained by authors, but it is possible that poor body condition is usually associated with

debilitating disease which may produce high somatic cell count (scc) associated with intramammary infection (Kivira *et al*., 2006) .

Teat injuries and lesions predispose the udder to infection that might be the reason of high prevalence of mastitis in injured teat. The finding of the present study is supported by previous studies conducted in Dar Elsalam, Tanazania by Kivaria *et al*., (2006)(P-value = 0.000) and Matios *et al.*, (2009).in Assell,Ethiopia (P-value = 0.000). It was explained by Uddin *et al* (2009) that teat injuries provide a medium for the growth of the pathogenic bacteria which affect the udder, so that, in case of injuries the risk of an infection increases.

Our result showed higher mastitis rate in pendulous udder than non-pendulous udder, 32.1% and 67.9% respectively. The significant statistical association (P-value = 0.002) is in agreement with previous findings in Faisalabad reported in Punjab, Pakistan by Ali (2009) (P-value = 0.05) and in Oromia, Ethiopia by Delelesse, (2010) (P-value = 0.05). It might be due to the reason that, pendulous udder gets more injuries and abrasions which may facilitate pathogens to enter and grow (Hussain *et al*., 2012).

Also our study documented significant statistical association of bedding (P-value = 0.008). A higher prevalence of mastitis in goat which were managed under poor floor without bedding 65.5% than those managed with proper floor 45.3%. This result could be attributed to the presence of environmental mastitis pathogens with reservoirs in mud (Ali *et el.*, 2009).Bedding replacement also showed significant statistical association with mastitis in our study (P-value = 0.002) and this result has been observed in a previous study achieved in Faisal Abad (p-value = 0.006) by Ali,(2009). The floor surface is a clear hazard to the animal, mud and

excessive moisture increase organism contaminating the udder (Ali *et al*., 2009).

# Conclusions

In view of these findings mastitis is prevalent in Khartoum state.

- Our study further confirmed that sub-clinical mastitis is most prevalent.

- Individual risk factors as body condition, lesion in the teat, type of udder influenced the prevalence of mastitis.

-Management risk factors as bedding and bedding replacement also influenced the prevalence of mastitis.

# Recommendations

Therefore based on the above conclusion the following points are forwarded as recommendations:-

- Culling of old and chronically affected goats, screening of goats and milk for clinical and sub-clinical mastitis, hygiene at milking and goat house hygiene should be considered in attempts to reduce prevalence of mastitis.

- Some epidemiological risk factors associated with mastitis prevalence need confirmation in further studies.

- Positive collaboration has to be established between regional veterinary laboratories and farm owners to promote awareness on the impact of mastitis on the economic losses from selling milk and, from the public health point of view of milk consumers, and the measures and precautions that should be considered to correct and/ or prevent their occurrence.

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# Appendix 1

**Distribution of 209 goat examined for mastitis (clinical and subclinical) in Khartoum state according to potential risk factors**

## Appendix 1.1: Locality

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Bahri | 77 | 36.8 | 36.8 | 36.8 |
| | omdorman | 75 | 35.9 | 35.9 | 72.7 |
| | alkhartoum | 57 | 27.3 | 27.3 | 100.0 |
| | Total | 209 | 100.0 | 100.0 | |

## Appendix 1.2: herd size

| | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| Valid | Large | 152 | 72.7 | 72.7 | 72.7 |
| | Small | 57 | 27.3 | 27.3 | 100.0 |
| | Total | 209 | 100.0 | 100.0 | |

## Appendix 1.3: clean of barn

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | No | 111 | 53.1 | 53.1 | 53.1 |
| | Yes | 98 | 46.9 | 46.9 | 100.0 |
| | Total | 209 | 100.0 | 100.0 | |

## Appendix 1.4: bedding

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | No | 58 | 27.8 | 27.8 | 27.8 |
| | Yes | 151 | 72.2 | 72.2 | 100.0 |
| | Total | 209 | 100.0 | 100.0 | |

## Appendix 1.5: bedding replacement

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | No | 137 | 65.6 | 65.6 | 65.6 |
| | Yes | 72 | 34.4 | 34.4 | 100.0 |
| | Total | 209 | 100.0 | 100.0 | |

## Appendix 1.6: age

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Old | 133 | 63.6 | 63.6 | 63.6 |
| | Young | 76 | 36.4 | 36.4 | 100.0 |
| | Total | 209 | 100.0 | 100.0 | |

## Appendix 1.7: parity

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | >4 | 58 | 27.8 | 27.8 | 27.8 |
| | 3_4 | 79 | 37.8 | 37.8 | 65.6 |
| | 1_2 | 72 | 34.4 | 34.4 | 100.0 |

## Appendix 1.7: parity

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | >4 | 58 | 27.8 | 27.8 | 27.8 |
| | 3_4 | 79 | 37.8 | 37.8 | 65.6 |
| | 1_2 | 72 | 34.4 | 34.4 | 100.0 |
| | Total | 209 | 100.0 | 100.0 | |

## Appendix 1.8: body condition

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Bad | 33 | 15.8 | 15.8 | 15.8 |
| | Good | 176 | 84.2 | 84.2 | 100.0 |
| | Total | 209 | 100.0 | 100.0 | |

## Appendix 1.9: breed

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Local | 50 | 23.9 | 23.9 | 23.9 |
| | Cross | 83 | 39.7 | 39.7 | 63.6 |
| | Foreign | 76 | 36.4 | 36.4 | 100.0 |

## Appendix 1.9: breed

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Local | 50 | 23.9 | 23.9 | 23.9 |
| | Cross | 83 | 39.7 | 39.7 | 63.6 |
| | Foreign | 76 | 36.4 | 36.4 | 100.0 |
| | Total | 209 | 100.0 | 100.0 | |

## Appendix 1.10: lesion in the teat

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Yes | 38 | 18.2 | 18.2 | 18.2 |
| | No | 171 | 81.8 | 81.8 | 100.0 |
| | Total | 209 | 100.0 | 100.0 | |

## Appendix 1.11: type of the udder

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Pendulous | 67 | 32.1 | 32.1 | 32.1 |
| | Not pendulous | 142 | 67.9 | 67.9 | 100.0 |
| | Total | 209 | 100.0 | 100.0 | |

## Appendix 1.12: lactation stage

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Late | 113 | 54.1 | 54.1 | 54.1 |
| | Early | 96 | 45.9 | 45.9 | 100.0 |
| | Total | 209 | 100.0 | 100.0 | |

## Appendix 1.13: washing of the hand

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | No | 208 | 99.5 | 99.5 | 99.5 |
| | Yes | 1 | .5 | .5 | 100.0 |
| | Total | 209 | 100.0 | 100.0 | |

## Appendix 1.14: washing of the udder

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | No | 208 | 99.5 | 99.5 | 99.5 |
| | Yes | 1 | .5 | .5 | 100.0 |
| | Total | 209 | 100.0 | 100.0 | |

## Appendix 1.15: previous mastitis

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Yes | 35 | 16.7 | 16.7 | 16.7 |
| | No | 174 | 83.3 | 83.3 | 100.0 |
| | Total | 209 | 100.0 | 100.0 | |

## Appendix 1.16: sup clinical mastitis

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Yes | 125 | 59.8 | 59.8 | 59.8 |
| | No | 84 | 40.2 | 40.2 | 100.0 |
| | Total | 209 | 100.0 | 100.0 | |

## Appendix 1.17: clinical mastitis

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Yes | 21 | 10.0 | 10.0 | 10.0 |
| | No | 188 | 90.0 | 90.0 | 100.0 |
| | Total | 209 | 100.0 | 100.0 | |

# Appendix 2

**Cross tabulation of clinical mastitis prevalence among 209 goats examined in Khartoum state with potential risk factor**

## Appendix 2.1: locality

| | locality | | | |
|---|---|---|---|---|
| | Bahri | omdorman | alkhartom | Total |

| | | | | | |
|---|---|---|---|---|---|
| clinical mastitis | Yes | 9 | 7 | 3 | 19 |
| | | 11.68% | 9.33% | 5.26% | 9.09% |
| | NO | 68 | 68 | 54 | 190 |
| | | 88.31% | 90.66% | 94.73% | 90.90% |
| Total | | 77 | 75 | 57 | 209 |

## Appendix 2.2: herd size

| | | herd size | | Total |
|---|---|---|---|---|
| | | Large | Small | |
| clinical mastitis | Yes | 17 | 2 | 19 |
| | | 11.18% | 3.5% | 9.09% |
| | No | 135 | 55 | 190 |
| | | 88.81% | 96.49% | 90.9% |
| Total | | 152 | 57 | 209 |

## Appendix 2.3: clean of barn

| | | clean of barn | | Total |
|---|---|---|---|---|
| | | No | Yes | |
| clinical | Yes | 12 | 7 | 19 |

| | | | | |
|---|---|---|---|---|
| mastitis | | 10.81% | 7.14% | 9.09% |
| | No | 99 | 91 | 190 |
| | | 89.18% | 92.85% | 90.9% |
| Total | | 111 | 98 | 209 |

## Appendix 2.4: bedding

| | | Bedding | | Total |
|---|---|---|---|---|
| | | No | Yes | |
| clinical mastitis | Yes | 5 | 14 | 19 |
| | | 8.62% | 9.27% | 9.09% |
| | No | 53 | 137 | 190 |
| | | 91.37% | 90.72% | 90.9% |
| Total | | 58 | 151 | 209 |

## Appendix 2.5: bedding replacement

| | | bedding replacement | | Total |
|---|---|---|---|---|
| | | No | Yes | |
| clinical mastitis | Yes | 15 | 4 | 19 |
| | | 10.94% | 5.55% | 9.09% |
| | No | 122 | 68 | 190 |

## Appendix 2.5: bedding replacement

| | | bedding replacement | | Total |
|---|---|---|---|---|
| | | No | Yes | |
| clinical mastitis | Yes | 15 | 4 | 19 |
| | | 10.94% | 5.55% | 9.09% |
| | No | 122 | 68 | 190 |
| | | 89.05% | 94.44% | 90.9% |
| Total | | 137 | 72 | 209 |

## Appendix 2.6: age

| | | Age | | Total |
|---|---|---|---|---|
| | | Old | young | |
| clinical mastitis | Yes | 15 | 4 | 19 |
| | | 11.27% | 5.26% | 9.09% |
| | No | 118 | 72 | 190 |
| | | 88.72% | 94.73% | 90.9% |
| Total | | 133 | 76 | 209 |

## Appendix 2.7: parity

| | | parity | | | Total |
|---|---|---|---|---|---|
| | | >4 | 3_4 | 1_2 | |
| clinical mastitis | Yes | 10 | 5 | 4 | 19 |
| | | 17.24% | 6.32% | 5.55% | 9.09% |
| | No | 48 | 74 | 68 | 190 |
| | | 82.75% | 93.67% | 94.44% | 90.9% |
| Total | | 58 | 79 | 72 | 209 |

## Appendix 2.8: body condition

| | | body condition | | Total |
|---|---|---|---|---|
| | | Bad | Good | |
| clinical mastitis | Yes | 12 | 7 | 19 |
| | | 36.36% | 3.97% | 9.09% |
| | No | 21 | 169 | 190 |
| | | 63.63% | 96.02% | 90.9% |
| Total | | 33 | 176 | 209 |

## Appendix 2.9: breed

| | | Breed | | | Total |
|---|---|---|---|---|---|
| | | Local | Cross | foreign | |
| clinical mastitis | Yes | 1 | 8 | 10 | 19 |
| | | 2% | 9.63% | 13.15% | 9.09% |
| | No | 49 | 75 | 66 | 190 |
| | | 98% | 90.36% | 86.84% | 90.9% |
| Total | | 50 | 83 | 76 | 209 |

## Appendix 2.10: lesion in the teat

| | | lesion in the teat | | Total |
|---|---|---|---|---|
| | | Yes | No | |
| clinical mastitis | Yes | 10 | 9 | 19 |
| | | 26.31% | 5.26% | 9.09% |
| | No | 28 | 162 | 190 |
| | | 73.68% | 94.73% | 90.9% |
| Total | | 38 | 171 | 209 |

## Appendix 2.11: type of the udder

| | | type of the udder | | |
|---|---|---|---|---|
| | | Pendulous | not pendulous | Total |
| clinical mastitis | Yes | 12 | 7 | 19 |
| | | 17.91% | 4.92% | 9.09% |
| | No | 55 | 135 | 190 |
| | | 82.08% | 95.07% | 90.9% |
| Total | | 67 | 142 | 209 |

## Appendix 2.12: lactation stage

| | | lactation stage | | |
|---|---|---|---|---|
| | | Late | early | Total |
| clinical mastitis | Yes | 8 | 11 | 19 |
| | | 7.07% | 11.45% | 9.09% |
| | No | 105 | 85 | 190 |
| | | 92.92% | 88.54 | 90.9% |
| Total | | 113 | 96 | 209 |

## Appendix 2.13: washing of the hand

| | | washing of the hand | | |
|---|---|---|---|---|
| | | No | yes | Total |
| clinical mastitis | Yes | 19 | 0 | 19 |
| | | 9.13% | 0% | 9.09% |
| | No | 189 | 1 | 190 |
| | | 90.86% | 100% | 90.9% |
| Total | | 208 | 1 | 209 |

## Appendix 2.14: washing of the udder

| | | washing of the udder | | |
|---|---|---|---|---|
| | | No | yes | Total |
| clinical mastitis | Yes | 19 | 0 | 19 |
| | | 9.13% | 0% | 9.09% |
| | No | 189 | 1 | 190 |
| | | 90.86% | 100% | 90.9% |
| Total | | 208 | 1 | 209 |

## Appendix 2.15: previous mastitis

| | | previous mastitis | | Total |
|---|---|---|---|---|
| | | Yes | No | |
| clinical mastitis | Yes | 4 | 15 | 19 |
| | | 11.42% | 8.62% | 9.09% |
| | No | 31 | 159 | 190 |
| | | 88.57% | 91.37% | 90.9% |
| Total | | 35 | 174 | 209 |

# Appendix 3

**Cross tabulation of subclinical mastitis prevalence among 209 goats examined in Khartoum state with potential risk factor**

## Appendix 3.1: locality

| | | locality | | | |
|---|---|---|---|---|---|
| | | bahri | omdorman | alkhartom | Total |
| sup clinical mastitis | Yes | 31 | 37 | 38 | 106 |
| | | 40.25% | 49.33% | 66.66% | 50.71% |
| | No | 46 | 38 | 19 | 103 |
| | | 59.74% | 50.66% | 33.33% | 49.28% |
| Total | | 77 | 75 | 57 | 209 |

## Appendix 3.2: herd size

| | | herd size | | |
|---|---|---|---|---|
| | | Large | Small | Total |
| sup clinical mastitis | Yes | 71 | 35 | 106 |
| | | 46.71% | 61.40% | 50.71% |
| | No | 81 | 22 | 103 |
| | | 53.28% | 38.59% | 49.28% |
| Total | | 152 | 57 | 209 |

## Appendix 3.3: clean of barn

| | | clean of barn | | |
|---|---|---|---|---|
| | | No | Yes | Total |
| sup clinical mastitis | Yes | 65 | 41 | 106 |
| | | 58.55% | 41.83% | 50.71% |
| | No | 46 | 57 | 103 |
| | | 41.44% | 58.16% | 49.28% |
| Total | | 111 | 98 | 209 |

## Appendix 3.4: bedding

| | | bedding | | |
|---|---|---|---|---|
| | | No | yes | Total |
| sup clinical mastitis | Yes | 38 | 68 | 106 |
| | | 65.51% | 45.03% | 50.71% |
| | No | 20 | 83 | 103 |
| | | 34.48% | 54.96% | 49.28% |
| Total | | 58 | 151 | 209 |

## Appendix 3.5: bedding replacement

| | | bedding replacement | | |
|---|---|---|---|---|
| | | No | Yes | Total |
| sup clinical mastitis | Yes | 80 | 26 | 106 |
| | | 58.39% | 36.11 | 50.71% |
| | No | 57 | 46 | 103 |
| | | 41.60% | 63.88% | 49.28% |
| Total | | 137 | 72 | 209 |

## Appendix 3.6: age

| | | Age | | |
|---|---|---|---|---|
| | | Old | Young | Total |
| sup clinical mastitis | Yes | 69 | 37 | 106 |
| | | 51.87% | 48.68% | 50.71% |
| | No | 64 | 39 | 103 |
| | | 48.12% | 51.31% | 49.28% |
| Total | | 133 | 76 | 209 |

## Appendix 3.7: parity

| | | parity | | | Total |
|---|---|---|---|---|---|
| | | >4 | 3_4 | 1_2 | |
| sup clinical mastitis | Yes | 28 | 43 | 35 | 106 |
| | | 48.27% | 54.43% | 48.61% | 50.71% |
| | No | 30 | 36 | 37 | 103 |
| | | 51.72% | 45.56% | 51.38% | 49.28% |
| Total | | 58 | 79 | 72 | 209 |

## Appendix 3.8: body condition

| | | body condition | | Total |
|---|---|---|---|---|
| | | Bad | Good | |
| sup clinical mastitis | Yes | 12 | 94 | 106 |
| | | 36.36% | 53.40% | 50.71% |
| | No | 21 | 82 | 103 |
| | | 63.63% | 46.59% | 49.28% |
| Total | | 33 | 176 | 209 |

## Appendix 3.9: breed

| | | breed | | | Total |
|---|---|---|---|---|---|
| | | Local | cross | foreign | |
| sup clinical mastitis | Yes | 20 | 44 | 42 | 106 |
| | | 40% | 53.01% | 55.26% | 50.71% |
| | No | 30 | 39 | 34 | 103 |
| | | 60% | 46.98% | 44.73% | 49.28% |
| Total | | 50 | 83 | 76 | 209 |

## Appendix 3.10: lesion in the teat

| | | lesion in the teat | | Total |
|---|---|---|---|---|
| | | Yes | No | |
| sup clinical mastitis | Yes | 15 | 91 | 106 |
| | | 39.47% | 53.21% | 50.71% |
| | No | 23 | 80 | 103 |
| | | 60.52% | 46.78% | 49.28% |
| Total | | 38 | 171 | 209 |

## Appendix 3.11: type of the udder

| | | type of the udder | | |
|---|---|---|---|---|
| | | pendulous | not pendulous | Total |
| sup clinical mastitis | Yes | 35 | 71 | 106 |
| | | 52.23% | 50% | 50.71% |
| | No | 32 | 71 | 103 |
| | | 47.76% | 50% | 49.28% |
| Total | | 67 | 142 | 209 |

## Appendix 3.12: lactation stage

| | | lactation stage | | |
|---|---|---|---|---|
| | | late | Early | Total |
| sup clinical mastitis | Yes | 60 | 46 | 106 |
| | | 53.09% | 47.91% | 50.71% |
| | No | 53 | 50 | 103 |
| | | 46.90% | 52.08% | 49.28% |
| Total | | 113 | 96 | 209 |

## Appendix 3.13: washing of the hand

| | | washing of the hand | | |
|---|---|---|---|---|
| | | No | Yes | Total |
| sup clinical mastitis | Yes | 105 | 1 | 106 |
| | | 50.48% | 100% | 50.71% |
| | No | 103 | 0 | 103 |
| Total | | 49.51% | 0% | 49.28% |
| | | 208 | 1 | 209 |

## Appendix 3.14: washing of the udder

| | | washing of the udder | | |
|---|---|---|---|---|
| | | No | Yes | Total |
| sup clinical mastitis | Yes | 105 | 1 | 106 |
| | | 50.48% | 100% | 50.71% |
| | No | 103 | 0 | 103 |
| | | 49.51% | 0% | 49.28% |
| Total | | 208 | 1 | 209 |

## Appendix 3.15: previous mastitis

| | | previous mastitis | | |
|---|---|---|---|---|
| | | Yes | No | Total |
| sup clinical mastitis | Yes | 14 | 92 | 106 |
| | | 40% | 52.87% | 50.71% |
| | No | 21 | 82 | 103 |
| | | 60% | 47.12% | 49.28% |
| Total | | 35 | 174 | 209 |

# Appendix 4

**Association of different potential risk factor with clinical mastitis using Chi-square test**

## Appendix 4.1: locality

| | $X^2$ | D.F. | p- value |
|---|---|---|---|
| Pearson Chi-Square | 1.644 | 2 | .439 |
| Likelihood Ratio | 1.762 | 2 | .414 |
| Linear-by-Linear Association | 1.594 | 1 | .207 |
| N of Valid Cases | 209 | | |

## Appendix 4.2: herd size

| | $X^2$ | D.F. | p- value |
|---|---|---|---|
| Pearson Chi-Square | 2.955 | 1 | .086 |
| Continuity Correction | 2.099 | 1 | .147 |
| Likelihood Ratio | 3.503 | 1 | .061 |
| Fisher's Exact Test | | | |
| Linear-by-Linear Association | 2.941 | 1 | .086 |
| N of Valid Cases | 209 | | |

## Appendix 4.3: clean of barn

| | $X^2$ | D.F. | p-value |
|---|---|---|---|
| Pearson Chi-Square | .847 | 1 | .357 |
| Continuity Correction | .462 | 1 | .497 |
| Likelihood Ratio | .859 | 1 | .354 |
| Fisher's Exact Test | | | |
| Linear-by-Linear Association | .843 | 1 | .358 |
| N of Valid Cases | 209 | | |

## Appendix 4.4: bedding

| | $X^2$ | D.F. | p-value |
|---|---|---|---|
| Pearson Chi-Square | .021 | 1 | .883 |
| Continuity Correction | .000 | 1 | 1.000 |
| Likelihood Ratio | .022 | 1 | .883 |
| Fisher's Exact Test | | | |
| Linear-by-Linear Association | .021 | 1 | .884 |
| N of Valid Cases | 209 | | |

## Appendix 4.5: bedding replacement

| | $X^2$ | D.F. | p-value |
|---|---|---|---|
| Pearson Chi-Square | 1.661 | 1 | .197 |
| Continuity Correction | 1.073 | 1 | .300 |
| Likelihood Ratio | 1.789 | 1 | .181 |
| Fisher's Exact Test<br>Linear-by-Linear Association | 1.653 | 1 | .199 |
| N of Valid Cases | 209 | | |

## Appendix 4.6: age

| | $X^2$ | D.F. | p-value |
|---|---|---|---|
| Pearson Chi-Square | 2.117 | 1 | .146 |
| Continuity Correction | 1.452 | 1 | .228 |
| Likelihood Ratio | 2.287 | 1 | .130 |
| Fisher's Exact Test | | | |
| Linear-by-Linear Association | 2.107 | 1 | .147 |
| N of Valid Cases | 209 | | |

## Appendix 4.7: parity

| | $X^2$ | D.F. | p-value |
|---|---|---|---|
| Pearson Chi-Square | 6.480 | 2 | .039 |
| Likelihood Ratio | 5.840 | 2 | .054 |
| Linear-by-Linear Association | 4.935 | 1 | .026 |
| N of Valid Cases | 209 | | |

## Appendix 4.8: body condition

| | $X^2$ | D.F. | p-value |
|---|---|---|---|
| Pearson Chi-Square | 35.269 | 1 | .000 |
| Continuity Correction | 31.459 | 1 | .000 |
| Likelihood Ratio | 25.214 | 1 | .000 |
| Fisher's Exact Test | | | |
| Linear-by-Linear Association | 35.100 | 1 | .000 |
| N of Valid Cases | 209 | | |

## Appendix 4.9: breed

| | $X^2$ | D.F. | p-value |
|---|---|---|---|
| Pearson Chi-Square | 4.593 | 2 | .101 |
| Likelihood Ratio | 5.715 | 2 | .057 |
| Linear-by-Linear Association | 4.320 | 1 | .038 |
| N of Valid Cases | 209 | | |

## Appendix 4.10: lesion in the teat

| | $X^2$ | D.F. | p-value |
|---|---|---|---|
| Pearson Chi-Square | 16.674 | 1 | .000 |
| Continuity Correction | 14.224 | 1 | .000 |
| Likelihood Ratio | 13.019 | 1 | .000 |
| Fisher's Exact Test | | | |
| Linear-by-Linear Association | 16.594 | 1 | .000 |
| N of Valid Cases | 209 | | |

## Appendix 4.11: type of the udder

| | $X^2$ | D.F. | p-value |
|---|---|---|---|
| Pearson Chi-Square | 9.281 | 1 | .002 |
| Continuity Correction | 7.777 | 1 | .005 |
| Likelihood Ratio | 8.566 | 1 | .003 |
| Fisher's Exact Test | | | |
| Linear-by-Linear Association | 9.237 | 1 | .002 |
| N of Valid Cases | 209 | | |

## Appendix 4.12: lactation stage

| | $X^2$ | D.F. | p-value |
|---|---|---|---|
| Pearson Chi-Square | 1.204 | 1 | .272 |
| Continuity Correction | .733 | 1 | .392 |
| Likelihood Ratio | 1.201 | 1 | .273 |
| Fisher's Exact Test | | | |
| Linear-by-Linear Association | 1.198 | 1 | .274 |
| N of Valid Cases | 209 | | |

## Appendix 4.13: washing of the hand

| | $X^2$ | D.F. | p-value |
|---|---|---|---|
| Pearson Chi-Square | .100 | 1 | .751 |
| Continuity Correction | .000 | 1 | 1.000 |
| Likelihood Ratio | .191 | 1 | .662 |
| Fisher's Exact Test | | | |
| Linear-by-Linear Association | .100 | 1 | .752 |
| N of Valid Cases | 209 | | |

## Appendix 4.14: washing of the udder

| | $X^2$ | D.F. | p-value |
|---|---|---|---|
| Pearson Chi-Square | .100 | 1 | .751 |
| Continuity Correction | .000 | 1 | 1.000 |
| Likelihood Ratio | .191 | 1 | .662 |
| Fisher's Exact Test | | | |
| Linear-by-Linear Association | .100 | 1 | .752 |
| N of Valid Cases | 209 | | |

## Appendix 4.15: previous mastitis

| | $X^2$ | D.F. | p-value |
|---|---|---|---|
| Pearson Chi-Square | .278 | 1 | .598 |
| Continuity Correction | .042 | 1 | .838 |
| Likelihood Ratio | .263 | 1 | .608 |
| Fisher's Exact Test | | | |
| Linear-by-Linear Association | .277 | 1 | .599 |
| N of Valid Cases | 209 | | |

# Appendix 5

**Association of different potential risk factor with subclinical mastitis using Chi-square test**

## Appendix 5.1: locality

| | $X^2$ | D.F. | p-value |
|---|---|---|---|
| Pearson Chi-Square | 9.228 | 2 | .010 |
| Likelihood Ratio | 9.367 | 2 | .009 |
| Linear-by-Linear Association | 8.860 | 1 | .003 |
| N of Valid Cases | 209 | | |

## Appendix 5.2: herd size

| | X2 | D.F. | p-value |
|---|---|---|---|
| Pearson Chi-Square | 3.580 | 1 | .058 |
| Continuity Correction | 3.017 | 1 | .082 |
| Likelihood Ratio | 3.606 | 1 | .058 |
| Fisher's Exact Test | | | |
| Linear-by-Linear Association | 3.563 | 1 | .059 |
| N of Valid Cases | 209 | | |

## Appendix 5.3: clean of barn

| | $X^2$ | D.F. | p-value |
|---|---|---|---|
| Pearson Chi-Square | 5.823 | 1 | .016 |
| Continuity Correction | 5.173 | 1 | .023 |
| Likelihood Ratio | 5.849 | 1 | .016 |
| Fisher's Exact Test | | | |
| Linear-by-Linear Association | 5.795 | 1 | .016 |
| N of Valid Cases | 209 | | |

## Appendix 5.4: bedding

| | $X^2$ | D.F. | p-value |
|---|---|---|---|
| Pearson Chi-Square | 7.035 | 1 | .008 |
| Continuity Correction | 6.239 | 1 | .012 |
| Likelihood Ratio | 7.129 | 1 | .008 |
| Fisher's Exact Test | | | |
| Linear-by-Linear Association | 7.001 | 1 | .008 |
| N of Valid Cases | 209 | | |

## Appendix 5.5: bedding replacement

| | $X^2$ | D.F. | p-value |
|---|---|---|---|
| Pearson Chi-Square | 9.376 | 1 | .002 |
| Continuity Correction | 8.505 | 1 | .004 |
| Likelihood Ratio | 9.466 | 1 | .002 |
| Fisher's Exact Test | | | |
| Linear-by-Linear Association | 9.331 | 1 | .002 |
| N of Valid Cases | 209 | | |

## Appendix 5.6: age

| | X2 | D.F. | p-value |
|---|---|---|---|
| Pearson Chi-Square | .198 | 1 | .657 |
| Continuity Correction | .090 | 1 | .764 |
| Likelihood Ratio | .198 | 1 | .657 |
| Fisher's Exact Test | | | |
| Linear-by-Linear Association | .197 | 1 | .657 |
| N of Valid Cases | 209 | | |

## Appendix 5.7: parity

| | $X^2$ | D.F. | p-value |
|---|---|---|---|
| Pearson Chi-Square | .702[a] | 2 | .704 |
| Likelihood Ratio | .703 | 2 | .704 |
| Linear-by-Linear Association | .000 | 1 | .986 |
| N of Valid Cases | 209 | | |

## Appendix 5.8: body condition

| | X2 | D.F. | p-value |
|---|---|---|---|
| Pearson Chi-Square | 3.230a | 1 | .072 |
| Continuity Correction | 2.584 | 1 | .108 |
| Likelihood Ratio | 3.262 | 1 | .071 |
| Fisher's Exact Test | | | |
| Linear-by-Linear Association | 3.215 | 1 | .073 |
| N of Valid Cases | 209 | | |

## Appendix 5.9: breed

| | $X^2$ | D.F. | p-value |
|---|---|---|---|
| Pearson Chi-Square | 3.101 | 2 | .212 |
| Likelihood Ratio | 3.116 | 2 | .211 |
| Linear-by-Linear Association | 2.519 | 1 | .112 |
| N of Valid Cases | 209 | | |

## Appendix 5.10: lesion in the teat

| | X2 | D.F. | p-value |
|---|---|---|---|
| Pearson Chi-Square | 2.349a | 1 | .125 |
| Continuity Correction | 1.832 | 1 | .176 |
| Likelihood Ratio | 2.362 | 1 | .124 |
| Fisher's Exact Test | | | |
| Linear-by-Linear Association | 2.338 | 1 | .126 |
| N of Valid Cases | 209 | | |

## Appendix 5.11: type of the udder

| | $X^2$ | D.F. | p-value |
|---|---|---|---|
| Pearson Chi-Square | .091 | 1 | .763 |
| Continuity Correction | .024 | 1 | .878 |
| Likelihood Ratio | .091 | 1 | .763 |
| Fisher's Exact Test | | | |
| Linear-by-Linear Association | .091 | 1 | .763 |
| N of Valid Cases | 209 | | |

## Appendix 5.12: lactation stage

| | $X^2$ | D.F. | p-value |
|---|---|---|---|
| Pearson Chi-Square | .557 | 1 | .455 |
| Continuity Correction | .369 | 1 | .543 |
| Likelihood Ratio | .558 | 1 | .455 |
| Fisher's Exact Test | | | |
| Linear-by-Linear Association | .555 | 1 | .456 |
| N of Valid Cases | 209 | | |

## Appendix 5.13: washing of the hand

| | $X^2$ | D.F. | p-value |
|---|---|---|---|
| Pearson Chi-Square | .976 | 1 | .323 |
| Continuity Correction | .000 | 1 | 1.000 |
| Likelihood Ratio | 1.362 | 1 | .243 |
| Fisher's Exact Test | | | |
| Linear-by-Linear Association | .972 | 1 | .324 |
| N of Valid Cases | 209 | | |

## Appendix 5.14: washing of the udder

| | X2 | D.F. | p-value |
|---|---|---|---|
| Pearson Chi-Square | .976 | 1 | .323 |
| Continuity Correction | .000 | 1 | 1.000 |
| Likelihood Ratio | 1.362 | 1 | .243 |
| Fisher's Exact Test | | | |
| Linear-by-Linear Association | .972 | 1 | .324 |
| N of Valid Cases | 209 | | |

## Appendix 5.15: previous mastitis

| | $X^2$ | D.F. | p-value |
|---|---|---|---|
| Pearson Chi-Square | 1.932 | 1 | .165 |
| Continuity Correction | 1.451 | 1 | .228 |
| Likelihood Ratio | 1.941 | 1 | .164 |
| Fisher's Exact Test | | | |
| Linear-by-Linear Association | 1.923 | 1 | .166 |
| N of Valid Cases | 209 | | |

# Appendix 6

## Questionnaire

**بسم الله الرحمن الرحيم**

**Questionnaire for data collection for survey of caprine mastitis in Khartoum state**

Locality…… Farm No……..

Date of investigation ……/……

## General characteristics:-

## Owner:-

Name…… Address……..

Age……....Telephone NO…….

## Housing and codes:-

**Herd size:-** small (<5) (1) large (>5) (0)

**Bedding:-** yes (1) No (0)

**Bedding replacement:-** yes (1) No (0)

**Clean of barn:-** yes (1) No (0)

## Goats in milking management:-

**Washing hand:-** yes (1) NO (0)

**Washing of adder:-** yes (1) No (0)

## Individual risk factors:-

**Age**:- Old (0) Young(1)

**Parity**:- >4 (0) 3-4 (1) 1-2 (2)

**Body condition:-** bad (0) good (1)

**Breed:-** Local (0) Cross (1) Foreign (2)

**Lesion in the teat**:- Yes (0) No (1)

**Type of udder:-** Pendulous (0) Not pendulous (1)

**Previous of mastitis:-** Yes (0) No (1)