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THE IMPORTANCE OF MASTITIS IN MILK QUALITY: A LITERATURE REVIEW

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ABSTRACT

Dairy farming is a widespread activity worldwide and occupies a prominent space in the world economy. Currently, Brazil is the world's third largest producer of milk, with more than 34 billion liters per year. However, despite its economic and social importance, milk quality is still a major challenge for the dairy sector. The quality of raw milk is closely related to the health of the milked animals, to the degree of initial contamination that occurs soon after milking and to the hygienic conditions of obtaining, storing and transporting the milk to the processing unit. Among these causes that exert an extremely harmful influence on milk quality, mastitis is considered the disease that most negatively impacts the dairy chain. Based on the great importance of this disease in the dairy chain, this study aimed to compile information about mastitis, such as: its impacts on milk quality, treatment and prevention measures. For this, a survey was carried out through a search in the online databases: Scientific Electronic Library Online (SciELO) and PubMed, covering articles published in the last five years. A total of 175 articles were identified based on the keywords: "bovine mastitis prevention"; "bovine mastitis treatment"; "bovine mastitis" AND "milk quality". A total of 113 studies were included, of which 42 (37.17%) referred to forms of prevention, 50 (44.25%) to treatment, and 21 (18.58%) to milk quality. The results show that management practices and emerging technologies are fundamental to reduce the incidence of mastitis and improve milk quality, while therapeutic alternatives, such as bacteriophages and nanocomposites, present promising solutions against antimicrobial resistance. Finally, changes in milk composition and industrial impacts reinforce the need for integrated approaches to mastitis control.

Keywords: Prevention of Bovine Mastitis. Treatment of Bovine Mastitis. Bovine Mastitis and Milk Quality.

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INTRODUCTION

The milk and dairy production chain is a sector of great economic and social importance for Brazil. Brazil is the third largest producer of milk in the world, with more than 34 billion liters per year (FAO, 2019), which is produced in 98% of Brazilian municipalities, with a predominance of small and medium-sized properties, employing close to 4 million people, both directly and indirectly (Zoccal, 2018). The country has more than 1 million milk-producing properties. According to the Regulation of Industrial and Sanitary Inspection of Products of Animal Origin (RIISPOA), milk is the product that comes from the complete, uninterrupted milking, in hygienic conditions, of healthy, well-fed and rested cows (Brasil, 2017).

Milk quality control should contribute to reducing costs, rationalizing investments and increasing the profitability of the dairy business. In addition to ensuring the food security of the population, when carried out in an integrated way with a program to improve milk quality, it brings financial returns to the entire production chain. The option for milk quality is today the option for the survival of the activity (Brasil, 2017).

To be a quality milk, it is essential to have a pleasant flavor, absence of undesirable residues, nutritional value and good composition, industrial yield, low somatic cell count and microbial load. Quality milk is favorable to the producer, the industry and also to the consumer (Brasil, 2017).

The dairy industry, as well as its legal guardians for the inspection of distributing a healthy final product regarding the quality of milk produced in Brazil, seeks to identify possible pathogenic or non-pathogenic factors that can affect the quality of milk and/or bring risks to human health, as well as seek strategies to have a product with good nutritional value and longer shelf life. Among the non-pathogenic factors, we can mention the evaluation of residues such as antibiotics and pesticides, low microbial load, low somatic cell count, and in its composition having high nutritional value and industrial yield (Brasil, 2017).

Producing milk with a high quality standard is an extremely important aspect of milk production systems, as it affects productivity, processing and technological properties (Oliveira, 2011). Aiming at the production of quality milk, the Ministry of Agriculture, Livestock and Supply (MAPA), regulates the standards for the standardization of milk quality in Brazil through the Regulation of Industrial and Sanitary Inspection of Products of Animal Origin (RIISPOA) and by Normative Instructions (IN), such as IN 76 and IN 77. With

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these standards, MAPA regulates the production, identity, quality, collection and transport of type A milk, refrigerated raw milk and pasteurized milk, with the main objective of ensuring quality milk to the consumer market (Brasil, 2017; Brazil, 2018a and Brazil, 2018b). The standardization of milk has the purpose of equalizing national standards with international standards and improving milk quality, making products destined for the domestic and foreign markets more competitive and safer (Oliveira, 2011).

To ensure milk quality, some indicators such as physicochemical and microbiological parameters should be evaluated through standard plate count (CPP) and somatic cell count (SCC). Of these, SCC is directly related to udder health, with mastitis as the main cause (Santos, Fonseca, 2007).

The microorganisms that cause mastitis are divided into contagious or environmental pathogens. The distinction between these two types of microorganisms depends mainly on their form of transmission. The profile of contagious bacteria is characterized by cow-to-cow transmission, while environmental transmission is characterized by infection of the cow by bacteria of environmental origin (Santos; Tomazi, 2012).

Dairy cows with clinical mastitis have inflammation in the udder and teats, changes in milk composition, such as a decrease in secreted volume, lumps and pus, changes in the animal's behavior, loss of appetite, fever, drop in milk production and death of the animal in more severe cases (Santos; Tomazi, 2012).

Unlike clinical mastitis, subclinical mastitis does not present symptoms of inflammation, but a decrease in production and an increase in milk somatic cell count (SCC) is noticeable (Santos; Tomazi, 2012).

The clinical form can be identified through the black bottom mug test that must be performed daily at each milking, becoming a routine of the property. The first three jets from each ceiling on the mug should be observed in relation to any changes such as lumps, pus, the presence of blood or a different color. To diagnose the subclinical form, SCC should be evaluated by laboratory examination and/or tests with CMT (*California Mastists Test*) performed in the milking parlor and WMT (*Winsconsin Mastists Test*). It is also possible to diagnose by electronic somatic cell count (Santos 2013).

In the case of mild and moderate clinical mastitis, the use of intramammary antibiotics based on β-lactam and cephalosporins for four days is recommended (Silva, 2015). In more advanced cases, combined therapy with the application of intramammary

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antibiotics for four or five days is recommended, also based on β-lactams and cephalosporins in conjunction with systemic antibiotics such as marbofloxacin, enrofloxacin, cefiquinoma, ceftiofur (Silva, 2015).

For acute mastitis, it is recommended to also apply systemic antibiotics with the same base and also use them in association with a non-steroidal anti-inflammatory drug and fluid therapy (Silva, 2015).

Treatment for subclinical mastitis is similar to the clinical form. The application of intramammary antibiotics is recommended in lactating cows suffering from subclinical mastitis. In animals already with an advanced SLI (days in lactation), the drying of the animal is guided using intramammary for dry cows, also being based on cephalosporins and teat sealant (Silva, 2015).

A professional should always be sought to evaluate the treatment of infected animals, including to define the best solution in cases of chronic infection, where disposal is considered a possibility so as not to compromise other individuals in the herd (Silva, 2015).

According to Veiga (2016), there are different recommendations for the prevention and control of mastitis, as it is multifactorial. Measures taken in isolation do not present full results in control and the return is not effective. They must be carried out by joining measures that will be put into practice together respecting the system of each property. Preventing mastitis means investing, especially in quality management, correct execution of procedures and qualified labor.

JUSTIFICATION

Mastitis has historically been considered the disease with the greatest economic impact on dairy herds worldwide, as it directly affects the volume of milk and the increase in production costs due to the use of drugs for prevention and treatment, causing significant losses to producers, the dairy industry and consumers. In view of the importance of this disease for this sector, this research seeks to compile current information about the disease and the need to implement preventive measures so that its impact on properties is mitigated.

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OBJECTIVES

GENERAL

The objective of this study is to carry out a descriptive approach to mastitis, its impacts on milk quality, treatment and prevention measures by searching the online databases: *Scientific Electronic Library Online* (SciELO) and PubMed, collecting information from articles published in the last five years.

SPECIFIC

- Seek information on the main advances in the prevention of bovine mastitis.
- Identify effective treatments and therapeutic innovations for disease control.
- To analyze the impacts of mastitis on milk quality and its industrial implications.

MATERIALS AND METHODS

To carry out this work, a literature review was carried out, with the purpose of a descriptive approach to mastitis, its impacts on milk quality, treatment and prevention measures. The initial survey was carried out through a search in the online databases: *Scientific Electronic Library Online* (SciELO) and PubMed, covering articles published between January 2019 and December 2024. The keywords used in the search were: "bovine mastitis prevention"; "bovine mastitis treatment"; "bovine mastitis" AND "milk quality". After the initial selection, the inclusion criteria considered articles that presented specific information about the topics investigated in the abstract or that were freely available.

RESULTS

In the initial analysis, 175 studies were identified, of which only 113 (64.57%) were eligible due to the inclusion criteria. It was not possible to obtain 62 articles, due to the unavailability of the scientific journal.

The electronic database that brought the largest number of publications was PubMed, 172 (98.29%) (Table 1) and the *Scientific Electronic Library Online* (SciELO) database brought only 3 (1.71%) publications (Table 2).

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Table 1 – Distribution of studies identified according to the PubMed database between January 2019 and December 2024. São Paulo, 2024.

PubMed	2019	2020	2021	2022	2023	2024	TOTAL
Bovine mastitis prevention	—	1	1	—	—	—	2
Bovine mastitis treatment	3	1	3	1	5	2	15
Bovine mastitis AND milk quality	28	24	25	27	29	22	155
TOTAL	31	26	29	28	34	24	172

Table 2 – Distribution of studies identified according to the *Scientific Electronic Library Online* (SciELO) database between January 2019 and December 2024. São Paulo, 2024.

SCIELO	2019	2020	2021	2022	2023	2024	TOTAL
Bovine mastitis prevention	—	—	—	—	—	—	—
Bovine mastitis treatment	1	—	—	—	—	1	2
Bovine mastitis AND milk quality	1	—	—	—	—	—	1
TOTAL	2	—	—	—	—	1	3

The results of this study were organized into three categories, according to the keywords used: Prevention of bovine mastitis; Treatment of bovine mastitis; Bovine mastitis and milk quality.

The analysis of the abstracts of publications related to mastitis prevention measures in cattle identified 42 (37.17%) publications that addressed the theme.

Among the advances related to the most relevant measures to prevent bovine mastitis, disease monitoring technologies stand out, such as the use of biosensors and *lab-on-chip devices,* which allow the early diagnosis of mastitis and reduce the need for curative interventions. These solutions have been shown to be efficient in detecting subclinical mastitis (Neculai-Valeanu *et al*. 2022). Other significant progress has been observed in the development of specific vaccines against *Mycoplasma bovis* and *Streptococcus agalactiae,* showing promising results in the prevention of mastitis (Imklin *et al*., 2024). In addition, practices such as the use of teat sealants during the dry period, such as *OrbeSeal*®, and chlorhexidine-based disinfectants continue to be effective in preventing intramammary infections (Liu *et al.,* 2023).

The analysis of the abstracts on the treatment of mastitis in cattle revealed 50 (44.25%) articles that addressed the theme.

The studies have highlighted the continued use of traditional antibiotics, such as gentamicin and third-generation cephalosporins, in the management of clinical cases of mastitis, despite growing concern about antimicrobial resistance (Gelgie *et al*., 2022). Additionally, innovative therapeutic alternatives have emerged, such as the use of carrageenan nanocomposites and flaxseed mucilage, which have demonstrated antimicrobial efficiency and improved food safety (Liu *et al*., 2023). Another promising

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approach is the use of bacteriophages, especially in the control of *resistant Staphylococcus aureus*. Formulations such as *Fago-Bov® have shown significant reductions in bacterial load in milk samples (Imklin et al*., 2024).

The analysis of the abstracts on the impact of mastitis on milk quality identified 21 (18.58%) publications that dealt with the theme.

The studies reinforce that mastitis significantly alters the physicochemical parameters of milk, including the reduction of lactose, casein and fat levels, compromising both nutritional and industrial quality. In addition, the presence of antimicrobial residues in milk poses a risk to human health and may restrict exports of dairy products. Industrial impacts have also been reported, especially in the manufacture of dairy products such as cheese. Changes in coagulation parameters, for example, have been identified as detrimental to cheese production, as identified by Neculai-Valeanu *et al*. (2022).

In addition, Liu *et al*. (2023) highlight that molecular interventions represent a promising strategy to mitigate the inflammatory impacts associated with subclinical mastitis in cows, contributing to the reduction of antimicrobial use. These interventions involve the use of technologies that modulate gene expression and cellular processes related to the inflammatory response in breast tissue. The study highlighted the potential of folic acid supplementation, which regulates long non-coding RNAs (LncRNAs), involved in the modulation of inflammation, resulting in decreased expression of pro-inflammatory genes, such as IL-6 and IL-1β. In addition, the modulation of LncRNAs contributed to the improvement of cellular homeostasis, promoting a balanced immune response and reducing the damage associated with chronic inflammation. These approaches stand out as sustainable and effective alternatives in the management of mastitis, reducing dependence on antimicrobials and favoring animal health and milk production.

CONCLUSION

Bovine mastitis remains a significant challenge for the dairy chain, with impacts that go beyond animal health, directly affecting milk quality and production costs. With the rise in antimicrobial resistance and the demands for safe and high-quality dairy products, it becomes essential to invest in preventive, therapeutic, and technological strategies. The adoption of emerging technologies, combined with management practices and therapeutic alternatives can minimize the effects of the disease and ensure greater sustainability in the sector. In addition, medications such as gentamicin and alternative solutions such as

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bacteriophages offer new perspectives for the effective management of mastitis. It is crucial that biosecurity policies are integrated with investments in research to develop more effective solutions.

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