Journal of Reproduction and Infertility 11 (3): 51-60, 2020
ISSN 2079-2166

DOI: 10.5829/idosi.jri.2020.51.60

Bovine Mastitis-A Review

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Abstract: To understand the drawback of mastitis on bovine milk production and economics, this review aimed to through light on bovine mastitis. Mastitis refers to an inflammation of the mammary tissue, accompanied by physical, chemical, pathological and bacteriological changes in milk and glandular tissue. Huge quantities of microorganisms have been known to cause bovine mastitis major causal microorganisms are bacteria, but mycoplasma, fungi and algae have also been reported to cause mastitis problems in some herds or regions. Bovine mastitis is predisposed by several epidemiological risk factors that play significant role in causing mammary incompetence to protect it from the invasion of infectious agents. Mastitis can be classified as clinical and subclinical. Clinical mastitis is characterized by change in the morphology of the udder, chemical and physical changes in the milk, while the sub clinical form is without any noticeable manifestations of inflammation. Subclinical mastitis is more common than the clinical mastitis and causes the greatest over-all losses in most dairy herds. It is one of the most economically destructive and zoonotic imminent disease for consumers irrespective of many years of research worldwide with different levels of economic losses identified by different countries. In Ethiopia, even though the disease of mastitis has been known locally, it has not been studied systematically; making information available on the prevalence of disease and associated economic loss inadequate. Diagnosis can be done on the basis of physical examination of udder and milk, California mastitis test, Somatic cell count, surf field mastitis test and bacteriological examination. The common methods of clinical mastitis treatment include stripping the gland frequently to remove organisms and toxins, injecting oxytocin to facilitate milk letdown, IV infusion of fluid and antibiotics (systemic or intra-mammary) whereas, treatments of sub-clinical mastitis involves treating the clinical flare-ups, or culling the cow. Appropriate control methods for mastitis mainly lies in first understanding the epidemiology of the disease and the causal agents and then implementing an integrated control strategy. Epidemiological investigation of bovine mastitis, status of infection, treatment pattern would provide useful management information to the producer, veterinarian and other mastitis control team members.

Key words: Bovine · Diagnosis · Mastitis · Risk Factors · Treatment

INTRODUCTION

Ethiopia has the largest livestock population in Africa. Cows represent the largest population of cattle production of the country [1]. Hence, development of the dairy sector in Ethiopia can contribute significantly to poverty alleviation and nutrition in the country [2]. However, milk production often does not satisfy the country's requirements due to a different of factors. Of these factors, Mastitis is one the factors contributing to reduced milk production [3]. Mastitis refers to an inflammation of the mammary tissue and is a common disease in dairy cattle [4]. It is accompanied by physical, chemical, pathological and bacteriological changes in milk and glandular tissues [5]. Almost any bacterial or mycotic organism that can opportunistically invade tissue

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and cause infection can cause mastitis. Over 135 different microorganisms have been isolated from bovine intra-mammary infections, but the majority of infections are caused by staphylococci, streptococci and gram-negative bacteria [6]. Mastitis had been classified as clinical and sub clinical. Clinical mastitis is characterized by change in the morphology of the udder, chemical and physical changes in the milk, while the sub clinical form is without any noticeable manifestations of inflammation. Sub clinical mastitis is more common than the clinical mastitis and causes the greatest over-all losses in most dairy herds [7].

Mastitis is a multifactorial disease. As such, its incidence depends on exposure to pathogens, effectiveness of udder defense mechanisms and presence of environmental risk factors, as well as interactions between these factors [8]. Diagnosing by screening tests for early detection of mastitis and proper treatment of affected animal are of paramount importance in order to minimize losses encountered due to sub clinical as well as clinical mastitis [9]. In general Bovine mastitis, the most significant disease of dairy herds, has huge effects on farm and country economics due to reduction in milk production (in quality and quantity), zoonotic effect and treatment costs [10]. Epidemiological investigation of bovine mastitis, status of infection, treatment pattern would provide useful management information to the producer, veterinarian and other mastitis control team members [3]. Therefore, the objective of this seminar is to review the bovine mastitis.

Etiology: Several species of microorganisms have been known to cause bovine mastitis [11]. The major causal microorganisms are bacteria, but mycoplasma, fungi and algae have also been reported to cause mastitis problems in some herds or regions [12]. The proportionate importance of the pathogens has varied between countries, regions and farms, mostly owing to differences in management and housing systems [13]. Classically, mastitis pathogens have been classified as contagious and environmental pathogens based upon their primary reservoir and mode of transmission (Table 1).

Table 1: Bacterial pathogens responsible for bovine mastitis in dairy herds

Environmental pathogens	Contagious pathogens	Others
Escherichia coli	*Staphylococcus aureus*	Coagulase-negative
Streptococcus uberis	*Streptococcus agalactiae*	staphylococci
Klebsiella pneumonia	*Corynebacteriumspp.*	(CNS)
Streptococcus dysgalactiae		

Source: [14].

Epidemiology

Risk Factors: Bovine mastitis is predisposed by several epidemiological risk factors that play significant role in causing mammary incompetence to protect it from the invasion of infectious agents. These should receive due consideration in the course of developing an integrated mastitis control program. The risk factors include the host factors, environmental factors and the pathogen factors [15].

Host Factors

Age and Parity: The prevalence of infected quarters increases with age, peaking at 7 year [11]. Cows at age group of young adult and adult had an infection rate of 65% and 93.2%, respectively and cows having greater than 5 calves were more affected than those with fewer and moderate calves [16].

Breed: Increased risk of clinical mastitis occurs in Friesian compared with Jersey and Ayrshire heifers [17]. But this may reflect differences in management rather than a true genetic difference. Valid comparisons between breeds have not been reported [11].

Stage of Lactation: Most new infections occur during the early part of the dry period and in the first 2 months of lactation, especially with the environmental pathogens. In heifers, the prevalence of infection is often high in the last trimester of pregnancy and several days before parturition, followed by a marked decline after parturition [11]. The first month of lactation displayed the highest incidence of mastitis (62.7%), while the late stage of lactation showed the lowest incidence (11.2%) [18].

Dry Period: The cow is at the maximum danger of obtaining new IMI with both contagious and environmental pathogens during the dry period [19]. A study suggests that a longer dry period (>40 days) increased the risk of clinical mastitis. The rate of new infection is not constant across the dry period but is elevated during the two weeks following drying off and the two weeks prior to calving. Increased susceptibility is due, in part, to changes in the teat canal, the primary defense barrier against bacterial penetration [20].

Milking Interval: The influence of an irregular interval between morning and evening milking (<12 or >12 hours/day) on the prevalence of mastitis may have been the consequence of an enhanced chance for bacteria to colonize teat ends and streak canals during the longer milking intervals [21].

Physical Condition of Udder: The teat end is the first barrier against invading pathogens and the efficiency of teat defense mechanisms depends on the integrity of teat tissue; its impairment leads to an increase in the risk of IMI [11]. Teat canal is the main route of entry of mastitis causing organisms except tuberculous mastitis (hematogenous route); hence, teat injury is most important risk factor of IMI [22].

Udder Defense and Milk Factors: Udder has physical and anatomical barriers to prevent entry of infectious organism in the teat canal. These barriers include teat skin, teat sphincter, keratin plug and fursten burg's rosette. Milk contains various soluble factors (e.g., Lactoferrin, immunoglobulins and transferrin) those play important role to prevent bacterial multiplication and establishment of infection [23]. The main function of immunoglobulins in secretions of the bovine mammary gland is opsonization of microorganisms for phagocytosis by leukocytes but they also play a role as antitoxin [24].

It is also important that an early inflammatory response in the infected mammary gland enables leakage of IgG2 (opsonizing antibodies) as this facilitates neutrophil phagocytosis of bacteria. The immune function of the mammary gland is impaired during the periparturient period; it is susceptible to mastitis during transition periods, such as drying off and colostrogenesis. As a result, the incidence of new intra-mammary infections is highest during the early non-lactating period and the peri-parturient period [11].

Pathogenic Risk Factors: Important pathogenic risk factors include presence of number of organisms on teat skin and their virulence factors, presence of minor pathogens and blind treatment. The incidence of mastitis seems to be related to the number of organisms on the teat skin and teat end. *Streptococci* and *Staphylococci* are in high numbers on teat skin; hence, they are the cause of most IMIs [25]. Natural infection with minor pathogens has a protective effect against infections with major pathogens, a phenomenon that is possibly related to the protective effect of the cell response triggered by the minor pathogens [11].

Environmental Factors: The housing system, climate, season, heat stress, milking hygiene, udder hygiene, milking machine and milking techniques play crucial role in the occurrence of mastitis and development of new cases particularly environmental mastitis [26]. Housing is a factor that aggravates the incidence of mastitis, first due to excess numbers of animals in a limited space; and also because of the use of bedding material that easily allows for bacterial survival and growth, which over exposes animals and challenges their immune defense mechanisms [27]. Heat and humidity may increase the pathogen load in the environment (field or housing), resulting in a greater incidence of mastitis in warm weather. The incidence of mastitis decreased with increasing ambient temperature but increased with decreasing ambient temperature [26].

Pathogenesis: Inflammation of the mammary gland predominantly occurs via the teat canal except in the case of tuberculosis, leptospirosis and brucellosis where the method of spread may be haematogenous [28]. The development of mastitis can be explained in terms of three stages as invasion, infection and inflammation. The invasive stage refers to the time in which pathogens move from the teat end to the milk through the teat canal. The infection stage is the stage in which the pathogens multiply rapidly and invade the mammary tissue. The stage of inflammation is the stage with varying degrees of clinical abnormalities of the udder and with systemic effects from mild to per acute as well as gross and subclinical abnormalities of the milk [11].

Types of Mastitis

According to Mode of Transmission of Pathogen

Contagious Mastitis: The sources of contagious mastitis are infected cows and transmission is from cow to cow, mainly at milking time and tends to result in chronic sub-clinical infections with flare-ups of clinical episodes [29]. The principal contagious pathogens are *Streptococcus agalactiae, Staphylococcus aureus, Corynebacterium bovis* and *Mycoplasma species*. Among these, *S. aureus* is currently the most frequently isolated contagious pathogen in subclinical and chronic bovine mastitis worldwide [30].

Environmental Mastitis: Environmental mastitis can be defined broadly as those IMIs caused by pathogens whose primary reservoir is the e nvironment in which the cow lives [29]. The pathogens causing environmental mastitis are *Streptococcus uberis*, *Streptococcus dysgalactiae*, *Escherichia coli* and *Klebsiella* spp. The major method of transmission is from the environment to the cow by inadequate management of the environment. Examples include wet bedding, dirty lots, milking wet udders, inadequate pre milking udder and teat preparation, housing systems that allow teat injuries and poor fly control [11].

According to the Clinical Symptoms

Sub Clinical Mastitis: The non-observable form of mastitis, such as no visible abnormalities of either the milk or the udder, is known as subclinical mastitis [31]. In excess of 50% of animals in a herd can have sub clinical mastitis at any given time. A sudden rise in milk somatic cell count observed in normal milk from normal udders may indicate the presence of sub clinical mastitis. Animals which have subclinical mastitis are usually not producing milk to their full potential and can serve as a potential source of infection to healthy udders [32].

The sub-clinical form of mastitis in dairy cows is important because this form is, 15 to 40 times more prevalent than the clinical form, it usually precedes the clinical form, of long duration, difficult to detect, reduces milk production, adversely affects milk quality and constitutes a reservoir of microorganisms that can affect other animals within the herd due to its contagious nature [33]. If the infection persists for longer periods, then it may form a fibrous tissue barrier between the organisms and the antibiotic preparations, thus, limiting their efficacy [31].

Clinical Mastitis: On the farm, mastitis is usually detected by the observance of abnormal milk such as flakes, clots, or a watery appearance. The udder producing this milk may become swollen, red, hot and hard and there may be also fever, rapid heart rate and loss of appetite [34]. This condition is known as clinical mastitis and is observed in less than 5% of animals in a well-managed dairy herd [32].

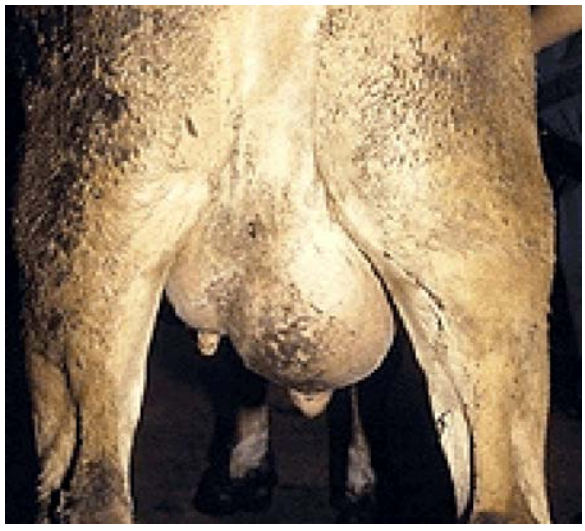

Fig. 2: Heifer with swollen rear gland with mastitis [39]

Cows that developed clinical mastitis suffered an immediate drop in production and will not regain previous production levels during the 60 days following the clinical onset [35]. Clinical mastitis is defined as the production of abnormal milk with or without secondary symptoms such as swollen quarters, elevated body temperature and/or other systemic signs [36].

Although clinical infections are rarely apparent prior to calving, routine observation for abnormal swelling is important. Normal pre-partum udder secretions range from a honey-like appearance to normal milk [37]. Clinical mastitis can be recognized in pre- and post-calving secretions, colostrum or milk by the presence of gargot (clots and flakes), abnormal texture or discoloration [38].

Status of Mastitis in Ethiopia: Mastitis remains the most economically destructive and zoonotic imminent disease for consumers irrespective of many years of research worldwide with different levels of economic losses identified by different countries [6]. However, bovine mastitis as a disease, has received little attention in Ethiopia, especially the sub clinical form Zenebe *et al.* [30]. Until now, efforts have only been so far concentrated on the treatment of clinical cases and not in minimizing the risk factors through appropriate methods of prevention and control [40]. In Ethiopia, even though the disease of mastitis has been known locally, it has not been studied systematically; making information available on the prevalence of disease and associated economic loss inadequate [35].

Several studies conducted in different corners of the country indicated a prevalence range: (13.7% to 81.1%) over all prevalence of mastitis [35, 41] (23% to 85%) prevalence of subclinical mastitis [30, 35], (2.6% to 62.9%) of clinical mastitis [3, 42] and (12.3% to 80.88%) prevalence at a quarter level in small and large scale dairy farms [41, 42]. In general, mastitis is of great economic importance to all dairy producers and also in pastoral and agro-pastoral dairy production systems of the country [43].

Diagnosis: The diagnosis of mastitis according to the International Dairy Federation (IDF) recommendations is based on the SCC and microbiological status of the quarter [44]. It is essential to diagnose mastitis at the initial stage of infection to initiate the treatment as early as possible before the bacteria are anchored in the mammary gland [45]. Diagnosis can be done on the basis of history of flies, season etc., on the basis of clinical signs, California mastitis test and Somatic cell count [46].

Physical Examination: Mastitis may lead to clinical symptoms and, as a consequence, it is often diagnosed directly by visual assessment of udder inflammation or by changes in milk's organoleptic properties [47]. Milk from healthy, uninfected mammary glands has a white to white-yellow appearance and is free of flakes, clots, or other gross alterations in appearance. Such abnormalities are indicators of milk that is unsuitable for human consumption. The presence of flakes, clots, or other gross alterations in appearance of quarter milk is evidence of clinical mastitis and is by definition, abnormal milk [48].

Somatic Cell Count (SCC): Somatic cells are mainly milk-secreting epithelial cells that have been shed from the lining of the gland and white blood cells (mainly neutrophils) that have entered the mammary gland in response to injury or infection. They are normal constituent of milk and only when they become excessive do they indicate IMI [49]. They are composed of leukocytes (75 %) and epithelial cells (25 %) [50].

SCCs in milk are commonly used as indicators of mastitis, on the basis that an increase reflects an immune response to the presence of infection in the mammary gland [51]. An infection is assumed when a specific concentration (normally 100, 000 cells/ml of milk) is exceeded while bacterial infection can cause it to increase to above 100, 000 cells/ ml. A cell count of 200, 000 cells/ml or greater is a clear indication that an inflammatory response has been elicited (subclinical mastitis), the quarter is likely to be infected [52].

The contagious pathogens (*Staphylococcus aureus*, Streptococcus *agalactiae*) generally cause the greatest SCC increase. An infection by environmental pathogens (*Streptococcus dysagalactiae, Streptococcus uberis*, *Corynebacterium bovis* and *Coagulase negative Staphylococcus*) usually causes considerably less SCC elevation [11]. In general, it is accepted that SCC is a golden standard in diagnostics of any form of mastitis in udder [33].

California Mastitis Test (CMT): The CMT is first choice of diagnosis in several investigations because it is more perfect, efficient and reliable than other field and chemical tests for diagnosis of subclinical mastitis [11]. It is based on the principle that the addition of a detergent to a milk sample with a high cell count will lyse the cells, release nucleic acids and other constituents and lead to the formation of a 'gel-like' matrix consistency [53]. It will be carried out as screening test for sub-clinical mastitis and for selection of samples for culture. A squirt of milk, about 2 ml from each quarter will be placed in each of four shallow cups in the CMT paddle. An equal amount of commercial reagent will be added to each cup. A gentle circular motion will be applied to the mixtures, in horizontal plane for 15s [54]. The degree of reaction between a reagent and the DNA of cell nuclei indicates the number of somatic cells in a milk sample, however, the relationship between SCC values and CMT is not precise because of the high degree of variability in SCC values within each CMT score [38].

Surf Field Mastitis Test (SFMT): The principle of the test is that when detergent is added into milk sample, it causes rupture of somatic cell and release DNA and other cell contents. DNA is acid in nature, while detergent contains alkyl-aryl sulfonate, which is basic in nature. DNA and detergents unite to form a gel; consistency of gel depends upon the number of somatic cells [47]. Quarter milk samples and surf solution mixed in equal quantities in petri-dishes separately for each quarter. The change in consistency of milk indicates mastitis, while no change in consistency of milk indicates healthy samples. The mastitis (the reaction of the mixture) will be graded into further four categories based on the severity of disease from lower to higher intensity as, + = moderate, ++ = severe, +++ = more severe, ++++= very severe [54].

White Side Test: The principle of this test is based on the increased number of leukocytes in mastitis milk. Milk samples are placed on a clean dry glass slide and add a drop of 4% sodium hydroxide and mix with a glass rod. If the milk is from animal having Mastitis, it becomes thickened and flakes appear. While the negative milk sample remain the same [55].

Bacteriological Examination: Bacteriological culturing is most often used as a diagnostic tool to solve mastitis problems. Knowledge on the infectious status of mammary glands, however, can also be very helpful to prevent transmission of pathogens by diagnosing a reservoir at an early stage. To effectively use bacteriological culturing as a diagnostic tool, milk samples have to be collected from the correct cows and quarters at the correct point in time [45].

Proper collection of milk samples is of paramount importance for identification of mastitis pathogens. Aseptic technique is an absolute necessity when collecting milk samples to prevent contamination by organisms found on the cows' skin, udder and teats;

hands of the sampler; and in the barn environment. Contaminated samples result in misdiagnosis, increased work and expense, confusion and frustration [48].

Treatment: The success of bovine mastitis therapy depends on the etiology, clinical presentation and antimicrobial susceptibility of the etiological agent among other factors [56]. Clinical mastitis has varying response to treatment, assigned to three reasons- Impermeability of blood-udder barrier to several drugs, presence of milk and accumulation of inflammatory debris in the milk alveoli and lack of milk fat/lipid solubility of many other drugs [57].

The most common route of administration of antimicrobials in mastitis is the IMM route. Systemic treatment is recommended in clinical mastitis due to *S. aureus* and in severe cases of coliform mastitis, preferably in combination with IMM treatment [58]. IMM route alone during lactation, due to presence of pus and milk does not allow the drug to be diffused [11].

Treatment of per acute mastitis includes: stripping the gland frequently to remove organisms and toxins (at 1 or 2 hrs intervals), injecting oxytocin to facilitate milk letdown, IV infusion or oral administration of fluids, administration of anti-inflammatory drugs, analgesics, antipyretics (given systemic) and/or antibiotics (systemic or intra-mammary). Treatment of acute mastitis includes: stripping frequently, administration of antibiotics (systemic or intra-mammary), administration of fluids if needed and administration of anti-inflammatory drugs, analgesics and/or antipyretics. Treatment of sub-acute mastitis includes IMI and stripping the gland (after oxytocin injection). Treatment of Chronic Mastitis usually involves treating the clinical flare-ups, or culling the cow. Treatment of subclinical mastitis is not economical during lactation, but rather is often done during the dry period with IMI of antibiotics for the herd [59].

Control and Prevention: Awareness of the economic losses associated with mastitis is resulting in a desire for mastitis control programs [60]. The wide ranges of microorganisms that can cause this disease and the ubiquity of these organisms, make complete eradication unlikely [44]. Optimum control therefore lies in first understanding the epidemiology of the disease and the causal agents and then implementing an integrated control strategy [61].

The control of mastitis has been successfully achieved through the establishment of effective herd health control programs [62]. Early diagnosis of mastitis with reliable tests facilitates successful treatment and control. The main control principles include: sound husbandry practices and sanitation, post milking teat dip, treatment of mastitis during non-lactating period and culling of chronically infected animals [44]. Other general practices to prevent contagious and environmental mastitis include the milking of infected animals last (milking order) and prevent the animals from lying down after milking. This can be accomplished by feeding them immediately after milking to ensure that they are standing for at least 30 minutes. This should allow enough time for the proper closure of the teat orifice [32].

Cow Hygiene: Maintaining excellent cow hygiene is an essential practice for controlling mastitis in the dairy herd as many studies have found a correlation between clean cows and lower bulk tank SCC. Similarly, some studies have proved that poor hygiene results in udder health problems [48]. Exposure to manure in cow housing areas can influence the rate of clinical mastitis. Moreover, cleanliness of the udder is thought to influence the quantity and type of bacteria that is present on teat surfaces. Dirty teats and udders, as a result of moisture, mud and manure in the environment of the cow, are considered to be sources of environmental bacteria in milk [63].

Pre- and Post-Milking Teat Dipping: Pre-milking teat disinfection was developed as a simple, effective and economic method to control environmental pathogens by reducing bacterial populations on teat skin before milking, thus minimizing their penetration into the teat canal. In addition, the process of preparing teats for milking has several other advantages, which include promoting milk letdown, speeding up the milking process and helping to ensure that the maximum amount of available milk is harvested without causing damage to the sensitive teat tissues [64]. While pre-milking teat dipping is necessary to reduce the microbial population and minimize new IMIs, post milking teat dipping has been used mainly in highly infected herds and it has been revealed also as a very effective tool to prevent mastitis incidence [65]. However, recent researches have revealed that not all types of mastitis causing pathogens are responding the same to teat dipping [66].

Dry Cow Therapy (DCT): All dairy animals usually have a period of 6-10 weeks prior to calving (usually annually) as a dry or resting period, a non-lactating phase. At this time, the cow remains susceptible to new intra-mammary infections, especially soon after the 'drying off' or cessation of milking and around calving [58].

Dry cow therapy (DCT) with antibiotics has been recommended as one of the choices to control IMIs and inhibit progress of mastitis [19]. Antibiotics are applied near the end of lactation and may persist in the udder in high concentrations only to destroy pathogenic bacteria for 20-70 days. The applied antibiotic has enhanced penetration capacity because of long time contact and curing IMIs unless resistance to novel antibiotics is developed by the entering pathogen [67].

Dry cow therapy (DCT) is 90-93% effective against subclinical *Streptococcus agalactiae* infections, 70-80% effective against *Staphylococcus aureus* and 70-90% effective against environmental streptococci. Treatment of *Staphylococcus aureus* infections during lactation may be 50% effective or less (Jones, 2009). Heifers can be given dry cow antibiotic treatment during gestation if *Staphylococcus aureus* is a problem in the heifers [69].

Blanket dry cow therapy is treatment of all four quarters at drying off, compared to selective dry cow therapy based on treatment of only those quarters that are infected. When subclinical mastitis is very low in some herds, selective dry cow therapy can be considered, but nearly all herds use blanket dry cow therapy [11]. In fact, particularly for subclinical udder infections, the most effective time to treat is at drying off because: (1) Higher doses can be used than in the milking cow (2) Antibiotics remain in the udder for longer – compared to the milking cow where a lot of antibiotic is lost at each milking [70].

Zoonotic Potential: With severe clinical mastitis, abnormalities of milk are easily observed and milk is discarded by the producer. Such milk normally would not enter the food chain. But when milk of cows with sub-clinical mastitis, i.e. with no visible changes, is accidentally mixed into bulk milk, it enters food chain and can be dangerous to humans. Although pasteurization is likely to destroy all human pathogens, there is concern when raw milk is consumed or when pasteurization is incomplete or faulty [71].

The bacterial contamination of milk from affected cows has zoonotic importance like tuberculosis, sore-throat, Q-fever, brucellosis, leptospirosis etc [44]. Milk and other dairy products are frequently infected with S. aureus. Milk of infected animals is the main source of enterotoxaemia S. aureus of animal origin. For example certain S. aureus strains produce heat-resistant enterotoxin, which cause nausea, vomiting and abdominal cramps when ingested by humans and are responsible for staphylococcal food poisoning outbreaks [72].

Another public health concern regarding mastitis is antibiotic residues in milk due to extensive use of antibiotics in the treatment and control of the disease. There is a possibility of direct reaction to residues or toxic, anaphylaxis. There is also likely hood of developing drug resistance strains of bacteria [28].

Economic Importance: Mastitis remains the most common and the ambiguity disease of dairy cattle throughout most of the world. It continues to be the most economically important disease of dairy industry, accounting for about 38% of the total direct losses [10]. It is the most economically important disease in the dairy industry in USA, estimated losses ranging from $185.00 to 265.00 per cow per year. This places annual losses in excess of $2 billion or about a 10% loss of total productive capacity [32]. Economic consequences of mastitis, clinical or sub-clinical, include reduced milk yield, poorer quality milk, increased culling rate, increased cost of veterinary services and medicine and increase labor cost for the farmers [73].

Mastitis affects the milk quality in terms of decrease in protein, fat, milk sugar (lactose) contents and increase in SCC. The processing of such milk results in substandard and sub-optimal output of finished fermented products like yogurt, cheese etc [44]. Losses due to mastitis may even be higher in developing countries because standard mastitis control and prevention practices (e.g. pre and post milking antiseptic teat dipping and dry period antibiotic therapy) recommended by NMC of USA are not being carried out in these countries [38].

CONCLUSION AND RECOMMENDATIONS

Bovine mastitis is an inflammation of mammary gland parenchyma of cow. There are various pathogens which can cause mastitis in cow of which bacteria is the most common one. It classified as clinical and sub-clinical bovine mastitis based on its clinical signs; however sub-clinical bovine mastitis is the most economically important disease that affects dairy industry. Routine physical examination of udder and milk, screening test along with bacteriological examinations are the most important methods in diagnosis of bovine mastitis. Successful control and prevention of mastitis involves sound husbandry practices, early diagnosis, dry cow therapy and culling of chronically infected animals. Based on above conclusion the following recommendations are forwarded: Regular screening for early detection and treatment, follow up of chronic case and strict control strategy should be implemented. Good hygiene and appropriate husbandry system should be practiced to

reduce the loss. The sub clinical mastitis which is highly prevalent and economically important should gain attention by the government and all other concerned bodies. In this regard awareness should be created on the importance of this type of mastitis to farmers/owners. Owners should be provide feeds as soon as the milking the cow in order to prevent laying down. Education of public at large about hazard of raw milk consumption and the possible control and preventive measures through heat treatment should always be encouraged before milk is consumed.

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