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Bovine Mastitis and Post-Dipping: A Review of the Milk Quality

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Abstract

The largest commercial cattle herd in the world is in Brazil. It is estimated that there are 177 million animals, of which 35 million located represent dairy cattle. Dairy activity plays an important role in the Brazilian economy, however it is noticed that the problems related to the poor quality of milk occur due to numerous factors, among them, the lack of knowledge of the importance of hygiene of milking, equipment and milkers, in addition to the acquisition of healthy animals, diagnosis and control of mastitis. Mastitis is a pathology of great economic loss for dairy cattle worldwide. The development of an effective mastitis control program in the herd implies some important measures. In particular for producing milk with quality and quantity, a healthy udder is essential and, for this, the utmost care must be taken in the pre and post-dipping. Some quality parameters are increasingly used to detect flaws in management practices, serving as a reference in the valorization of raw materials. Due to the complexity of these factors, some methods of checking milk quality were developed, such as microbiological examination, California Mastitis Test (CMT) and Somatic Cell Count (SCC).

Keywords: Animal Health; Staphylococcus Spp.; Bovine Mastitis; Post-Dipping

Abbreviations: CMT: California Mastitis Test; SCC: Somatic Cell Count; GDP: Gross Domestic Product; USA: United States of America.

Introduction

The largest commercial cattle herd in the world is in Brazil. It is estimated that there are 177 million animals, of which 35 million (20%) represent the number of dairy cattle. A herd of 19 to 20 million cows are on the properties of 1.4 million breeders who produced 32 billion liters of milk in 2012, taking the country to fourth place in the world ranking of dairy production [1].

Dairy activity plays an important role in the Brazilian economy, however it is noticed that the problems related to the poor quality of milk occur due to numerous factors, among them, the lack of knowledge of the importance of milking hygiene, equipment and milkers, in addition to the acquisition of healthy animals, diagnosis and control of mastitis [2].

Mastitis is a pathology of great economic loss for dairy cattle worldwide. The high economic impact highlights the

need to monitor the disease in order to reduce the losses caused by the disease [3].

The conventional method of mastitis control during milking basically consists of washing the teats with water and asepsis with chemicals with antimicrobial action such as chlorine, iodine or ammonium quaternary [4].

The development of an effective mastitis control program in the herd implies some important measures. In particular for producing milk with quality and quantity, a healthy udder is essential and, for this, the utmost care must be taken in the pre- and post-dipping.

Thus, the efficiency of the products used in the pre and post-dipping to maintain hygiene in the milking management, is of fundamental importance in the dairy activity, being a critical point for the control of mastitis. The most effective way of control is prevention through asepsis and periodic monitoring tests [5].

Thus, the health of the mammary gland, milking hygiene, the environment in which the cow is housed and the cleaning procedures of the milking equipment are factors that directly affect the microbial contamination of raw milk [6].

This contamination produces significant changes in the main components of milk such as protein, fat and lactose and also in the less expressive components such as minerals and enzymes. The occurrence of changes in the milk components is due to the damage to the milk-producing epithelial cells and the increase in vascular permeability that results in the passage of blood components into the milk [7].

Some quality parameters are increasingly used to detect flaws in management practices, serving as a reference in the appreciation of raw materials. Due to the complexity of these factors, some methods of checking milk quality have been developed, such as microbiological examination, California Mastitis Test (CMT) and Somatic Cell Count (SCC).

The elevation of the SCC can cause changes in the results of cheese production, mainly in the reduction of the industrial yield, changes in the organoleptic properties, increase of the clotting time, low clot stiffening rate producing texture defects, high loss of solids in the serum that results from the lower concentration of casein and increased whey proteins [8].

However, adequate hygiene of the mammary gland is perhaps the single most important measure in preventing new intramammary infections, as there is a direct relationship between the number of bacteria present on the teats and the rate of intramammary infections [9].

Brazilian Milk Production

In the economic and social order of Brazilian agribusiness, the dairy segment has an outstanding position and an important performance in the Gross Domestic Product (GDP) of livestock. The growth of our production has been showing year-over-year rates above the world average and this leads Brazil to the fifth position in the ranking of the largest milk producing countries on the planet. The productive sector is represented by 1.3 million dairy properties, distributed practically all over the country, with some more and others less technified [10].

The Confederation of Agriculture and Livestock of Brazil (CNA) estimates that milk production in 2017 will be 34.9 billion liters, with average prices of R $ 1.32 per liter and a turnover of R $ 46.8 billion. An increase of 3.3% higher than the percentage of 2016, which was R $ 44.7 billion [11].

These expressive values show the relevance of the dairy activity to the Brazilian economy, both domestically and abroad. As a consequence, milk production in Brazil grows concomitantly with exports, consolidating itself as a great development potential and as a product of importance in the national economy [12].

Dairy farming is also an important activity in the social field, playing an important role in generating jobs and income for the population. The Northeast region has stood out in relation to national production, since the last decade and was the third region that grew the most in this period, in a percentage of 70%. Currently, the Brazilian Northeast is responsible for 12% of all milk produced in the country [13].

Milk represents 24% of the gross production value (VBP) generated by livestock, being lower only than beef and higher than the value of chicken, pork and egg production. Even with positive data, the sector faces problems of production efficiency and quality of the raw material, which causes loss of competitiveness [14].

Considering the various realities of the Brazilian milk production chain, which affects the entire national territory and the peculiar character inherent in the production environment, the need to classify producers with respect to the comparison between the rates achieved by the producer and the obtained in different production systems. Several criteria for the standardization of milk production systems have been adopted, conditioned to the proposed objectives.

This universe of Brazilian dairy production can be identified as a major cause of impediment to the more accelerated development of the activity. With familiar characteristics, the producers are mostly small or medium

and produce between 50 to 100 liters / day. In this situation, it is possible to detect little investment in the activity and problems in the entire production chain, such as low technification, lack of animal health control and inadequate hygienic conditions during milking, conservation and transport [12].

Bovine Mastitis

Bovine mastitis is an inflammation of the mammary gland and the bigger it is the interaction between risk factors related to the animal, man, the environment and the presence of pathogens, the more severe the inflammatory process will be. The causative agents of mastitis, in most cases, are bacteria, and there may also be fungi, yeasts, viruses and algae. Mastitis is the cause of the greatest economic losses in the milk production chain. To minimize damage, it is necessary to maintain controlled and strict breast hygiene, good milking practices and the adoption of an animal health program [13].

The in fl ammatory process has the capacity to alter the physical and chemical characteristics of milk, damage breast glandular tissue, causing a decrease in milk production and also the transmission of pathogenic microorganisms to man and the animals themselves. This disease is considered the main affection that affects mammals, especially those destined for dairy production. Economic losses in production occur both on the property and in the industry, causing high-performance animals to be discarded early [15].

In the United States of America (USA), losses are estimated at $ 1.8 billion. The cost per cow reaches US $ 184.00 and each clinical case generates a loss of US $ 100.00 due to reduced production and loss due to disposal. In Brazil, production losses occur between 12 and 15%, which translates into a total of more than 2.8 billion liters per year [16].

According to the form of manifestation of the infection, mastitis can be classified as being clinical or subclinical, the latter being the most prevalent and causing the greatest economic losses, representing 5 to 25% of milk production [17].

Clinical mastitis generates high losses due to milk disposal, medication costs, functional loss of glands and even death of the animal. However, the greatest damage is caused by subclinical mastitis, as it does not show visible signs and goes unnoticed by owners and employees. Subclinical mastitis can spread in the herd, infecting other cows. As a consequence, destruction of the functional capacity of the mammary gland can occur, causing decreased milk production and damage to the animal's health [18].

Mastitis is a multifactorial disease and, epidemiologically, is linked to three components: animal (host), etiologic agent and environment. The risk factors related to this infection can be individual or environmental. The individual factors include the animal's defense mechanisms and the anatomy of the roof and udder. Environmental ones are related to the type of climate in the region, cleaning of the facilities, food and virulence of microorganisms [19].

According to Ramalho, et al. [17] about 90% of the entire etiology of bovine mastitis is caused by bacteria. Microorganisms of contagious origin are the most prevalent and among these, the genus *Staphylococcus* stands out for having a higher frequency in clinical and subclinical cases of the disease, with *Staphylococcus* aureus being the most relevant species for the dairy industry [20].

Mastitis is a disease that afect milk cows and reduce the catle production [21]. Contagious mastitis is caused by pathogens whose preferred habitat is the interior of the mammary gland and the skin surface of the teats. Transmission occurs mainly through the colonization of the skin of the teats, and occurs during milking through the hands of the milker, contaminated cloth/sponge used for drying the teats in several cows, presence of residual milk in the teat cups and inadequate milking equipment.

Strict attention and observation in the handling of animals at the time of milking is essential since the microorganisms that cause contagious mastitis spread among cows during this process. Any object that moves between cows is capable of potentially functioning as a source. As a general rule, no object or surface should be transported from cow to cow without prior disinfection [22].

Whether manual or mechanical, it is essential to establish a milking line: 1º) first calf heifer; 2nd) cows that have never had mastitis; 3rd) cows that had clinical mastitis for more than six months; 4th) cows that had clinical mastitis in the last six months and finally, separate cows with clinical mastitis from the herd. Always perform the mug test before each milking with the first jets of milk. This test allows the diagnosis of clinical mastitis and reduces the rate of milk contamination [13].

In order to obtain effective control of contagious mastitis, the exposure of teats to pathogens must be reduced by means of hygienic-sanitary control that reduces the colonization rate and disinfects the colonized surface. Thus, attention should be focused on the correct handling of milking, institute training for milkers and disinfect the liners after use. Disinfection should also be carried out before and after milking, which is complete immersion of teats in disinfectant solution [18].

The prevalence of mastitis is mainly related to management before, during and after milking. This explains the importance of awareness of the milker, of the proper milking procedures, including the correct ways of cleaning and disinfecting the environment, the animal, the professional and all the tools used in milking [13].

Mastitis Monitoring

Monitoring of mastitis control in a herd is done by constant data collection. Within this context, they confirm that this control depends on valuable information, including: cow identification; affected rooms; date of the mastitis event; number of lactations; identification of the pathogen(s); treatment employed, including dose, route and duration; duration of the period of suspension of milk use and the moment when it was used again; recent maximum level of milk production [23].

Several methods can be used to monitor clinical and subclinical mastitis. Detection of clinical mastitis is possible by palpating the mammary gland and observing the appearance of the milk. In subclinical mastitis, auxiliary tests are necessary, such as SCC, CMT and microbiological examination [18].

Dark Bottom Tray Test

The Process consists of examining the first jets of milk before milking in a dark-bottomed or screened tray. The presence of residues such as lumps, filaments, clots, pus and blood is sought. It is used for the observation of the occurrence of clinical mastitis [16].

Somatic Cells Count (SCC)

Somatic cell count is directly related to the prevalence of breast infections (mastitis) in dairy herds. After the invasion of pathogens in the mammary gland, an inflammatory process begins which results in the migration and increase in the number of leukocytes (mainly polymorphonuclear neutrophils) in the mammary gland. Somatic cells are cells of the immune system, which migrate from the bloodstream (lymphocytes, macrophages and neutrophils) and from the scaling of the mammary gland itself, present in milk [24].

The CCS can be performed from milk samples taken directly from the tank and sent to a specialized laboratory or by counting individual somatic cells, in which the samples are taken from each cow, individually and sent to the laboratory [25].

Individual somatic cell counting is an electronic counting method increasingly used in Brazil and which forms the basis for monitoring udder health in developed countries [18].

California Mastitis Test (CMT)

A test widely used in the examination of milk is the "California Mastites Test". The CMT is a practical, popular and low-cost test. The milk samples are taken from each mammary quarter and placed in an appropriate tray, to which a reagent is added that breaks the membranes of the somatic cells present in the sample, releasing the DNA which, in contact with water, hydrates and becomes viscous [18].

For this, about 2 ml of each gland unit is collected in a special tray and another 2 ml of CMT reagent is added, homogenized and observed if the mixture had a gelatinous aspect. Otherwise the appearance of the mixture will be similar to the consistency of the milk [22].

The CMT is also known as a racket test. Depending on the volume of white blood cells (somatic cells) in the milk, the formation of a gel is observed. The severity of subclinical mastitis will be determined by the intensity of the gel formation. The evaluation of the CMT test follows a pattern determined on the degree of increase in numbered viscosity in one, two, three or four crosses [16].

It is advisable to exercise caution when interpreting CMT, since in certain physiological conditions (end of lactation) and in some diseases (bovine leukosis) there may be an increase in cellularity without mastitis. A sample of milk in a sterile tube must be collected under careful antisepsis to perform the bacteriological examination [21].

Microbiologic Investigation

Microbiological examination is the definitive method for diagnosis because it reveals the specific etiologic agent and allows choosing the appropriate therapy and prophylaxis [26].

Milk samples from infected mammary glands can be taken for microbiological examinations, aiming at the identification of the responsible microorganisms that are triggering infections in the herd [18].

With the determination of the type of bacteria that causes mastitis, we have an idea of the origin of the contamination, whether it was caused by lack of environmental hygiene or lack of cleanliness and organization in milking. In this way, it is identified the point of the herd management that must be improved and which medicine needs to be applied, avoiding unnecessary expenses [27].

Mastitis can be caused by several microorganisms, which

are classified as environmental or contagious pathogens, according to the mode of transmission. Contagious mastitis is caused by microorganisms and is transferred from an infected room to a healthy one, mainly through the hand of the milker or milking liners at the time of milking, these microorganisms are well adapted for survival in the udder *S. aureus* se stands out as one of the most frequent pathogens in cases of bovine breast infections. In Brazil, it is one of the main causative agents of bovine mastitis, with isolation rates ranging between 8.3% and 49.23% [28].

Microbiological examination is considered the standard laboratory method for the diagnosis of bovine mastitis and its main objective is to offer safe results by practicing specific control measures aimed at the environment or for milking hygiene that can be indicated according to the infection found [29].

Pos-Dipping

The most important isolated practice of controlling new intramammary infections is the disinfection of the teats at the end of milking. It should be emphasized that the teat dipping, the teat dipping, must be complete, that is, at least two thirds of the ceilings must be completely immersed in the disinfectant solution [18].

The most commonly used commercial active principles for disinfecting ceilings are iodine, chlorhexidine, sulfonic acid, chlorine, peroxides, lauricidin and chlorous acid. To minimize irritation to the skin of ceilings, some bases and emollients are used in the formulation of these products, such as glycerin, lanolin, propylene glycol, sorbitol, vegetable oils, minerals and collagen [29].

The use of antiseptic solutions tends to control and even decrease the risk of infections in new mammary glands. However, disinfectants can show little efficiency when in the presence of organic matter, dirt or urine, thus hindering the effective performance of the product [30].

The disinfectant compounds that present the best results are: iodine, 0.7% to 1.0%; chlorhexidine, 0.5% to 1.0% and chlorine, 0.3% to 0.5%. The best application method is the use of mugs for immersion of ceilings, especially those of the model without return (one way), which prevent the return of the solution after application [18].

The use of disinfectant products in post-dipping is the most important method in the control of contagious mastitis, especially those caused by *Staphylococcus aureus* and *Streptococcus agalactiae* and guarantees, in addition to disinfection, the formation of a physical barrier against infections, even several hours after its application. Studies have already demonstrated the importance of using post-dipping to reduce the incidence of new intramammary infections caused by *Staphylococcus* spp. and other pathogens related to mastitis cases, as well as a decrease in somatic cell count [31].

Milk Quality

Milk is a food consumed on a large scale by practically the all population. It is a product of high nutritional value, as a source of proteins, lipids, carbohydrates, minerals and vitamins, being therefore considered a great substrate for the growth of various groups of microorganisms, desirable and undesirable [32].

However, inadequate conditions for obtaining milk and fraudulent practices, such as the addition of substances, generate serious public health problems, whether due to the action of potentially pathogenic bacteria, especially when milk is consumed raw, or due to the harmful effect on the human body, mainly caused by bacterial growth inhibitors or substances used to alter pH, in addition to carcinogens [33].

The sanitary conditions of its production and the health of the herd, reveal that the microbial contamination index can be used to judge its intrinsic quality. Considering the potential to multiply, these bacteria in milk can cause chemical changes, such as the breakdown of fats, proteins or carbohydrates, which can make the product unsuitable for consumption and industrialization.

Social, economic, cultural and even climatic factors are involved in the poor quality of milk produced in Brazil. The problem is considered chronic and difficult to solve and even so it has not received due attention in the political field, despite the important role played by milk in the population's diet.

Health status of the herd and the hygienic quality of the milk are directly related. As well as proper handling of equipment used in milking (manual or mechanical) and the presence of microorganisms or other residues in the milk. Factors like these are able to change not only the composition, but also organoleptic characteristics such as odor, taste and viscosity, which can compromise the quality of the raw material.

Milk is classified as quality when it has adequate organoleptic, nutritional, physical-chemical and microbiological characteristics, with a pleasant taste, high nutritional value, absence of pathogens and contaminants, reduced somatic cell count (SCC), and low microbial load.

The quality of the final product derived from milk is

directly related to its microbiological load when it reaches the processing industry. The acceptance of milk by the consumer depends largely on its sensory characteristics, such as taste and aroma, as well as its nutritional value, attributes that can be altered by the proteolytic and lipolytic action of bacteria with damage to the life- shelf life and the quality of pasteurized milk.

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