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Management and Control of Mastitis

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ABSTRACT

Mastitis is a devastating disease in the dairy industry. The severity of mastitis depends upon its type and duration. It can either be caused by contagious pathogens or environmental pathogens. These pathogens enter the udder and cause toxicity which not only affects milk production but also the quality of milk. This disease has a worldwide impact affecting farmers economically. Several diagnostic approaches are used to evaluate mastitis, to control and manage this disease including somatic cell count and specific enzyme concentration in milk. This disease can be treated by using antibiotics and alternatives to antibiotics such as bacteriocin. Some modern approaches like vaccination (immunization) are also used as a pre-adaptive treatment of mastitis. Sometimes, genetic factors contribute to resistance against mastitis. We can also prevent the disease by adopting some techniques and methods. Mastitis is the most economically significant bacterial disease of dairy cattle. It needs further improvement in control to ensure the sustainability of dairy farming.

Keywords: Somatic cell count, genetic resistance, bacteriocin, vaccination.

1. Introduction:

Mastitis is the inflammation of the udder. It is responsible for major economic losses on dairy farms worldwide, due to a decrease in milk production, an increase in healthcare costs, and an increase in culling and death rates [1]. It is the most contagious disease. Mastitic milk negatively affects the quality of different milk products. Somatic cell count is generally increased in mastitic milk. Bacterial pathogens are almost 70% involved in mastitis. These pathogens invade the udder, manipulate and produce toxins that damage the udder, affecting the yield and quality of milk. Minor causes (30%) are due to trauma and physical injury. Several attempts are made to control this disease including vaccination against gram-negative bacteria to minimize the chances of clinical mastitis. Antibiotic treatment of clinical and subclinical mastitis in dairy cattle is an established component in mastitis control programs.[2] The prevalence of disease requires knowledge about the disease-causing pathogens and the adaption of therapeutic techniques. Mastitis can be lethal if left untreated, so different methods and techniques should be adopted for the prevention of mastitis.

2. Classification:

2.1 Contagious mastitis: It is caused by bacteria living inside the udder or skin of teats. It can be further categorized into 3 classes:

2.2 Clinical mastitis: It is marked by the presence of visible signs of inflammation (it can be per-acute mastitis, acute mastitis, and subacute mastitis)

2.3 Subclinical mastitis: it is marked by a change in milk composition but no signs of visible inflammation or milk abnormalities.

2.4 Chronic mastitis: It is an inflammatory response that can last for months and may continue from one lactation to another [3].

2.5 Environmental mastitis: It is caused by a bacteria named *Escherichia coli* which usually does not live in the udder or on the skin. It can enter the teat canal when comes in contact with contamination.

2.6 Summer mastitis: It can be caused by the mass of the fly population. It causes acute illness in dry cows or heifers and can damage half of a quarter of cows. Different types of mastitis are shown in the Fig. 1 [4][5].

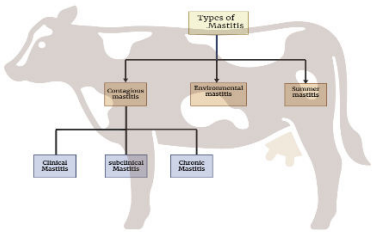

Fig. 1: Types of mastitis (Retrieved from BioRender)

3. Causes of mastitis:

Mastitis can be caused by contagious pathogens or environmental pathogens.

3.1 Contagious pathogens: The disease is transmitted from animal to animal, mainly during the milking process. It can be caused by *staphylococcus aureus*, *streptococcus agalactiae,* and *Corynebacterium*.

3.2 Environmental pathogens: Transmission is done by the habitat of dairy cows. The pathogens responsible for this infection are *Escherichia coli*, *Streptococcus uberis, Streptococcus dysgalactiae,* and gram-positive catalase-negative cocci [6].

Mostly subclinical mastitis is caused by fungi. *Candida* species are usually responsible for mastitis (*candida glabrata* and *candida krusei*) [7]. Bacteria like *Streptococcus aureus* and *Streptococcus agalactiae* are responsible for mastitis and are considered more contagious. *Corynebacterium* lives on cow udder and can enter into the teat canal of a cow and causes inflammation. In sub-clinical cases usually somatic cell count (SSC) is increased [8].

4. Diagnosis:

4.1 Somatic cell count: It is an effective diagnostic tool used for the detection of mastitis. Somatic cell count is mostly composed of macrophages (66-88%), in addition to neutrophils, epithelial and mononuclear cells. Whenever bacteria invade into udder the neutrophils rush towards the infected quarter leading to increased somatic cell number. If the bacteria are removed from the gland the number of neutrophils will be normal and an inflammatory episode is required to restore the activity of quarter [9].

A healthy cow requires no treatment having SCC<100000 cells/ml. A clinically infected cow was receiving veterinary treatment after showing clinical signs of mastitis and SCC >800000 cells/ml [10].

4.2 Enzymes: The performance of N-Acetyl-β-d-glucosaminidase (**NAGase**) activity in detecting clinical and subclinical mastitis and distinguishing infections caused by minor and major bacteria was investigated [11]. **NAGase** is an intracellular, lysosomal enzyme that is released into milk from neutrophils during phagocytosis [12]. Increased level of these enzymes is used as a biomarker in diagnosis.

5. Genetic resistance in mastitis:

5.1 Blad (Bovine Leukocytes Adhesion Deficiency)**:** CD18(BTA1) gene linked with Blad. The gene encodes the beta-subunit of an integrin family of adhesion molecules and a deleterious allele responsible for the non-expression of beta-2-integrin adhesion molecule on the surface of leukocyte. Homozygous deleterious allele leads to diapedesis of leukocytes. Hence, animals are susceptible to mortality and infection [13].

5.2 Lactoferrin and lysozyme: These two genes have unique properties in milk. Lactoferrin (LF) is responsible for iron binding and bacteriostatic properties. However, bacteria that have high iron requirements are susceptible to the bacteriostatic activity of LF [14]. Lysozyme (BTA5) cleaves bacterial cell wall. Lysozyme is a bactericidal protein that cleaves peptidoglycans from the cell wall of Gram-positive bacteria. The present study reveals that the lysozyme concentration is significantly higher in clinical cases than in subclinical cases. The significant increase in milk lysozyme activity obtained from mastitic cow's udder plays a crucial role in increasing the antimicrobial effectiveness [15].

6. Treatment:

A broad range of antibiotics are applied to treat mastitis in a sophisticated way. *Streptococcus* infection is eliminated but there is no surety for the elimination of staphylococcus infection due to escalation of *Corynebacterium* infection or fungal infection. Antibiotic therapy can destroy saprotrophic microflora and participates in milk fermentation [16]. Some antibiotics used for the treatment of mastitis are pirlimycin, methicillin, cloxacillin, amoxicillin, novobiocin, penicillin G, and erythromycin etc.

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Broad-spectrum antibiotics are used to prevent the infection. Local antibiotics are also used through the intramammary route, mostly used in dry periods. Bacteriocin (polypeptide antibiotic) is an alternative treatment used against mastitis. These are small antimicrobial peptides synthesized by gram-positive and gram-negative bacteria. They are active against a wide range of bacteria. Some commercial bacteriocins are developed as nisin [17]. Its action is almost comparable with antibiotics. Bacteriocin is nontoxic for eukaryotic cells and their peptic nature is broken in the gut. Hence, residues of bacteriocins in milk are not a problem [18].

7. Vaccination:

Most intra-mammary infections are caused by gram-negative bacteria. The dairy animals are vaccinated against these pathogens. Hence, minimizing the risk and chances of mastitis. This technique is widely used by farmers to vaccinate animals for particular strains of bacteria [19].

8. Prevention and management:

The milker's hand should be clean, dry, and washed properly. The dung and urine should be removed immediately, which reduces the chances of mastitis. Dry bedding and a clean environment ensure less chances of mastitis. Methods should be adapted against lice, fleas, and ticks because they are usually vectors or carriers of disease. Wet places should be dried as soon as possible as these places support the growth of fleas. There should be proper sanitation of the wet places [20,21]. Machine milking should be used, to prevent disease. Pre-milking sanitization method should be adopted as a hygienic measure to avoid infection. The use of vitamin E and selenium in diet reduces the incidence and duration of clinical mastitis. Genetic selection is the tool that can prevent the chances of mastitis. Vaccination is also an adaptive measure to prevent the cases and chances of mastitis.

9. Conclusions:

Bovine mastitis is a devastating disease, and it highly affects the dairy industry and dairy producers. The quality of milk is more important than quantity. The dairy industry cannot process milk with a higher SCC or milk containing antibiotic residues. This means that controlling mastitis is crucial. The use of the correct dose of antibiotics under given circumstances minimizes the chances of mastitis and resistance of bacteria against antibiotics. It can be prevented by immunization of animals against bacteria as a pre-adaptive measure. By adopting hygienic and adaptive measures, we can reduce the chances of mastitis.

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