

A Review on Mastitis Control through Dry Cow Therapy

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ABSTRACT

Mastitis is a multifactorial disease which is characterized by the inflammation of the parenchyma of mammary glands. The maximum new intramammary infections are acquired during the dry period. Therefore dry cow therapy is cornerstone for mastitis control in bovines. Dry cow therapy is use of intra-mammary antimicrobial therapy immediately after the last milking of lactation. It is implementation of the five-point plan for the mastitis control. It mainly aims on removing the prevailing intra-mammary infections and inhibiting new intramammary infections during the dry period. Recently, there is growing concern of indiscriminate use of antibiotics. Therefore, the non-antibiotic therapy, teat seals is gaining popularity and there is need of development for other new approaches for control of mastitis. This review focus on new bacterial infections during dry period and the various approaches involving control of mastitis.

Key words: Mastitis; Dry cow therapy; Intramammary; Teat seals

INTRODUCTION

Mastitis is the inflammation of the parenchyma of mammary glands, which is a multifactorial disease and is characterised by physical, chemical and usually bacteriological changes in milk along with pathological changes in glandular tissue of the udder¹. Mastitis is a disease of global importance and it adversely affects the animal health, milk quality and causes huge economic losses to dairy sector. The economic losses are in terms of reduction in milk yield, discarding of milk, treatment cost and premature culling of animals². Approximately 140 microbial species, subspecies and serovars have been

isolated from bovine mammary gland. Among microbial species various types of bacteria, viruses, fungi and algae have been identified as mastitis causing pathogens. Among bacteria contagious pathogens (*Staphylococcus aureus*, *Streptococcus agalactiae*, *Mycoplasma bovis*, *Corynebacterium bovis*); teat skin opportunistic pathogens (*coagulase negative staphylococci*) and environmental pathogens (*Streptococcus uberis*, *Streptococcus dysgalactiae*, *E. coli*, *Klebsiella* spp.) have been found to be frequently associated with the cases of mastitis¹. Various approaches have been implicated to combat the infectious pathogens causing the mastitis.

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The lactation therapy and dry cow therapy are the major ways to treat the cases of mastitis. However in lactation therapy the use of antibiotics is criticized due to the concern of antibiotic residues in milk. Moreover, the chances of getting new intramammary infections (IMI's) are very high during the dry period. Therefore during dry period the institution of therapy for control of mastitis is very advantageous³. With the advent of antibiotics in the 1940's, the quickly and easily eradication of the mastitis was expected. But up to two decades after this, it was not achieved⁴. Thereafter introduction of a five-Point plan was developed. This plan was heavily depended on the motivation, education and commitment of the milkers and the herd owners to achieve the consistent results. The five point mastitis control programme is as follows-

1. Udder hygiene and proper method of milking
2. Proper maintenance of milking machines
3. Dry cow management and therapy
4. Appropriate therapy of the mastitis cases during lactation
5. Culling of chronically infected cows

This five point plan is highly successful for the control of contagious mastitis but it is not sufficient for control of the environmental mastitis. After that five additional managerial practices were recommended for giving emphasis on the appropriate environment practices and ten-point mastitis control programme was developed¹. Now-a-days there is increase in consumer fear over the antibiotic resistance due to indiscriminate use of antibiotics. Therefore, the emphasis is given non-antibiotic approaches for control of mastitis.

DRY PERIOD AND NEW BACTERIAL INFECTIONS

Dry period is the period between two successive lactation phases. Dry period is divided in three phases: First phase – period of active involution; second phase – steady state period; third phase – period of transition. The mammary glands are most susceptible to the

new infections during the first phase and the third phase^{5,6,7}. There are a number of factors which contribute to increased susceptibility of udder to new infection during the first and last phase of dry period. As there is termination of milking (milking has flushing effect on bacteria) and milking practices (such as forestripping and predipping) which prevent new bacterial infections during the lactation period so there is increased exposure and growth of bacteria on teat skin and in the streak canal after drying-off. The development of a physical barrier (the keratin plug in the streak canal) is an important intramammary defense mechanism. Reports from both New Zealand and North America have demonstrated that by second, fourth and six weeks after dry off; respectively 40 per cent, 30 per cent and 24 per cent keratin plug was not formed in dry cows^{8,9}. The development of the keratin plug has been significantly related to production level at drying-off. Dingwell *et al.*^{9,10} reported that teats canals were still open up to 6 weeks after drying-off in half of the cows that produced more than 21 kg of milk on the day before they were dried. The clinical cases of new IMI's during the first 100 days lactation are due to acquired IMI's during the dry period. Two weeks prior to parturition there is breakdown of keratin plug and decrease in leucocyte protection¹¹, therefore the mammary glands becomes immunosuppressed and chances of getting new IMI's increases. These new IMI's have more chances to develop as clinical cases of mastitis during the subsequent lactation¹² and the environmental bacteria are the major pathogens which are responsible for these post- partum cases of clinical mastitis¹¹.

DRY COW THERAPY (DCT)

Dry cow therapy is the use of intramammary antimicrobial therapy at the end of lactation. It is one of the key points in mastitis control programme and has become a very effective and widely used method for control of mastitis. It has two aims. First aim is to cure the existing infections and second is to prevent the establishment of new IMI's during the dry period¹³. During the dry period the elimination

and control of infection is more effective as there is sustained and uniform concentration of antibiotic in udder. In addition, the economic losses due to discarding of milk are alleviated. In various experimental studies, it is reported that therapy dry period is the best and effective way of controlling intramammary infection due to *Streptococcus agalactiae* and up to some extent in *Staphylococcus aureus*^{14,15,16}.

APPROACH TO DCT

Before start of DCT cessation of lactation in animals is necessary. The standard method for cessation of lactation (drying-off) for industry is abrupt cessation of milking, through which milking is stopped on the day scheduled for dry-off (all cows are usually scheduled to be dry off on the same day each week) and this helps in facilitation for administration of dry cow intramammary preparations. Abrupt drying-off leads to higher new IMI rate in the dry period as compared to intermittent drying-off, although the increase in prevalence is most evident in cases that are not treated during dry period. The best approach to dry off cows therefore, is intermittent milking. After involution, the udder is resistant to the infections due to the high lactoferrin concentration, and the low citrate/lactoferrin molar ratio inhibits the establishment of gram negative organisms¹⁷. As the cow is susceptible for the new IMI's in initial weeks of dry period by environmental pathogens and in last weeks by environmental and coliforms pathogens. Therefore, the dry cow therapy should be extended over the whole dry period^{18, 19}.

DRY COW ANTIBIOTIC THERAPY

The dry cow antibiotic therapy requires good activity against *Staph. aureus* including β -lactamase producing strains, *Staph. uberis*, *Strep. dysgalactiae*, *Strep. agalactiae*, and if prophylaxis against the summer mastitis is required, therapy should also be effective against *Arcanobacterium pyogenes*²⁰. Therefore, the widely used intramammary injections contain narrow spectrum penicillins (penicillin, cloxacillin, oxacillin and nafcillin), cephalosporins and spiramycins. The use of effective dry cow products results in 70-98 per

cent elimination of existing infections. Although, dry cow antibiotic therapy is very effective yet, it suffers some disadvantages like appearance of antibiotic residues in milk. As a consequence of it, milk is withheld for a period of time after calving, which results in economic losses. The antibiotics used in dry cow therapy should be such that, it is readily milked out after calving²¹. Because of the intracellular location of *Staph. aureus*, elimination of it is less successful²². Along with it there is growing concern of indiscriminate use of antibiotics, which may contribute to the increase in the antibiotic resistant microorganisms²³. It is important that the instructions mentioned on the label should be followed carefully for the recommended dosage level, required withdrawal period, storage guidelines and expiry dates.

TEAT SEALS

The major defence mechanism in the teat canal is the formation of keratin plug. But the rate of closure of teat canals after drying-off varies greatly from cow to cow with fifty per cent of teats still 'open' up to 10 days after drying-off. This delay in keratin plug formation may lead to an increase in new IMI's, as 97 per cent of dry period IMIs occur in open teat canal ends⁸. But recently there is global widespread concern on indiscriminate use of antibiotics and there is growing interest on application of organic farming. Therefore, sealing the teat canals of uninfected quarters at the end of lactation may provide an acceptable alternative to blanket treatment with antibiotics. Due to the biologically inert property of teat seals, these have no concern of antibiotic resistance and the residual problems in milk. Therefore the idea of using teat seals as a prophylactic treatment for mastitis has gained popularity. There are of two types of teat seals, external teat seals and internal teat seals. External teat seals are non-irritant and made up of latex, acrylic or polymer based films and these are applied like a teat dip to produce a layer over the teat end, thus they prevent the entry of bacteria into the teat canal. Quarters with external seals have been shown to have a lower level of new IMI's during the dry period

than do unsealed quarters, but the existing external teat seals are ineffective as a long-term treatment²⁴. External teat seals failed to achieve satisfied control after 48 hours of administration²⁵. Much greater success has been achieved with internal teat seals as compared to external teat seals. A teat seal containing bismuth subnitrate was developed in the 1970s and was shown to be effective at preventing new dry period infections in an artificial challenge study^{13,26}. Tiwari *et al.*,²⁷ reported a higher decrease in new infection rate with the intramammary infusion of bismuth subnitrate as compare to intramammary antibiotic combination of colistin sulphate and cloxacillin sodium. As in late dry period the concentration of antibiotic falls below the therapeutic level, therefore the combination of intramammary antibiotic and internal teat seals has been used²⁸. Bradley *et al.*,²⁹ found the better decrease in newer IMI rates in cases of mastitis when the combination of both antibiotic and internal teat seal were used in combination as compared to the alone use of antibiotic.

BACTERIOCINS

Bacteriocins are polypeptides which are synthesized by ribosomes and they usually possess antibacterial activity against bacteria of the same or closely related species³⁰. Bacteriocins are identified as potential antimicrobials. Lactococcal bacteriocin, nisin has a wide spectrum of activity against gram positive bacteria, including species of *Enterococcus*, *Lactobacillus*, *Lactococcus*, *Leuconostoc* and *Pediococcus*³¹. The use of nisin-containing germicidal formulation in preventing mastitis in cattle has been investigated and Pieterse and Todorov³² reported a significant reduction in pathogens, in experimentally challenged teat surfaces after one minute exposure to the germicidal formulation. Another bacteriocin, Lacticin 3147 was investigated for use as an antimicrobial agent as it inhibits common mastitis causing pathogens, including *Staph. aureus*, *S. dysgalactiae*, *S. uberis* and *S. agalactiae*³³. As the internal teat seal formulations are gaining popularity in DCT as

a prophylactic measure to reduce the number of new IMI's (34). But due to the biologically inert property of the internal teat seal formulation, they have no antimicrobial effect and therefore the internal teat seal relies on good udder hygiene practices for effective control of the disease. To prevent new infections antibiotics such as cloxacillin have been added to the teat seals. However, prolonged exposure to antibiotics at low levels may lead to increase in the risk of antibiotic resistance by pathogenic bacteria. The bacteriocins such as lacticin 3147 may act as good alternative for antibiotics in DCT^{35,36}.

CONCLUSION

For the effective and economic control of mastitis there is need of dry cow therapy because the chances of getting new intramammary infections are highest during the dry period. Antibiotic dry cow therapy is effective for control and treatment of intramammary infections, but due the growing concern of antibiotic residues in milk and evolving antibiotic resistant pathogens, attention has been focussed on evolving other approaches for treatment and control of mastitis. Teat seals due to their inert biological property are gaining popularity for dry cow therapy. Internal teat seals are very potent in preventing new intramammary infections. Bacteriocins (Nisin and Lacticin 3147) which are the ribosomally synthesised polypeptides, because of their antimicrobial property and no residue problem in milk, these may play important role in control of mastitis and may act as good alternative for antibiotics.

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