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Abstract

Purpose: Mastitis is an inflammatory disease condition of udder affecting milk production negatively and having a serious impact on the economy of dairy enterprises. It is considered to be the most costly disease of dairy animals and losses mainly occur through discarded milk, reduction in milk yield, premature culling of animals and replacements. It is usually caused due to the effects of infection by bacterial or mycotic pathogens. Pathological changes to milk-secreting epithelial cells due to the inflammatory processes often bring about a decrease in functional capacity. The general objective of the study is establish the effect of mastitis on milk production in dairy cows in Kenya

Methodology: The paper used a desk study review methodology where relevant empirical literature was reviewed to identify main themes and to extract knowledge gaps.

Findings: The study found out that mastitis significantly affect milk production and leads to losses due to discarded abnormal milk and withheld milk from cows treated with antibiotic. There is also lack of information on the economic impact of the disease in the majority of developing countries; lack of awareness among farmers concerning sub-clinical mastitis and the importance of udder health; and lack of specific national programmes to control mastitis in the majority of countries.

Recommendations: The study recommends that government should create awareness, management and control measures to be developed for education at farmers' level as udder health, hygiene and nutrition play an important role in the control of mastitis. The best practices for reducing the incidence of mastitis like teat dip after milking; not allowing the cows to sit for 30 minutes after milking should be propagated widely among the farming community through mass media. The government should provide provision adequate funds and infrastructure required to undertake research in this direction.

Keywords: *Mastitis, Milk Production, Dairy Cows*

1.0 INTRODUCTION

Mastitis is a multi-etiological and complex disease, which is defined as inflammation of parenchyma of mammary glands. It is characterized by physical, chemical and, usually, bacteriological changes in milk, and pathological changes in glandular tissues (Gera and Guha, 2011). The occurrence of disease is an outcome of interplay between three major factors: infectious agents, host resistance, and environmental factors (Gera and Guha, 2011). Mastitis is a global problem as it adversely affects animal health, quality of milk and the economics of milk production, affecting every country, including developed ones and causes huge financial losses (Sharma, Maiti and Sharma, 2007). There is agreement among authors that mastitis is the most widespread infectious disease in dairy cattle, and, from an economic aspect, the most damaging (Tiwari *et al.*, 2010).

Mastitis is the most dreaded disease for dairy farmers because of reduced milk production, increased treatment costs, labour, milk discarding following treatment, death and premature culling (Yang et al., 2011). Annual losses in the dairy industry due to mastitis have been approximately 2 billion dollars in USA and 526 million dollars in India due to subclinical mastitis where as clinical mastitis is responsible for approximately 70% and 30% respectively of dollar losses (Varshney and Naresh, 2004). The decrease in milk production per cow due to the clinical and subclinical prevalence of mastitis is usually recognized as the main pathway in causing economic losses due to this disease (DeGraves and Fetrow, 1993). Other production effects that cause economic loss are mainly reduced longevity and short term lethality, the negative effects on body weight and feed intake, penalties or loss of premiums related to the somatic cell count of bulk tank milk and the milk withdrawn during and after antibiotic treatment, and also the money spent on its treatment. Mastitis has been recently reported to have a detrimental effect on reproductive performance in lactating dairy cows (Hertl et al., 2010 and Nava-Trujillo et al., 2010).

Clinical and sub-clinical mastitis are the two major forms of the disease: Clinical mastitis results in alterations of milk composition and appearance, decreased milk production, and the presence of the cardinal's signs of inflammation (pain, swelling and redness, with or without heat in infected mammary quarters). It is readily apparent and easily detected. In contrast, detection of mammary quarters with sub-clinical mastitis is more difficult because signs are not readily apparent (Kivaria, 2006) and, because of the lack of any overt manifestation, its diagnosis is a challenge in dairy animal management and in veterinary practice.Clinical mastitis is characterized by sudden onset, swelling and redness of the udder, pain and reduced and altered milk secretion from the affected quarters. The milk may contain clots or flakes or become watery in consistency accompanied by fever, depression and anorexia. The subclinical mastitis is characterized by having no visible signs either in the udder or in the milk, but the milk production decreases and the somatic cell count (SCC) increases, having greater impact in older lactating animals than in first lactation heifers. A negative relationship generally exists between SCC and the milk yield. Milk from normal uninfected quarters generally contain below 200,000 somatic cells/ml. A value of SCC above 300,000 is abnormal and an indication of inflammation in the udder(Hertl et al., 2010).

Mastitis in dairy animals is considered as one of the most important economic diseases resulting into huge economic loss to the country. Globally, mastitis accounts for about 38 per cent of the total direct costs of the common production diseases (Sudhan & Sharma, 2010). The economic losses due to mastitis have increased about 115 folds in last five decades. Lack of awareness, delay in detection of sub-clinical mastitis, lack of markers for detecting ensuing mastitis, unhygienic milking practices, diverse production systems, inadequate treatment etc. are some of the important contributing factors in higher incidence of mastitis. Mastitis reduces milk yield and alters milk composition. The magnitude of these changes in individual cows varies with the severity and duration of the infection and the causative microorganisms (Sudhan & Sharma, 2010). Mastitis almost always is caused by bacteria. These microorganisms produce toxins that can directly damage milk-producing tissue of the mammary gland, and the presence of bacteria initiates inflammation within the mammary tissue in an attempt to eliminate the invading microorganisms. The inflammation contributes to decreased milk production and is primarily responsible for the compositional changes observed in milk from infected quarters and cows. In general, compositional changes involve an increase in blood components in milk and a decrease in normal milk constituents (Sudhan & Sharma, 2010)

Prevention is the key in mastitis control. A control program should emphasize factors that reduce the rate of new infections. New infections are controlled by adopting measures like proper milking procedures, improved milking hygiene and housing management (Arnold, 2011). A combination of preventive measures and therapeutic use of antibiotics will markedly reduce the incidence of mastitis. The udder should be washed thoroughly in a sanitizing solution with individual paper towels and after milking, the teats should be immersed in appropriate teat-dip solution. The teat cup assembly, milk pipes and other utensils should be cleaned and sanitized between each milking. After milking, the sphincter muscle surrounding the teat canal remains dilated for a varying period of time facilitating invasion of the teat canal by bacteria. Thus teat dips are most effective when applied immediately after milking machine is removed. Cows are also exposed to mastitis organisms via the milking machine when milked after a cow affected with clinical or sub clinical mastitis(Arnold, 2011)..

1.2 Statement of the Problem

Mastitis is the most economically challenging disease on a dairy farm. This is due to losses like discarded abnormal milk and withheld milk from cows treated with antibiotic, costs of early replacement of affected cows, reduced sale value of culled cows, costs of drugs and veterinary services, and increased labor costs. Intra mammary infection, even if restricted to sub-clinical levels, has been reported to affect milk production negatively. The reduction in milk production is largely due to physical damage to the mammary parenchyma of the affected mammary gland (Zhao and Lacasse, 2008). In the affected animals, the milk yield is reduced considerably. Estimates of milk yield loss by different workers range from 100 to 500 kg/cow per lactation. When clinical mastitis occurs, additional costs result from discard of abnormal milk, cost of drugs and veterinary services. The estimated loss following clinical mastitis in cows was almost 700 kg in first lactation and 1,200 kg in the second or higher lactation (Zadoks, Middleton, Mcdougall, Katholm &Schukken, 2011).

1.3 Objectives of the Study

The general objective of the study is to establish the effect of mastitis on milk production in dairy cows in Kenya

1.4 Justification and Significance of the Study

The study is beneficial to the government and agricultural sector stakeholders in Kenya. They may use the study findings to improve on measures to prevent mastitis on milk production. Additionally, the findings of this study enrich existing knowledge by adding to the pool of information available in regard to the topic under study. Hence, it is of interest to both researchers and academicians who seek to explore and carry out further investigations.

2.0 LITERATURE REVIEW

2.1 Empirical Review

Harjanti and Sambodho (2020) conducted a study on Effects of mastitis on milk production and composition in dairy cows and noted that Mastitis is the biggest economic problem in dairy industry. Mastitis also causes animal welfare problem and it is a thread to food safety and security. A baseline survey involving small-holder dairy farms was conducted to identify the correlation between mastitis (mammary inflammation) and cow's productivity. The performance of cows, in terms of milk production, milk composition, as well as mammary inflammation levels was observed. The research was conducted in Central Java, Indonesia. A total of 103 lactating cows in the 2nd to 3rd month of lactation and parity were used. California Mastitis Test was used to analyse the inflammation level of mammary gland. Milk protein, fat and lactose contents were determined with Lactoscan Milk Analyzer. Milk production was recorded daily at morning and evening milking. The result shows statistically negative correlation ($P<0.0001$) between the level of mammary inflammation and milk production ($r = -0.59$) as well as milk protein ($r = -0.55$), lactose ($r = -0.51$), and fat contents ($r = -0.46$). It is concluded that, when the mammary infection in cows increased, milk production and milk components will be decreased.

Ruegg (2017) sought to review and highlight important advances in detection, management, and prevention of mastitis that have occurred since the first volume of the *Journal of Dairy Science* was published in 1917. Initial research efforts were directed at understanding the nature of pathogenic bacteria that were responsible for most intramammary infections. For decades, researchers worked to identify effective strategies to control mastitis caused by *Streptococcus agalactiae* and *Staphylococcus aureus*. To develop successful control programs, mastitis workers first had to identify mechanisms of infection, define the clinical and subclinical states of the disease, discover appropriate screening tests, determine likely points of exposure, identify pathogen-specific characteristics, and develop effective procedures for machine milking. Pioneering researchers eventually recognized that mastitis control was based on preventing new infections from occurring in healthy cows and reducing the duration that cows remained infected. Development of a control program that incorporated post-milking teat dipping, hygienic milking procedures, and strategic use of antibiotic therapy at dry-off resulted in widespread control of contagious pathogens. As herd management changed, researchers were tasked with defining control of mastitis caused by opportunistic pathogens originating from environmental sources.

As mastitis pathogens have evolved, researchers have sought to define antimicrobial usage that will maintain animal wellbeing while minimizing unnecessary usage. During the last century, tremendous significant advances in mastitis control have been made but changing herd structure and more rigorous processor standards ensure that mastitis will remain an important subject focus of future research.

Nakov, Dimitar Trajcev , Andonov, Sreten, Andric and Dusica. (2012) noted that Clinical mastitis is the most prevalent health disorder in dairy farms and causes changes in the milk quality and milk yield. The objectives of this study were to determinate the occurrence of clinical mastitis in dairy herd and its influence on cows milk production. The analyses included cows that presented clinical mastitis during lactation and clinically healthy cows, as control group. Clinical mastitis was detected by clinical examination of the udder and determination of visible changes in milk. The traits analyzed were the average of the monthly test day milk yields, cow parities and days in lactation while first case of clinical mastitis was occurred. For these purpose there were recorded data for monthly test day milk yield of the cows at the 2nd, the 3rd and the 4th monthly test day (TD). TDs were chosen according to the average number of days in lactation to diagnose the first case of clinical mastitis, which meant that 2nd, 3rd TD were made before the diagnosis of the first locational case of clinical mastitis, while the 4th TD was made after the diagnosis. Data analysis was carried out by univariate procedure with GLM-General Linear Model. Pearson's coefficient of correlation was used for calculation of interdependence between variables in the model. Annual prevalence of clinical mastitis per 100 lactations was 19.97%. Lactation incidence risk (LIR) was 21.49%. The prevalence of clinical mastitis and LIR tended to significantly increased ($p<0.001$) with increasing the parity, as risk factor for occurrence of clinical mastitis. Regardless parities, the first case of clinical mastitis in dairy herd occurred on the average 108.09 ± 83.182 days in lactation. Before contracting the disease, cows with clinical mastitis yielded more milk than did healthy cows. Mastitis clearly affected the milk yield and the difference between the milk yield of the healthy cows and the mastitic cows after clinical mastitis was statistically significant. There was a significant decrease in the milk yield in the 3rd TD, before the diagnosis of clinical mastitis ($p<0.001$), and during the 4th TD, after the diagnosis of clinical mastitis ($p<0.001$).

Kamau, Kimani, Chege, Bitek and Olwande studied Risk Factors Associated with Occurrence of Mastitis in Mathira East in Nyeri County, Kenya. The authors sought to estimate proportion of lactating dairy cows with mastitis, identify mastitis causing pathogens and determine risk factors for mastitis in Nyeri County, Kenya. They used a cross-sectional study design and randomly selected 19 villages and 169 farms from the 6 wards of Mathira Constituency. California mastitis test was used to detect positive animals whose samples were collected for culture and identification. Association between prevalence and breed, stage of lactation, floor type, udder cleanliness, milker, body condition, udder consistency, average milk production and parity were compared using Chi square tests. Farmers' knowledge of signs of mastitis was also assessed including measures taken by farmers to minimize incidents of mastitis. Prevalence of mastitis was 92% at cow level and 86.5% at quarter level. Staphylococcus aureus was the most common bacteria isolated (68.5%) either singly or in combination with other bacteria. Holstein/Friesian breed and poor udder hygiene were identified as major risk factors for mastitis ($p \leq 0.05$). Majority of the farmers were able to tell whether a cow has mastitis when there was a reduction

in milk production (60%) or when animals produced milk with curds or which curds on boiling (59%). All farmers interviewed cleaned hands and animal udder before milking as measures to control mastitis. Disposable hand towels (4%), udder disinfectants (9) and dry cow therapy (5%) were rarely used. Good hygiene which includes dairy farm, cow and milker hygiene is key in eliminating mastitis. Udder cleanliness should be emphasized as dirty udders serve as means by which bacteria enter the teat canal. Frequent screening can help identify cases early and reduce incidences of pathological changes in the udder tissue. Farmers' education on awareness and common mastitis signs could help in detecting cases early. Use of disposable paper towels, udder disinfectants and dry cow therapy should be embraced to reduce incidences of mastitis.

3.0 METHODOLOGY

The study adopted a desktop literature review method (desk study). This involved an in-depth review of studies related to effects of mastitis on milk production in dairy cows in Kenya. Three sorting stages were implemented on the subject under study in order to determine the viability of the subject for research. This is the first stage that comprised the initial identification of all articles that were based on duplicity in regulation and its effect on performance from various data bases. The search was done generally by searching the articles in the Article title, abstract, keywords. A second search involved fully available publications on the subject of effects of mastitis on milk production in dairy cows in Kenya. The third step involved the selection of fully accessible publications. Reduction of the literature to only fully accessible publications yielded specificity and allowed the researcher to focus on the articles that related to effects of mastitis on milk production in dairy cows in Kenya which was split into top key words. After an in-depth search into the top key words (mastitis, milk production, dairy cows), the researcher arrived at 10 articles that were suitable for analysis. The drawing and interpretation of research findings and sense which is not a quantitative impact evaluation, was important in this context, which implies that qualitative and thematic analysis was most suitable in this study.

4.0 FINDINGS, CONCLUSION AND POLICY IMPLICATION FOR FURTHER STUDY

Findings

The study found out that mastitis reduces milk yield and alters milk composition. The magnitude of these changes in individual cows varies with the severity and duration of the infection and the causative microorganisms. The loss of milk production is not just restricted during the course of the disease but may continue throughout the life of the animal because of the permanent damage that mastitis can cause to the mammary secretary tissues. The milk from the suffering animal generally carries microbial load that renders it unsuitable for human consumption. There is a considerable increase in the somatic cell count in milk of cows and buffaloes suffering from mastitis. It is, therefore, important that researchers undertake a nationwide plan to prevent and control mastitis.

Conclusion

The study concludes that there is lack of information on the economic impact of the disease in the majority of developing countries; lack of awareness among farmers concerning sub-clinical mastitis and the importance of udder health; and lack of specific national programmes to control mastitis in the majority of countries. All these imply a need for concerted future effort to control

mastitis. The findings of this study warrants the need for strategic approach including dairy extension that focus on enhancing dairy farmers' awareness and practice of hygienic milking, regular screening for sub-clinical mastitis, dry cow therapy and culling of chronically infected cows.

Recommendations

The study recommends that government should create awareness, management and control measures to be developed for education at farmers' level as udder health, hygiene and nutrition play an important role in the control of mastitis. The best practices for reducing the incidence of mastitis like teat dip after milking; not allowing the cows to sit for 30 minutes after milking should be propagated widely among the farming community through mass media. The government should provide provision adequate funds and infrastructure required to undertake research in this direction.

The study recommends that Dairy cooperatives should come forward to establish and promote the concept of "Clean Milk" and provide incentives in the form of better price for clean milk to the farmers. Testing Centres at various levels need to be established for screening of milk for somatic cell count and total bacterial count.

The study recommends that effective organization of veterinary services with periodical training of the staff is important for good performance. It should involve all stakeholders with clear delineation of their duties for effective execution of mastitis control programme. Awareness camps to understand the responsibilities of various stakeholders and potential benefits for sustained involvement of the participants are also important.

Recommendations for further study

There exists a research gap in mastitis and its effect on milk production: The field can benefit from further research in prevention of mastitis. Research programs in other sectors need to be researched on mastitis and its effect on milk production may help develop new ideas for comparison purposes.

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