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Advances in the Management of Bovine Mastitis

***[1]Garima Kansal; [2]Dhawal Kant Yadav; [2]Amit Kumar Singh; [2]Manmohan Singh Rajput**
[1]MVSc Scholar, LPM Section, IVRI, Izatnagar, Bareilly, UP
[2]Ph.D. LPM Scholar, Division of Livestock Production and Management, NDRI, Karnal, Haryana
*Corresponding Author: dhawalyadav777@gmail.com

***Abstract:** It is always suggested by research workers that on a successful dairy farm, proper management of mastitis becomes necessary. Mastitis is the disease that has caused huge losses to dairy industry. It affects not only the developing nations but also to the developed ones. Each and every year a huge amount of milk and money is spoiled through mastitis. Moreover, it affects body condition of bovines and their udder health status is also adversely affected. Both milk yield and quality gets lowered. It is rightly said that prevention is better than cure. Proper management conditions are like prevention for the mastitis. There are several and easy management strategies through which unwanted conditions in the farm may be eliminated. This review paper enlightens the management strategies through which the bovine mastitis can be eliminated before it may appear.*
***Keywords:** Management, Bovine, mastitis, milk yield, udder health*

Introduction

Milk is one of the most important food of human beings and is recognized globally as a complete diet due to presence of essential components required for human health. India has a good number of dairy animal population which plays an important role in economy of the country. India continues to be the largest producer of milk in the world (19% of the world's total milk production) with annual milk production of 176 million tons in 2017-18(BAHS, DAHD&F,GOI). The per capita availability of milk in India is above the ICMR recommended level of 280 gram per day. By the year 2030 milk demand would be around 200 MT.

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With this existing rate of growth in milk production (6.37%) supply is likely to fall short of demand in the next two decades. There are several barriers in achieving the production targets among which mastitis is one of the biggest challenging impediment since the affected quarter may have 30% less productivity and a cow may loss 15% production (Shrivastva*et al*., 2015)

Mastitis: Mastitis, the inflammation of parenchyma of mammary glands, is a complex multi etiological disease affecting dairy cattle worldwide. It is characterized by physical, chemical and usually bacteriological changes in milk and pathological changes in glandular tissues affecting milk production and its quality (Radostits, 2000)

Etiology of mastitis: It can be of an infectious, traumatic or toxic nature. Of the several causes of mastitis, the microbes are the vital players in causing bovine mastitis. More than135microbial species, subspecies and serovars have been isolated from the bovine mammary glands(Watts, 1988).

Prevalence of mastitis: Subclinical mastitis is believed to be more prevalent than clinical mastitis in most countries. Recent studies reported high incidence of subclinical mastitis ranging from 20 to 83 per cent in cows and 45 per cent in buffaloes. According to Kumari *et al*., 2018 the prevalence of subclinical mastitis in five states of Punjab, Haryana, Uttar Pradesh, Madhya Pradesh, and Maharashtra was 53.52%, 51.18%, 39.58 %, 62.49 % and 35.11 % respectively.

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Risk factors of mastitis:

Host factors: breed, species, age, parity, stage of lactation, dry period, transition period, milking interval, udder defence etc.

Pathogenic risk factors: Important pathogenic risk factors include presence of number of organisms on teat skin and their virulence factors.

Environmental factors: Various environmental factors like housing system, climate, heat stress, milking hygiene, udder hygiene, milking machine, milking techniques etc.can play a crucial role in the occurance of mastitis.

Annual economic loss due to mastitis in India: Global estimated economic losses per year due to mastitis amounts to USD 35 billion. The annual economic loss due to mastitis in India has been calculated to be approximately Rs.7165.51 crores; (Project Directorate on Animal Disease Monitoring and Surveillance, 2011)

Reasons of loss: Decreased milk quality, milk rejection, cost of treatment, loss of udder Tissue; culling of animal. The economic losses due to bovine subclinical mastitis is in range ofRs.21,677/- to 88,340/- per animal per lactation (Rathod *et al.*, 2017).Other causes are the elimination of milk containing antibiotics used in treating sick animals, loss of genetic value by culling cows early and more expensive replacement, veterinary fees, drug expenditures, payments of extra labor hours and the commercial value reduction of cows removed. The economic losses associated with mastitis has been estimated to be due to reduced milk yield (up to 70%),milk discard after treatment (9%),cost of veterinary services (7%) and premature culling (14%).

Advances in management of bovine mastitis at farm level:

Machine Milking: The advent of mechanization in farm management has revolutionized dairy production operations and undoubtedly, machine milking has emerged as one of the most utilized technological interventions in that process. It simplified the most labor intensive part of dairying, improved milking performance and milk quality. But inadvertently, it has also resulted in udder disorders which has been attributed to defective milking machine and faulty milking management (Paoilova*etal.*, 2011).Improper handling of machine, over use, machine malfunction and inadequate training of the personnel may accrue chances for increased incidence of mastitis and other teat related disorders.

Vacuum and pulsations applied in the milking procedures lead to certain changes of teat tissue appearance, such as teat end congestion, changes in teat dimensions, color, texture and formation of callus ring on top of the teats. Milking machine may increase the incidence of mastitis by facilitating transfer of bacteria between cows or quarters on the same cow, aiding in the multiplication of bacteria at the teat end, increasing the bacterial penetration of the teat during milking, modifying the teat/ intra-mammary environment to enhance bacterial infection or impair host defenses.

Proper functioning of the several parts of the milking machine is a prerequisite for hassle free and smooth operation of milking machine. In order to avoid machine generated factors leading to mastitis regular appraisal of machine performance at

Pre milking cow preparation: Premilking preparation includes cleaning teats before unit attachment and examination for clinical mastitis and abnormal milk. The combination of effective teat cleaning and fore stripping will provide sufficient stimulation for milk letdown. Proper teat-end disinfection can reduce teat surface bacteria. Pre-dipping is most effective in the control of environmental pathogens (E. coli and environmental streptococci)(Ruegg *et al.*, 1987, Fox *et al.*, 1997).A minimum contact time of 20-30 seconds is needed for effective disinfection.

Unit attachment: To maximize milking efficiency, units should be attached from 45 to 90 seconds from the beginning of stimulation.

Unit removal: Milking units should be removed promptly when the milk flow rate from the udder drops below 0.5 kg/ min. Early unit removal may result in reduced milk yield. Overmilking poses highest risk for developing new mastitis infections and teat damage.

Post milking management: Post-milking teat antisepsis scan reduce the incidence of new udder infections by 50-90%.

Automated teat dipping and backflushing: After a cow has finished milking, a signal to the individual control system is given, the milk line is closed and disinfection fluid is sprayed into mouthpiece chamber of teat liner. The unit is detached within 1 s. after which the system allows about 10-15 seconds for the disinfection fluid to disinfect the liner then rinsed 6-10 times with alternating cold water, followed by compressed air to remove any chemical residue and clean each liner **(**Riekerink *et al.*, 2012)

Dipping solutions: various dipping solution-Iodophor solution (0.1% - 1%), Sodium hypochlorite (4%), Chlorhexidine(0.35–0.55%), DodecylBenzene Sulfonic Acid (DDBSA), Quaternary Ammonium compounds(0.05- 1.0%)

Alternative to these chemicals are the **herbal products**– Mastidip, Mastilep, Phytomast, etc.

Frequency of slipping or falling teat cups: Minimize the slipping or falloffs to less than 5% of cow's milking's. Heavy clusters, uneven weight distribution within the cluster, blocked air admission holes or poor liner design are other common causes of slips and falloffs.

Dry Cow Therapy: Treating or infusing teat of lactating dairy animals with long acting antibiotics or teat sealants or both at drying-off following last milking for management of subclinical mastitis is called dry cow therapy (Biggs, 1998). It not only helps in preventing the risk of udder infection during dry period but also the milk yield in subsequent lactations is increased. This therapy cure existing infections and prevent new infections in the early dry period.

Advances at diagnostic level: Correct and quick diagnosis help in effective control of mastitis. Various tests for diagnosis are:

Indirect tests: California mastitis test (CMT), Somatic cell count (SCC), Electrical conductivity test (EC),White side test (WST), Sodium lauryl sulphate test (SLST) Surf field mastitis test (SFMT),Chloride test, Catalase test, Bromothymol blue test (BTB), NAGase test, Infrared Thermography(IRT), Proteomic techniques.

Direct tests: PCR, Rennet coagulation test, Lactose determination test, Modified Hulendorfer Mastitis probe (MHMP), Radial immunodiffusion test

Biochemical tests: Arginase enzyme, Lactate dehydrogenase (LDH), Alkaline Phosphatase (ALP), Alanine aminotransferase (ALT)

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Therapeutic management of mastitis: Generally post mastitis management is done through antibiotics.

However, their regular use poses many problems like widespread bacterial resistance against antibiotics, no new drug in pipeline, chemical residues in milk indirectly affecting human health, violation of guidelines for organic farming. These challenges demands the need for the therapeutic advancements for managing mastitis.

Advances in therapeutic management:

Nanotechnology: Nanotechnology has enabled to synthesize nanosized particles using them in a wide range of applications, particularly in drug delivery. Nanoparticles possess increased surface areas and therefore have increased interactions with biological targets (such as bacteria) compared with micron particles. Moreover, they are much more likely to enter cells than micron particles. The nanoparticles may be considered potential delivery systems in the treatment of bovine mastitis since they may be taken up by the phagocytes. As example, silver nanoparticles showed to inhibit S. Aureus isolated from subclinical mastitis (Dehkordi *etal*., 2011).

Bacteriophages: Bacteriophage therapy can be a possible alternative to antibiotics in the fight against mastitis infections. Phages presented several features critical to their use as phage therapy, like wide range of host, high lytic activity, and thermo stability, do not affect normal micro biota, eco-friendly etc.

Phage K is an anti-staphylococcus phage, with lytic and antimicrobial action and has been used as prophylactic measure in infections caused by S. aureus.

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Kwiatek *et al.* isolated a new virulent phage (MSA6) from a cow with mastitis, which presented a wide lytic spectrum against staphylococcal strains of bovine origin. Fenton *et al.* 2013 tested bacteriophage-derived peptidase; CHAPK against S. aureus isolated from mastitis infected cows. CHAPK was effective against biofilms either by preventing biofilm formation or by disrupting established biofilms of staphylococci strains associated with bovine mastitis.

Vaccination: Nowadays, vaccination became an important area in mastitis control strategies. Effect of vaccination depends on several factors: type of vaccine, age of cow, environmental conditions. ***Streptococcus uberis* vaccine**: Bacterin vaccine, Live vaccine, Subunit vaccine, Recombinant cytokine vaccine (IL-2, TNF-a), ***Staphylococcus aureus***: Bactrin***, E.Coli*** vaccine: J-5"bactrin"and "mastiguard" J-Vac.

Natural Compounds

Plant-Derived Antimicrobial: Plants are promising sources of new biologically active agents with antimicrobial action. Moreover, plant-derived drugs have the advantage of not inducing resistance after prolonged exposure (Domadia *et al.*, 2007, Ohno *et al*., 2003) Eg. diterpenes.

Fonseca *et al*. tested three diterpenes: manool, ent-kaurenoic acid, and entcopalic acid against several bovine mastitis pathogens. Entcopalic acid (CA) was the most active against most of the microorganisms tested. Besides its antibacterial potential, CA did not to cause a cytotoxic effect on human fibroblast cell line, so this fact encourages its possible use on bovine mastitis control and treatment.

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Some of the plants and their parts with promising results against mastitis pathogens have been used. These include Tinospora cordifolia, Curcuma longa, Allium stivum, Azadirachtaindica,Ocimumsanctum,Terminaliachebula,Morindacitrifolia,Taraxacummongolicum, Eucalyptusglobulus.

Animal-Derived Antimicrobial: The immunomodulators, naturally produced by mammals, such as lactoferrin, acts as potential non-antibiotic antimicrobial agents for treatment and prevention of bovine mastitis. Lactoferrin is a glycoprotein found in several body secretions such as saliva, tears, bronchial mucus, and milk. This molecule exhibited an antibacterial effect against E. coli, S. aureus, coagulase-negative staphylococci, Pseudomonas aeruginosa and K. pneumonia (Kutila *et al*., 2003). Other example include β-lacto globulin (whey), marine sponges (Cinachyrella sp., Haliclona sp., and Petromica citrine)

Bacteria and Bacteria-Derived Antimicrobials: Natural compounds produced by bacteria presenting antimicrobial action can be an alternative antibiotics for the control and treatment of bovine mastitis. Weisella confusa (lactic acid bacteria) and its metabolites active against S. aureus and S. Agalactiae (Serna-Cock *et al.*, 2012). Bouchard *et al.* tested live lactobacillus casei as mammary probiotics. These bacteria were able to prevent the internalization of S. aureus into mammary epithelial cells and therefore reduce chronicity and recurrence of S. aureus mastitis infections.

Stem cell therapy: Stem cells are commonly defined as "cells capable of self-renewal through replication and differentiating into specific lineages". Beside this, stem cells have important property that they also serve as a sort of internal repair system, dividing essentially

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without limit to replenish other cells as long as the person or animal is alive.Secreted factors of these stem cells have multiple positive effects like their role in the formation of new blood vessels and promotion in migration of cells, both of which are integral in healing tissue damaged by mastitis. Some factors protect epithelial cells from damage caused by bacterial toxins, and others proved to be antimicrobial peptides that play a role in killing bacteria. It could also help the antibiotics work better, since they produce some of those antibiotic properties (Van de Walle, 2018).

Disease resistant breeding: With the advancement of molecular/ quantitative genetics, marker-assisted selection (MAS) are one of the novel ways for selecting disease resistant breeds for mastitis. Candidate genes can be chosen on the basis of known relationship between physiological/biochemical processes as well as production traits so called Quantitative Trait Loci (QTL) (Deb *et al*., 2012). Various novel genes has been identified and their association analysis with SCC revealed mastitis resistant biomarkers viz. TLR2 (Zhang *et al*., 2009), TLR4 (Deb *et al*., 2013), IL8 (Chen *et al*., 2011), BRCA1, (Xu *et al*., 2011), CACNA2D1 (Yuan *et al*., 2011).

Conclusion: Advances in mastitis research have brought new technologies that can be used to solve complex problems confronting dairy production. A better understanding of the multiplicity of pathogens causing mastitis their virulence, knowledge of mammary gland immunology, will facilitate development of effective mastitis vaccines. Novel developments, strategies, and advances in mastitis diagnosis, treatment and prevention (phages, stem cell therapy, nanoparticles etc.)can improve udder health and result in reduced severity of mastitis, increased production and profitability.

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