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MANAGEMENT AND MICROBIOLOGICAL QUALITY OF BOVINE MILK IN THE SERTÃO OF PARAIBANO

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Abstract: This dissertation was carried out with the aim of analyze the management and microbiological quality of bovine milk in the Paraíba hinterlandthrough an exploratory, qualitative and descriptive study, carried out in the municipality of Cajazeiras - PB located in the hinterland of Paraiba. The target population of this research consisted of milk producers producers producers in the region. The sample consisted of three selected dairy farmers taking into account the availability of and access to producers willing to take part in the study. Data was collected through direct observation and the application of a checklist of good milk production practices. In addition, microbiological analyses were carried out on the fresh milk from the three farms. The results of the microbiological tests on the milk showed no bacterial growth on the selected culture media. With regard to the Good Dairy Production Practices Checklist, the dairy farms analyzed showed a diverse panorama, with positive aspects such as hygiene in the milking facilities, water quality and commitment to waste management standing out. However, areas in need of improvement were identified, including feed management, disease prevention and the implementation of ongoing training. The evaluation of feed management highlighted the need for more elaborate nutritional planning to ensure the nutritional efficiency of dairy cows, while the research emphasized the importance of practices such as regular vaccinations, preventive treatments and segregation of sick animals to preserve milk quality. Waste management, although compromised globally, requires special attention in areas such as feces removal and packaging disposal to promote sustainable practices. As for training, its importance is recognized, but the implementation of ongoing programs lacks more systematic approaches. The disparity in the adoption of records and documentation between farms highlights the need to promote this practice in order to improve operational efficiency, product quality and compliance with industry standards. Therefore, the complexity of dairy production management in the context of the Sertão Paraibano is highlighted. The study not only identifies areas of excellence, but also highlights specific challenges that can be addressed through improved practices, investments in training and capacity building, and an integrated approach to ensuring sustainability and quality in bovine milk production in the region.

Keywords: Good practices. Milk. Microbiology. Livestock. Producers.

INTRODUCTION

Milk production is considered an essential activity for human nutrition and takes place mainly in developing countries and in family farming systems. According to data from the Food and Agriculture Organization of the United Nations - FAO (2020), in the last three decades, world milk production has increased by more than 59%, from 530 million tons in 1988 to 843 million tons in 2018. India is considered the world's largest milk producer, with 22% of global production, followed by the United States of America, China, Pakistan and Brazil.

From this perspective, the dairy agro-industrial activity developed in Brazil is present in almost every municipality. It is considered one of the main sources of employment and income, with more than one million producers in the countryside, as well as generating millions more jobs in other segments of the chain (JUNG; MATTE JÚNIOR, 2017; ROCHA; CARVALHO; RESENDE, 2020). The authors add that this activity is a seventha among national agricultural products, with the gross value of primary milk production reaching almost R$35 billion in 2019.

With this growing demand in the consumer market, the need has arisen for analysis to guarantee the microbiological safety of these products.o that the inspection service intervenes. Despite this, there are several outbreaks and cases of poisoning and infections reported, all of which are associated with milk and its derivatives. This is proven by consumer complaints, medical reports, health and epidemiological surveillance, as well as municipal and state health departments (SANTOS et al, 2019).

According to Santos et al. (2019), molds and yeasts are usually found because they are widespread in nature and are often observed in industrial dairy environments because they are places that have favorable conditions for their growth and development. According to Silva and his collaborators (2018), milk is contaminated due to the poor quality of the water used to clean the equipment; however, there is a high presence of total coliforms in milk due to the use of water before, during and after milking; however, in order to obtain better quality milk, water must be sanitized and contact with contaminated surfaces must be avoided due to the increase in environmental agents, as well as pathogenic microorganisms, in addition to the need to use good management and hygiene practices during milking.

According to Mörschbächer et al. (2017), milk is an excellent culture medium for the majority of microorganisms present in nature, and usually contains high counts of microorganisms, indicating failures in production hygiene. Simple procedures such as discarding the first three jets of milk, cleaning materials used in milking with chlorinated alkaline detergent, submersion in chlorinated solution and eliminating residual water from milking utensils have been practical and very effective in improving the microbiological quality of milk.

These contaminating microorganisms are especially mesophilic and psychrotrophic bacteria. Mesophilic bacteria cause acidification in unrefrigerated milk and at low temperatures, around 4ºC, psychrotrophic bacteria grow and also acidify the medium (SILVA et al., 2018).

The importance of analyzing milk is extremely important because a lack of knowledge can lead to problems for the consumer, which is why attention and vigilance to good practices can reverse many scenarios that have become a problem. Thus, with the application of new methods, the demand for the input and its by-products is visible due to the benefits they bring to the consumer, increasing demand and generating quality for the population involved. (MÖRSCHBÄCHER et al., 2017)

In this sense, the microbiological analysis of bovine milk plays a fundamental role in guaranteeing food quality and safety, especially in regions such as the Sertão Paraibano, where dairy production is a major economic activity. Milk is a highly perishable food that is prone to contamination by pathogenic microorganisms and can pose risks to public health if consumed without due care.

OBJECTIVES

GENERAL OBJECTIVE

To analyze the management and microbiological quality of bovine milk in the Paraíba hinterland.

SPECIFIC OBJECTIVES

a) Describe the main processing methods for extracting bovine milk.

b) Identify possible errors that can cause contamination in milk.

c) Evaluate the most effective procedures that can be applied to improve the microbiological quality of milk.

THEORETICAL BACKGROUND

DAIRY AGRO-INDUSTRIAL ACTIVITY

The dairy agro-industrial activity plays a significant role in the economy and the agricultural sector in many countries, including Brazil. It encompasses the entire production chain related to the production, processing and marketing of milk and its derivatives. Dairy farming involves raising and managing herds of cattle, as well as other dairy species such as goats and sheep. Dairy farmers play a fundamental role in this activity, being responsible for caring for the animals, feeding them properly, milking them, controlling their health, among other practices necessary to guarantee the quality of the milk produced (ALVARENGA et al., 2020).

Demand for dairy products has grown more than the population worldwide. According to Vilela et al. (2017, p. 08), this refers to às "changes in the structure of the population pyramid, consumption habits, increased purchasing power and people's well-being conditions that have positively influenced *per capita* dairy consumption in emerging countries".

Over the last 50 years, milk production in Brazil has grown significantly for the national economy. However, this activity is considered a major challenge for producers, as the number of establishments producing milk in 1996 was more than of 1.80 million rural establishments. In 2006 this number fell to 1.350 million and in 2017, the most recent census identified 1.176 million producers. This indicates that more than 600,000 producers have left dairy farming in just over 20 years (IBGE, 1996; 2009).

However, the data on the drop in the number of milk producers has not had a negative impact on the evolution of production (ALVARENGA et al., 2020; ROCHA; CARVALHO; RESENDE, 2020). The aforementioned authors state that despite the decrease in milk producers, the expansion of Brazilian production is due to the increase in the scale of production per farm, which has grown significantly.significantly in recent years.

In view of Given the importance of this economic activity, it is essential to understand the theme of the milk production chain, which encompasses the entire agro-industrial chain. (2011), it can be defined as an integral part of a larger agro-industrial system (Figure 1), prioritizing the relationships between agriculture, the processing industry and distribution within the scope of a main product.

Thus, the production chain includes inputs, factors for production or raw materials. These are inputs for treating the animal, as well as machinery for milking, cooling, storing and distributing the milk, among others. It also includes producers or primary production units. We also see the role of the distribution and logistics network, often through associations and cooperatives, in intermediating the distribution of milk, still *in natura*, facilitating access between producers and industries. As well as the establishments responsible for processing the milk, such as artisanal dairies and large industries (ALVARENGA et al., 2020).

From this perspective, it can be seen that the production chain acts as a system, in which interactions are established that converge in the realization of a production process. This includes everything from the collection of raw materials (inputs) to the production of the final product, which is usually geared towards supplying the market (PEROBELLI; ARAÚJO JÚNIOR e CASTRO, 2018).

According to Montoya and Finamore (2005), the dairy production chain is capable of generating impacts on various sectors of the economy, due to the effects of production linkages, both in terms of the acquisition of

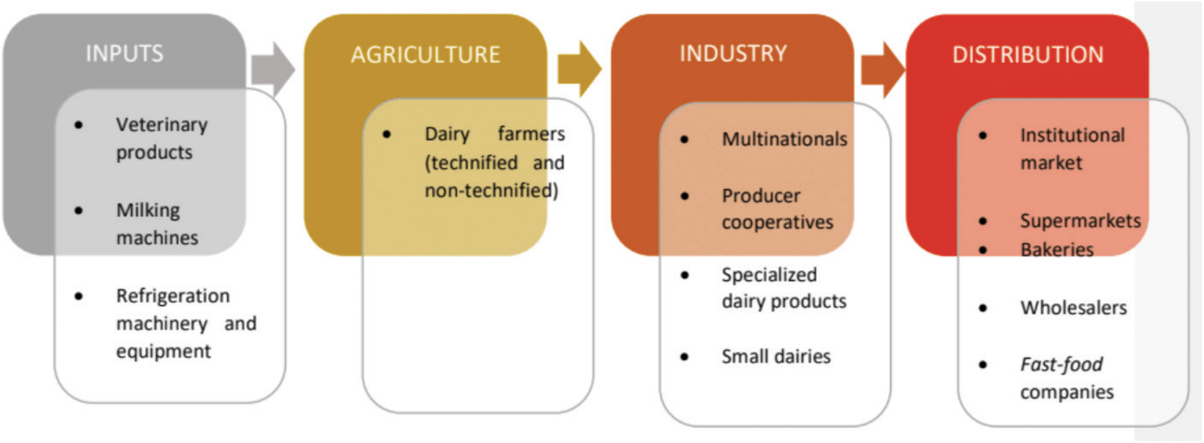

Figure 1: Milk Agroindustrial System.

Source: ALVARENGA et al., 2020.

inputs and in terms of supplies to the processing industries. Therefore, dairy farming is an important generator of direct and indirect jobs throughout the production chain, contributing to a better understanding of the regional growth process.

DAIRY PRODUCTION SYSTEMS

Characterizing the dairy production system is important in order to understand the production sector and the implementation of regional development projects, given that there is a diversity of milk production systems in Brazil. From this perspective, it is important to "promote intervention strategies aimed at minimizing this heterogeneity of productive actions, promoting the social and economic development of small and medium-sized producers" (LANGE, 2013, p. 14). From this angle, Silva Neto and Basso (2015) point out that this system corresponds to a a set of methodological knowledge developed and the results of observation, delimitation and analysis of an agricultural activity in its particularity.

In dairy farming, it is therefore possible to see the coexistence of various models of production systems, which are being used simultaneously in the same region or locality. Smith, Moreira and Latrille (2002) state that a from the association and combination of factors involving the physical base, including the socio-economic and cultural factors of the property, it is possible to demonstrate a diversity in the definition of production systems in each production unit.

Lange (2013) adds that within a regional context, each property starts from the type and nature of production that must be in line with the demands for the product and its marketing. This makes it possible to study production systems in order to understand the aspects related to à efficiency, production costs and the technical and economic efficiency of the systems.

However, it is possible to see the disparities between the production systems adopted on the farms. This is even more evident with the process of modernization by the different layers of producers who have been instrumental in the expansion of the activity. As such, studies of cattle production systems are essential for informing public policies, and through them we can obtain a better analysis of dairy farming and its sustainability trajectory (LANGE, 2013; SMITH; MOREIRA; LATRILLE, 2002).

Considering that animal productivity is a function of a set of technologies, Assis et al. (2005), collaborates that four types of systems have been defined, according to the degree of intensification and the level of productivity, and characterized according to the bulk feed adopted. Thus were divided into: Extensive system, with animals producing up to 1,200 liters of milk per milked cow per year, raised exclusively on pasture; Semi-extensive system, with animals producing between 1,200 and 2,000 liters of milk per milked cow per year, raised on pasture and with volume supplementation at the time when the pasture grows less; Intensive pasture system, with animals producing between 2,000 and 4,500 liters of milk per milked cow per year.500 liters of milk per milked cow/year, raised on pasture with forage of high support capacity, with volume supplementation in the season of lesser pasture growth and, in some cases, throughout the year; and the Intensive Confinement System, which are animals with production above 4,500 liters per milked cow/year, kept in confinement and fed at the trough with preserved forage, silage and hay.

In the semi-arid northeast of Brazil, the vast majority of dairy production is carried out by family farms, which have a low level of technological innovation and seasonal production, due to arainy and dry periodss of the year. The authors Galvão Júnior et al. (2015) state that extensive and semi-intensive farming regimes are predominant, in which the animals use the native vegetation of the Caatinga biome for their maintenance and production.

The aforementioned authors also add that in this system there is little investment in facilities, with food support based on native pastures and concentrated and mineral supplementation, when it exists, is not always adequate for the herd's nutritional requirements. Another relevant aspect is the low reproductive and sanitary control, which leads to low milk productivity per animal.

In the semi-intensive system, the farmer has more control over the animals, usually spending part of the day stabled, providing them with bulky and concentrated food supplementation, commonly used in the dry season or throughout the year. As a result, there is a greater interest in improving forage support by establishing areas for the production of roughage under irrigation and enriching native pastures with productive, drought-resistant crops. In addition, control over health and reproductive aspects is favored, leading to better production rates compared to the extensive system (GALVÃO JÚNIOR et al., 2015).

Thus, based on the social and economic conditions of those involved in the dairy cattle production sector, it is necessary to analyze and reflect on what reality these people live in, especially in relation to social, labor, health and education factors. Since it is of great importance to define policies on infrastructure, transport, logistics, feasibility analysis of regional development projects and colonization and settlement programs. It is also important for establishing strategies in health surveillance, traceability, geographical risk assessment of diseases and studies into the dynamics of the agricultural sector (ZOCCAL et al., 2006).

MICROBIOLOGICAL ANALYSIS OF MILK

It is extremely important to know the composition of milk in order to determine its quality, as this influences various sensory and industrial characteristics. The main parameters used in most milk quality control programs are fat content, protein, total solids and somatic cell count. Quality milk is milk that does not contain pathogens or other contaminants, such as antibiotic and pesticide residues. In addition, it is desirable for the milk to have low microbial contamination, a pleasant taste, an adequate physicochemical composition and a low somatic cell count (ROSA et al., 2023), Jay, Loessner and Golden (2005) report that the presence of pathogenic microorganisms in milk poses a serious health risk to consumers. Bacteria such as Salmonella spp., Escherichia coli O157:H7 and Listeria monocytogenes, for example, can cause serious gastrointestinal illnesses, including diarrhea, vomiting, fever and in more severe cases, complications that can lead to hospitalization and even death. In addition, the yeasts and fungi present in milk can produce toxins and undesirable metabolites, compromising the quality and safety of the product. The presence of mycotoxins, such as aflatoxins produced by Aspergillus species, is particularly worrying, as they can be carcinogenic and cause liver damage in humans.

The list of microorganisms that do not make up the milk microbiota is becoming more and more frequent due to direct and indirect contact on the surfaces where the product is stored. Research indicates that more than one hundred genera and 400 species have already been found in milk, making it fundamentally important to assertively analyze the presence of bacteria that do not make up the lactobacilli (FERREIRA, 2021).

The direct sources of contamination are poorly cleaned equipment, compartments where the feed is preserved, such as where the input is preserved such as refrigeration tanks, feeding rooms and even in the animal's teats, often with the presence of fecal coliforms, which are frequently found, making up the main contamination by enterobacteria due to poor hygiene of the apparatus (CAMPOS, 2019).

Indirect sources of contamination include animal feed, which is directly linked to the ingestion of spoiled products that can cause disturbances in the animal's body, antibiotic treatment, which primarily alters the natural microbiota of living beings, causing impacts on the input, poor supervision of the water that washes the equipment, which can contain enterobacteria and consequently contaminate the milk. (SANTOS et al., 2019)

If there is contamination in the product, a physical-chemical change can be observed, due to the production of gases and acids produced by bacteria, altering fundamental characteristics of milk such as pH, reducing the availability of favorable nutrients for consumption, making it impossible to produce products from this input, such as cheese (FERREIRA, 2021).

In this sense, the microbiological analysis of milk is an essential tool for identifying and quantifying these pathogenic microorganisms and their toxic metabolites. Using appropriate methods, such as the microbiological culture technique, it is possible to isolate, identify and characterize the microorganisms present in milk, allowing for an accurate assessment of the health risk.

The authors Silva Júnior and Fernandes Júnior (2015) highlight the importance of following standardized methods in the microbiological analysis of milk in accordance with Brazilian legislation. These methods are developed and validated by regulatory bodies and reference institutions in order to guarantee the reliability and comparability of the results.

By adopting standardized methods, milk microbiological analysis laboratories ensure that they are carrying out scientifically recognized and validated procedures. This is essential for obtaining consistent and reliable results, allowing a proper assessment of milk quality and safety. These standardized methods include specific procedures for the detection and identification of pathogenic microorganisms, such as the use of selective and differential culture media, isolation techniques and biochemical identification. In addition, they establish counting criteria and microbiological limits that must be followed to assess milk quality (SILVA JÚNIOR; FERNANDES JÚNIOR, 2015).

Following standardized methods also makes it easier to compare results between different laboratories, allowing for a more accurate assessment of milk quality nationwide. In addition, it contributes to monitoring and the adoption of corrective measures by the health authorities, with the aim of guaranteeing food safety and protecting the health of consumers.

The material collected for analysis must always be sterile, as this increases accuracy and assertiveness dof the material studied, since microbiological research needs to expose data that could be compromising in cases where there is an unacceptable practice in this area.t(MÖRSCHBÄCHER et al., 2017)

The analysis of milk export containers and the animal's udders and teats cannot go unnoticed as they require certain anamneses, because the external environment where the material is exposed can lead to contamination by residues that are not added to the product, making it unviable for consumption and therefore having to be discarded (FERREIRA, 2021).

The presence of bacteria in contaminated food is extremely frequent, as it occurs when humans or animals ingest food contaminated with a pathogen due to poor treatment of the input or product, triggering various infectious processes that can lead to death (SANTOS et al., 2019).

The temperature at which the milk is stored has a great deal to do with its quality. If there is any inconsistency, the input is more exposed to microorganisms dispersed in the environment, favoring a wide growth of bacterial strains due to the pleasantness of the place, favoring their incubation (FERREIRA, 2021).

Microbiological analysis requires extensive investigation when questioning the quality of a particular input such as milk, due to the àIt is therefore essential to carry out a thorough investigation, not just of the input being handled, but of the entire environment in which the product is stored. thermophilic Psychrotrophic and thermophilic bacteria support low and high temperature environments, if the place where the milk is being stored is experiencing temperature variations there will be a favorable environment for multiplication in the product and contamination will occur (SANTOS et al., 2019).

METHODOLOGY

TYPE OF RESEARCH

This research is an exploratory, qualitative--quantitative and descriptive study. According to Marconi and Lakatos (2009), exploratory research is widely used to carry out a preliminary study of the main objective of the research to be carried out, i.e. to familiarize oneself with the phenomenon being investigated, so that subsequent research can be designed with greater understanding and precision, and descriptive research.

Quati-qualitative research, on the other hand, aims to obtain a better understanding and broader explanation of the subject, which in turn describes the complexity of a given problem, making it necessary to understand and classify the dynamic processes experienced by groups, contributing to the process of change, enabling a clearer understanding of the subject (MARCONI; LAKATOS, 2009).

LOCATION OF THE STUDY

The study was carried out in the municipality of Cajazeiras - PB, which (Figure 2) is located in the interior of the state of Paraíba, belonging to the Sertão Paraibano mesoregion, occupying an area of 565.899 km². Its population, estimated by the 2020 demographic census, is 62,576. In the economy, the municipality stands out in the Agriculture, Industry and Services sectors (IBGE, 2020). It should be noted that the city's area in terms of agricultural establishments is around 21,428 ha, with the number of agricultural establishments standing at around 1,544 units.

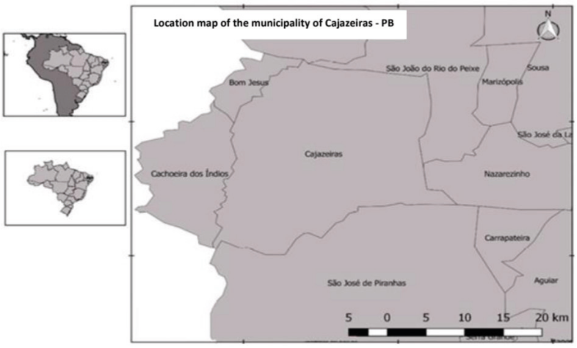

Figure 2: Location of the Municipality of Cajazeiras-PB.

Source: IBGE, 2019

The climate of the study area is predominantly semi-arid, according to the Köppen classification, of the hot and dry type, with a rainy season in summer and annual droughts. It is characterized by irregular rainy seasons with long periods of drought, in which the average annual rainfall is low (< 800 mm) and a markedly dry season, with an average annual temperature above 27.4ºC (IBGE, 2020).

As far as vegetation is concerned, there is a predominance of hyperxerophilous Caatinga, with a range of adaptations to the type of climate found here. The soils are predominantly Luvissolos, which have "medium to high natural fertility, sandy/clayey and medium/clayey texture, stony phase, gently undulating relief, well drained, relatively shallow and very susceptible to erosion and relatively shallow" (IBGE, 2020).

DATA COLLECTION PROCEDURES

The target population for this research consisted of dairy farmers in the region. The sample consisted of three selected dairy farmerstaking into account the availability of and access to producers willing to take part in the study.

Data was collected through direct observation and the application of a checklist of good milk production practices. The checklist covered aspects related to milk processing, monitoring, handling and quality control. Practices adopted by producers were assessed, such as milking hygiene, proper milk storage, equipment cleaning, among other relevant criteria to ensure food safety.

The data collected was stored and manipulated in Excel *spreadsheets* (Microsoft Office ©), which allowed for greater control and mastery of the data set. The data included qualitative and quantitative variables, and where necessary, transformations were made for analysis using descriptive statistics.

The total area of the property, the conditions under which the land is used, the destination of the milk produced and the marketing price of the milk were evaluated. As well as the total number of cows in the herd, daily milk production and the number of daily milkings.

DATA ANALYSIS

Microbiological analyses were carried out following the methodology recommended by the Association of Official Analytical Chemists (AOAC, 2002), in accordance with the requirements established by Resolution - RDC No. 12 of the National Health Surveillance Agency (BRASIL, 2001), which defines the microbiological standards for food sold in retail outlets. These analyses included the detection of Salmonella sp., total coliforms, thermotolerant coliforms and mesophilic aerobes.

The samples collected were sent to a specialized laboratory for microbiological analysis. The detection of pathogenic microorganisms was carried out following the standardized methods recommended by the regulatory authorities. The results of the analysis were interpreted in accordance with the microbiological criteria established by current legislation.

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In addition to the microbiological analysis, were weres visits were made to milk producers to understand their practices and methodologies used in milk production and quality control. This information was analyzed together with the results of the microbiological analysis to identify possible causes of contamination and verify which practices are adopted to guarantee food safety.

RESULTS AND DISCUSSIONDISCUSSION

The results were divided into two parts, the first looking at the tests carried out and the second analyzing the Checklist of good milk production practices.

TESTS CARRIED OUT ON MILK

The tests carried out on the input were initially to apply bacteriological methods such as separating samples into aliquots in sterile collectors over a short period of time so that the sample is not compromised at varying temperatures, avoiding contamination with other bacteria from the external environment. Three milk samples were evaluated, classified as producer 1 (P1), producer 2 (P2) and producer 3 (P3).

The culture media selected for sowing the milk were selective and non-selective media, and Mueller Hinton medium as the appropriate medium for antibiogram analysis, where it was not necessary because there was no growth of bacteria present in the aliquots separated by the producers.

The milk samples were sown with the aid of sterile swabs, in linear movements or exhaustion in each space of culture medium selected on the plate. They were then incubated in a bacteriological oven at an optimum temperature of 37 °C.

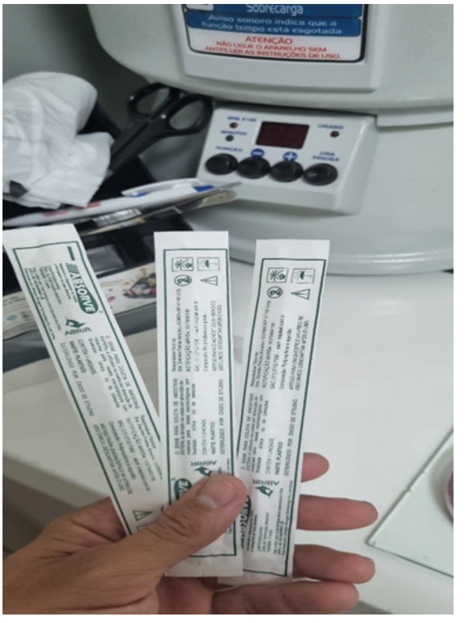

Figure 3: Sterile swab for sowing the sample.

Source: Research data, 2023.

As a method of identification, the plates were marked with a black pen and differentiated as P1, P2 and P3.

Figure 4: Plate identification.

Source: Research data, 2023.

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Blood agar, being a non-selective medium, where its formation consists of horse, sheep or rabbit blood, added at a temperature of 50 °C, preventing the lysis of red blood cells, evaluates the bacteria that grow in this medium if they, when incubated at a temperature of 37 °C, will cause hemolysis of the blood, these being classified as alpha hemolytic, beta hemolytic or gamma hemolytic. Its evaluation is crucial for identifying Streptococcus spp. and Staphylococcus spp. bacteria.

Chocolate agar is also made up of horse, sheep or rabbit blood. It differs from blood agar according to its preparation, where blood is added to the base of the medium at a high temperature, approximately 80 °C, eventually causing the lysis of the red blood cells and a change in the final color of the culture medium to a brown color.

Mac Conkey agar is a selective medium for gram-negative bacteria, evaluating mainly non-lactose fermenting enterobacteria, where the color of the colonies can be seen with the naked eye, distinguishing between reddish-pink petri dishes where there are lactose fermenting bacteria and yellowish colonies where there is no lactose fermentation.

The use of the Mueller Hinton culture medium is specific to the antibiotic analysis of the antibiogram test, and is only necessary when there is a growth of bacteria in some of these media that have been chosen, consequently, their colonies are isolated in an enriching broth such as Tryptic Soy Broth (TSB) and incubatedincubated for a period of 24 hours at 37 °C. The colonies are then seeded in this medium and antibiotic disks are added to assess their sensitivity and resistance through the halos formed.

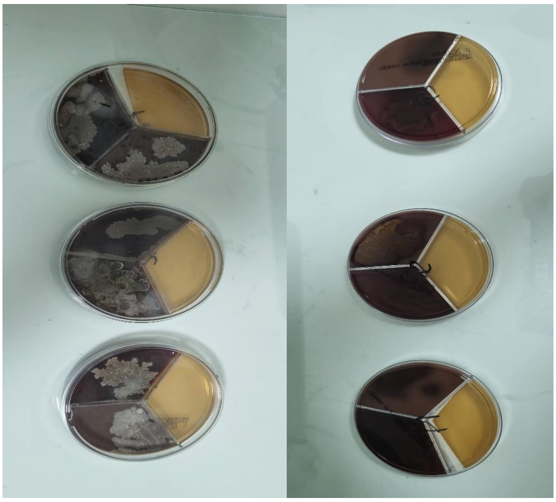


Figure 5: Samples after 24 hours of incubation.

Source: Research data, 2023.

Conformitye figure 5, no bacterial growth was observed in any of the selected culture media because they did not present homogeneous colonies that are classified as pathogenic to humans, consequently it was not necessary to use the Mueller Hinton culture medium, for the reason that it did not have colonies to be evaluated by the antibiotics that would be coupled to the medium together with the antibiotics. àthe colonies.

This result was contrary of the study by Abreu and Moésia (2017) who checked the quality of non-industrialized bovine milk “in natura”, sold informally in the city of Cajazeiras. The authors’ results showed that the in natura milk sold in Cajazeiras, Paraíba, was contaminated with various species of bacteria, which can facilitate the occurrence of food poisoning outbreaks, and that this product did not meet the quality standards required for consumption in the form in which it is sold. In addition, the authors observed a lack of basic hygiene principles throughout the process, from milk collection to consumption.

It is worth highlightingr that this study differs from the work carried out by Abreu and Moésia (2017) because, in contrast, our analysis focuses directly on the production phase, specifically on the farm. Unlike the previous approach, which focused on marketing, our research explores the initial processes, identifying potential sources of contamination right at the origin of the product. According to Santos (2017), contamination can often occur during transportation or due to inadequate marketing conditions, such as the lack of refrigeration and proper storage of fresh milk. This broader perspective allows for a more complete understanding of the factors that contribute to unsatisfactory product quality, focusing not only on the final stage of the chain, but also on crucial aspects from production to distribution.

According to Sequetto et al. (2017), inadequate temperature control during milk storage can lead to the proliferation of mesophilic aerobic bacteria. Refrigeration, which aims to regulate the development of these microorganisms, is essential, since most of them ferment lactose, resulting in the production of lactic acid. This acidification process compromises the use of milk in industry. However, it is important to note that refrigerating milk also favors the growth of psychrotrophic bacteria, as low temperatures provide an environment conducive to their multiplication (SEQUETTO et al., 2017).

CHECKLIST OF GOOD MILK PRODUCTION PRACTICES

Dairy farming in Brazil is remarkably diverse, with a wide variety of production systems. This diversity encompasses different management practices, animal breeds, milking specialization, milk storage methods on the farm, production volumes and producers' economic conditions. Improving conditions at all stages of the process, from production to storage, transportation and packaging in processing facilities, is crucial to ensuring the quality of milk and its derivatives (SEQUETTO et al., 2017).

Good Milk Production Practices (GMP) refer to guidelines and standards established to guarantee quality, safety and sustainability in milk production. These practices cover all stages of the process, from feeding and handling the animals to obtaining, storing and transporting the milk (PAULO; RODRIGUES, 2022).

Graph 1 below highlights the assessment of the conditions of hhygiene conditions in the properties analyzed.

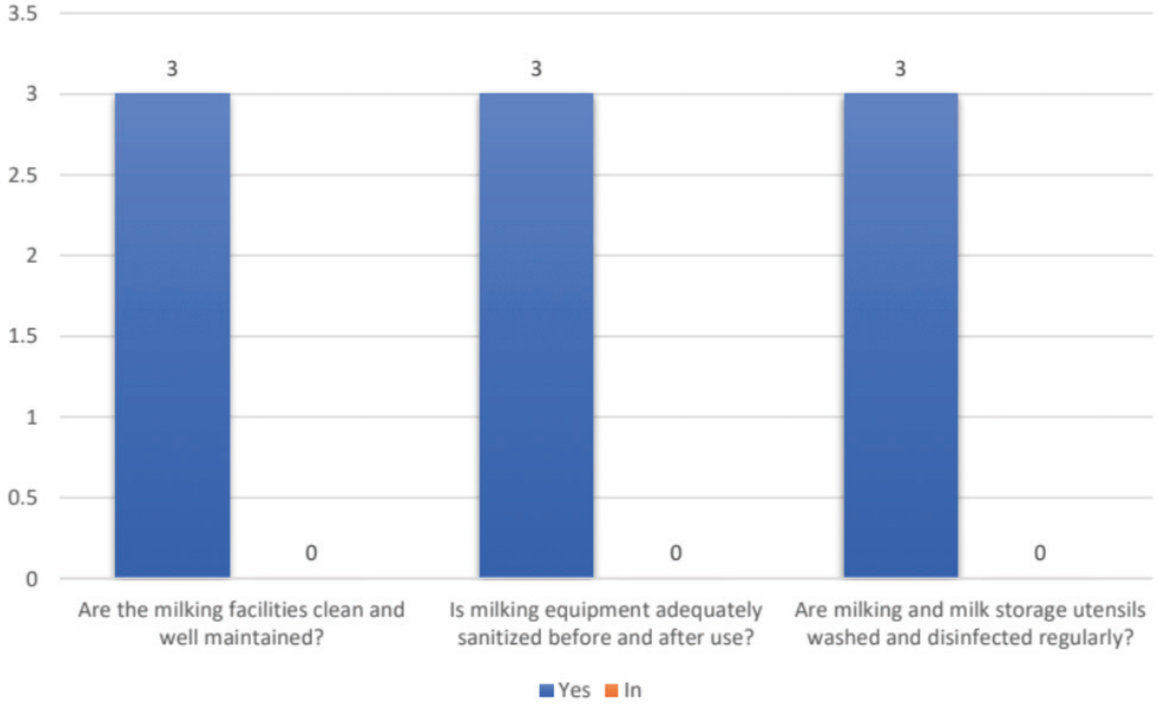
The assessment of the hygiene conditions in the milking facilities reveals a fairly satisfactory situation, as all 3 farms are in compliance. This suggests that the facilities are adequately clean and well maintained, providing an environment conducive to milk production. The sanitization of milking equipment, both before and after use, stands out, indicating a consistent practice in preventing milk contamination by unwanted microorganisms

Another positive aspect is the regular washing and disinfection of milking and milk storage utensils, also scoring the maximum. This additional care is essential for maintaining the quality of the milk throughout the process. These effective hygiene practices contribute not only to food safety, but also to preserving the quality of the end product, which is crucial for consumer confidence.

Graph 1 indicates that good hygiene practices are being applied consistently in the milking facilities, providing an environment conducive to the production of high quality milk.

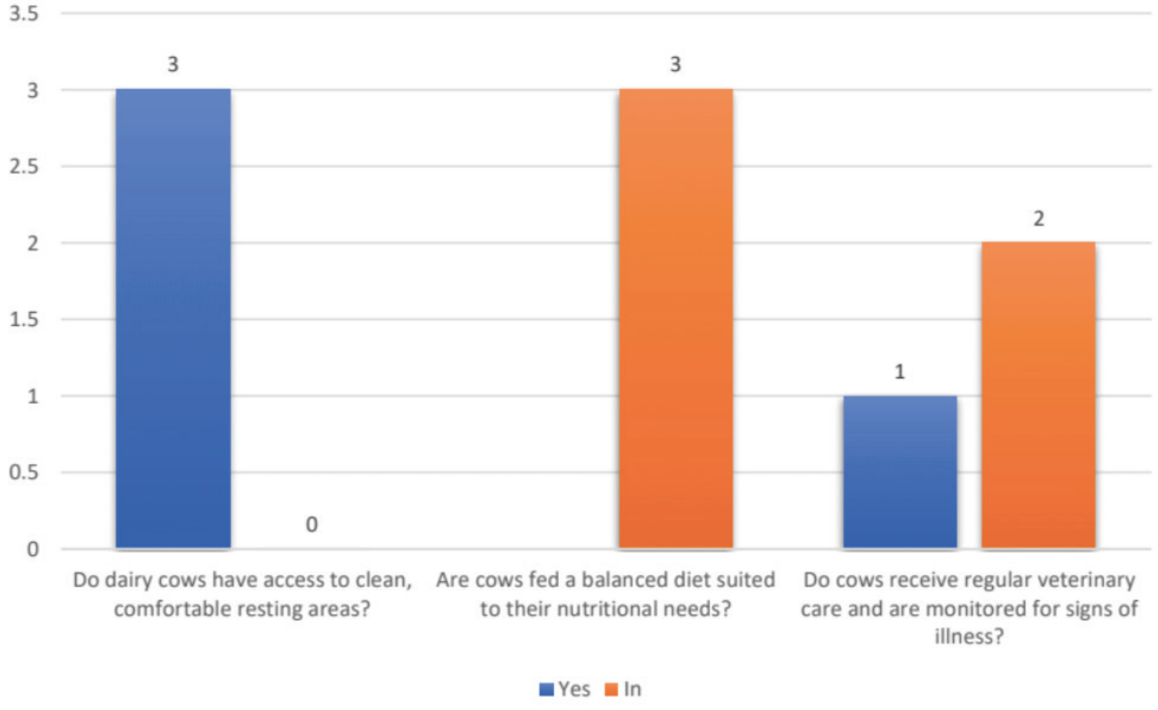
Graph 2 highlights the assessment of animal welfare.

With regard to the first criterion, which refers to the dairy cows' access to clean and comfortable resting areas, all the farms comply, indicating that this aspect of animal welfare is met in a positive way on all the farms studied.



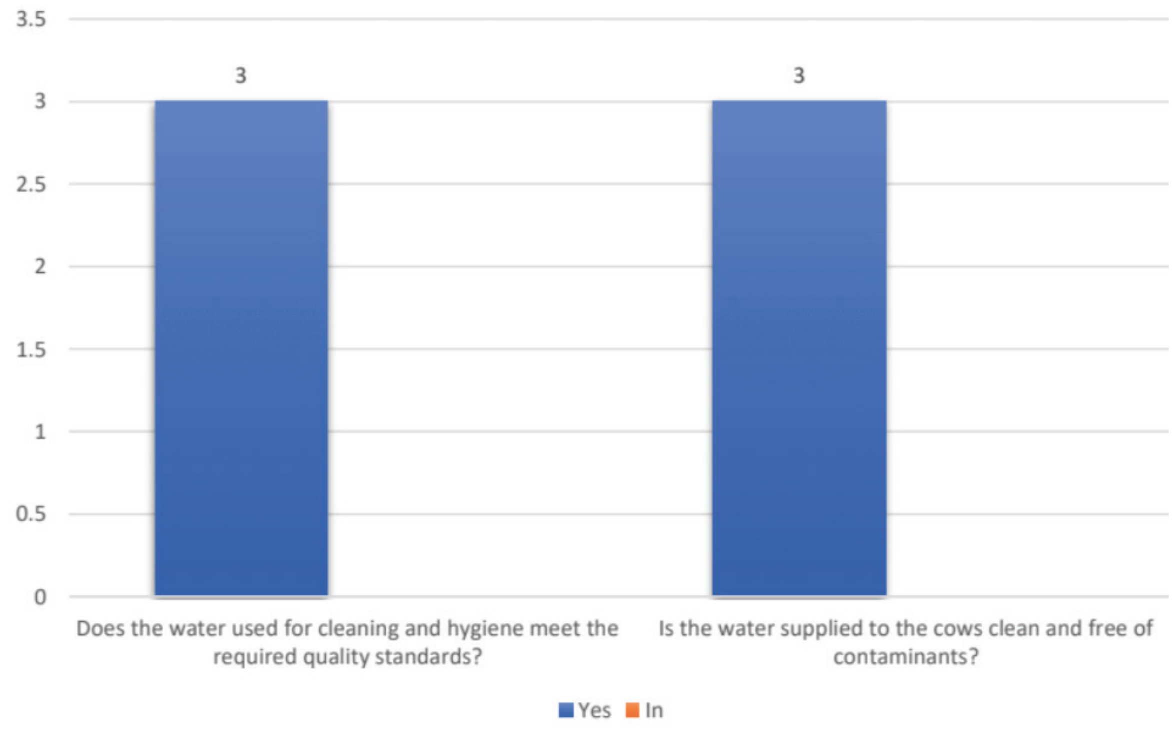
Graph 1: Evaluation of hygiene conditions.

Source: Research data, 2023.



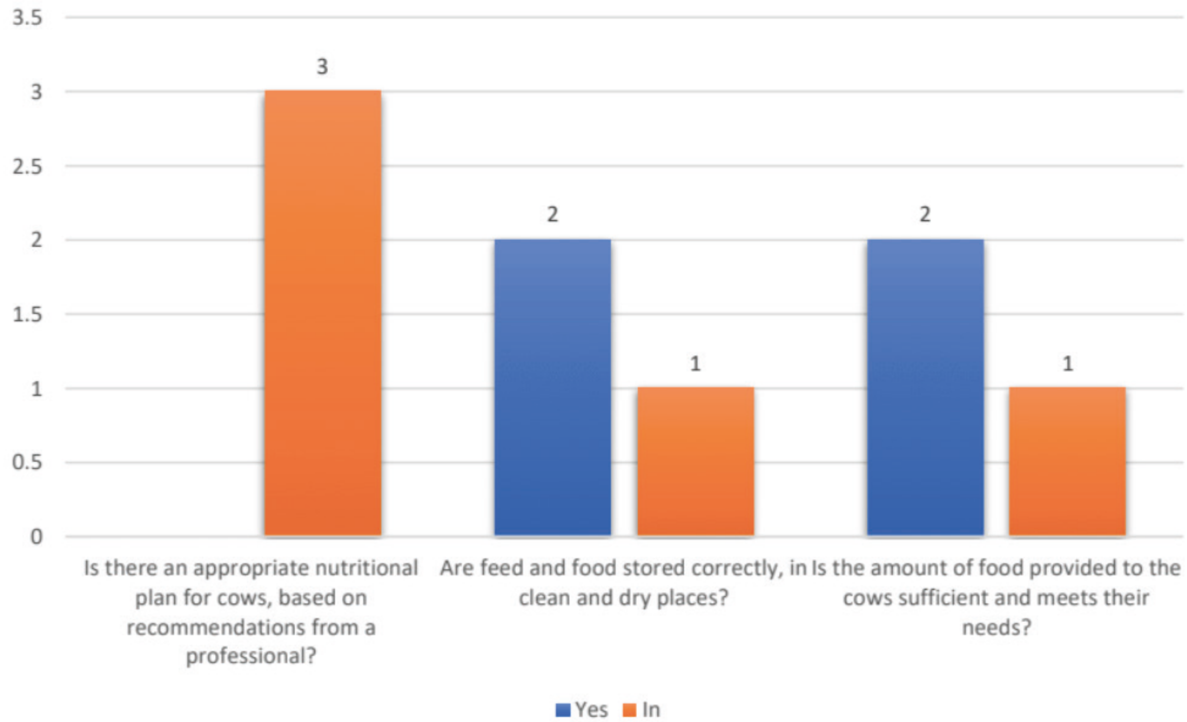
Graph 2: Animal Welfare Assessment.

Source: Research data, 2023.



Graph 3: Water Quality Assessment.

Source: Research data, 2023.



Graph 4: Evaluation of Food Management.

Source: Research data, 2023.

With regard to the second criterion, which relates to balanced feeding that is adequate for the cows' nutritional needs, all the properties reported no. According to Carneiro et al. (2023), during certain times of the year, the scarcity of rainfall and drought conditions represent a significant challenge for livestock farming in the sertão, directly impacting the availability of pasture and, consequently, cattle feed. During these periods, the lack of pasture requires producers to take supplementary measures to ensure adequate nutrition for the herd. However, supplementary feeding often becomes an expensive solution for producers. Purchasing supplementary feed, such as concentrates and additional forage, entails high costs, which can compromise the economic viability of production. This financial difficulty can result in inadequate feed for cattle, affecting not only their nutritional status, but also the herd's overall productivity (CARNEIRO et al., 2023).

As for the third criterion, which assesses regular veterinary care and monitoring for signs of disease. Two properties do not carry out this care regularly, and only one property does.

In graph 3 highlights-is the assessment of water quality in two different dimensions in the facilities.

In the first criterion, which considers whether the water used for cleaning and hygiene meets the required quality standards, all the properties report that it does, indicating that the quality of the water used for these purposes complies with the established standards.

In the second criterion, which assesses whether the water supplied to the cows is clean and free of contaminants, the information "Yes" suggests that, on the properties in question, the water intended for animal consumption is adequate, meeting the requirements of cleanliness and absence of contaminants. This attention to water quality is crucial to ensure not only the well-being of the animals, but also the integrity of the cleaning and hygiene processes in the facilities, thus contributing to the production of high quality and safe milk.

As highlighted by Almeida et al., (2016), water plays a crucial role in the milk production of dairy cows, since milk is mainly composed of water, accounting for around 87% of its composition. It is therefore vital to ensure that dairy cattle have access to quality water in sufficient quantity to maintain their health and productivity, especially during the lactation period. Aspects to look out for include cleanliness, freshness, low levels of solids and alkalinity, as well as freedom from toxic compounds, such as high concentrations of salt (NaCl), which can be harmful to cattle.

According to the Vale do Rio Doce Cooperative (2020), inadequate water quality not only poses a risk for the transmission of diseases to humans and animals, but is also a potential vector for mastitis-causing agents. Poor water quality negatively impacts animal consumption in dairy production, directly affecting production performance. In addition, the use of bacteriologically inadequate water can lead to health problems such as diarrhea in young animals and outbreaks of mastitis in the herd, compromising milk quality and contaminating milking and refrigeration equipment.

In the tropical region of the dairy chain, the production of one kilogram of feed requires a considerable volume of water, approximately 20,000 liters per kilogram. This figure includes not only the needs of the pastures, but also the intake of adult animals, which consume between 40 and 120 liters per day. Therefore, ensuring an abundant source of clean, high-quality water is a priority for dairy farms, as water quality plays a vital role in all of the animals' essential physiological functions (COOPERATIVA VALE DO RIO DOCE, 2020).

Graph 4 shows the evaluation of Food Management.

Graph 4, which assesses the different aspects of food management on the farms, reflects some significant challenges. Notably, none of the farms analyzed has an adequate nutritional plan based on professional recommendations, suggesting a possible gap in food planning. The absence of such a plan can negatively impact the nutritional efficiency of dairy cows, directly influencing their milk production. This is a crucial area that requires attention to ensure that cows receive a balanced diet adapted to their specific needs.

With regard to the storage of feed and food, two farms store it in clean places and one does not store it correctly. Incorrect storage can affect the quality and safety of the food supplied to the cows, highlighting the importance of uniform and rigorous standards on all farms.

In two properties, the amount of feed provided was sufficient, while in one it was not. Ensuring an adequate supply of food is fundamental to promoting the health and productive performance of the herd, as shown in Graph 2.

Graph 5 highlights Disease and Parasite Control.

Graph 5 shows that in relation to regular vaccinations and preventive treatments, two farms demonstrate a commitment by answering "Yes", indicating a proactive approach to preventing diseases and parasitic infestations. However, it is worrying to note that one property answered "No" to this criterion, suggesting a gap in preventive practices, which could impact on the overall health of the herd.

As for veterinary monitoring to identify and treat diseases and parasitic infestations, the situation is the opposite, with only one property indicating that it does this. On the other two properties, "No" suggests a lack of emphasis on the early detection and effective treatment of health problems in the herd, which can compromise animal welfare.

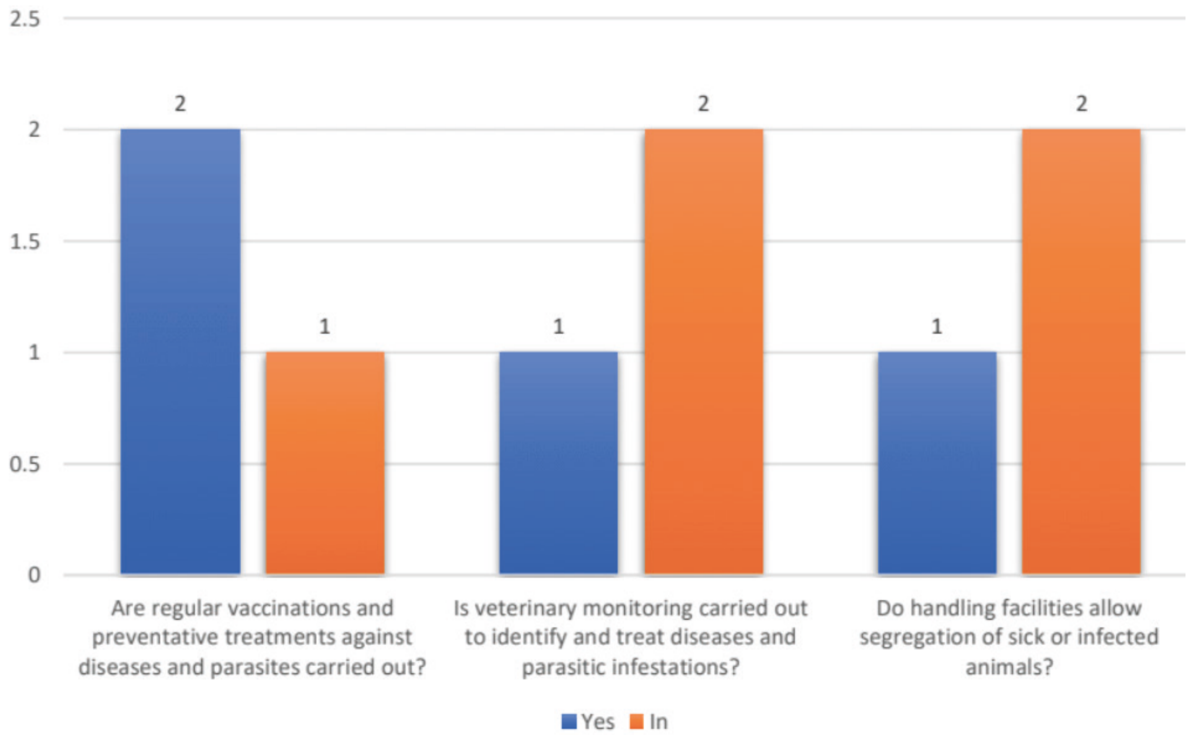
Segregating sick or infected animals is a crucial aspect of disease control, and the results of the graph show that only one property adopts this practice. In the other two, the absence of this measure could represent a risk of spreading diseases in the herd.

Milk quality is susceptible to the influence of various diseases and parasites that can affect the health of dairy cattle. The implementation of health management practices, such as regular vaccinations, parasite control, maintaining hygiene in the facilities and constant monitoring of herd health, are essential measures to mitigate these risks and guarantee the production of safe, high-quality milk.

Mastitis is the main disease affecting dairy cattle and has a significant negative impact on the economy due to its high prevalence in herds. The economic losses result from various factors, including a reduction in milk production, costs associated with labor, professional fees, medication expenses, the death or premature disposal of animals, and a decrease in the quality of the final product, resulting in a drop in industrial yield (LANGONI et al., 2011).

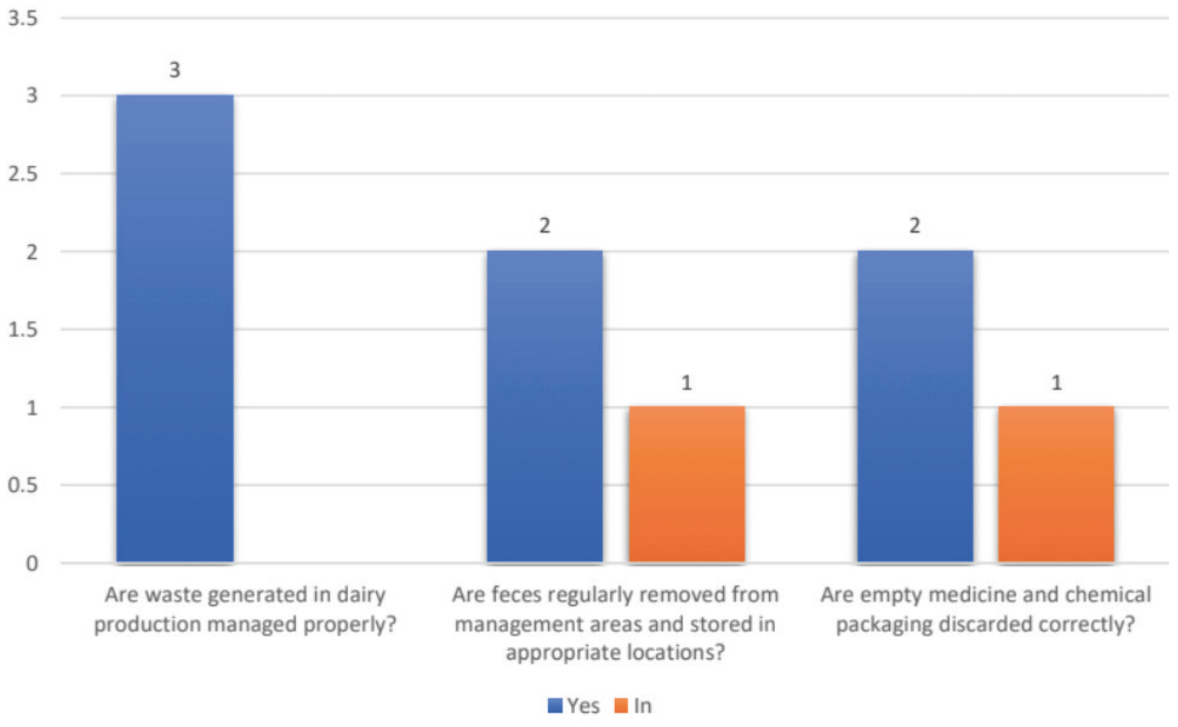
There are more than 140 different types of microorganisms capable of triggering mastitis. The most common pathogens include Staphylococcus aureus, Streptococcus agalactiae, Streptococcus dysgalactiae, Streptococcus uberis, Escherichia coli, Corynebacterium bovis, Pseudomonas aeruginosa, Enterobacter spp, and others such as Mycoplasma spp., Mycobacterium bovis, Brucella abortus and Listeria monocytogenes (MARTINS et al., 2010; LANGONI et al., 2011).

Other diseases are: worms, brucellosis, foot-and-mouth disease and salmonellosis. Worms, gastrointestinal parasitic infestations, and diseases such as foot-and-mouth disease, bovine brucellosis and salmonellosis represent significant threats to milk quality. As well as causing discomfort and weight loss, worms can reduce the productive performance of dairy



Graph 5: Evaluation of Disease and Parasite Control.

Source: Research data, 2023.



Graph 6: Evaluation of Waste Management.

Source: Research data, 2023.

Graph 7: Evaluation of the provision of training and qualifications to employees.

Source: Research data, 2023.

cows, directly affecting milk quality. Foot-and-mouth disease, a contagious viral disease, can result in teat wounds, contaminating the milk with blood and pus. Bovine brucellosis, in addition to causing infertility, poses the risk of contaminating milk with the bacterium Brucella abortus, representing a potential danger to public health in the absence of proper pasteurization. Salmonellosis, caused by Salmonella bacteria, can contaminate milk through contaminated feces, not only posing risks to human health, but also damaging milk production and quality in affected animals (SCHAFHÄUSER JUNIOR; PEGORARO; ZANELA, 2016).

Graph 6 shows how waste is managed.

Graph 6 shows that all three farms have a positive view of their overall commitment to sustainable practices. All the farms manage the waste generated in dairy production properly, indicating a consistent focus on environmental responsibility. However, when analyzing the regular removal of faeces and its storage, it can be seen that two farms adopt adequate practices, while one did not meet this criterion, highlighting the importance of improvements in waste management to maintain a hygienic and healthy environment.

As for the disposal of empty packaging from medicines and chemical products, two properties were assessed positively, indicating responsible procedures. However, one property did not meet this criterion, pointing to the need to improve disposal procedures to avoid negative environmental impacts.

Analysis of Graph 6 highlights a general commitment to waste management on the dairy farms evaluated. Although there are specific areas, such as feces management and packaging disposal, that need improvement, the overall positive score reflects an effort to promote more sustainable and responsible practices in dairy production. This approach is essential for mitigating adverse environmental impacts and contributing to the long-term sustainability of dairy operations.

Graph 7 shows whether the farms train their employees.

Graph 7 shows that two farms are committed to providing training for employees involved in milk production. This approach is crucial to ensure the implementation of appropriate and sustainable procedures in the day-to-day running of the farm, contributing to efficiency and quality in milk production.

However, with regard to the "Continuous Training Program for Improving Management Practices", only one property indicates that it has such a program, while the other two do not meet this criterion. This situation points to an opportunity to implement continuous learning initiatives on farms, with the aim of constantly improving the skills and knowledge of those involved in dairy production.

It is worth noting that there are Rural Technical Assistance Programs aimed at Good Management Practices. However, Gonçalves et al. (2014) identifies several restrictions to the progress of the production chain in the dairy industry, one of which is the limited effectiveness of the use of technical assistance services. Technical assistance plays a crucial role in offering specialized guidance to producers, helping them to implement and maintain agricultural practices that promote quality, safety and sustainability in milk production.

Graph 8 highlights the use of records and documentation on the property.

The analysis of Graph 8 on records and documentation on dairy farms highlights a disparity in the adoption of this practice between the two farms evaluated. While one farm shows a commitment to keeping records, indicating a systematic approach to documenting activities related to milk production, the other two farms do not adopt this practice.

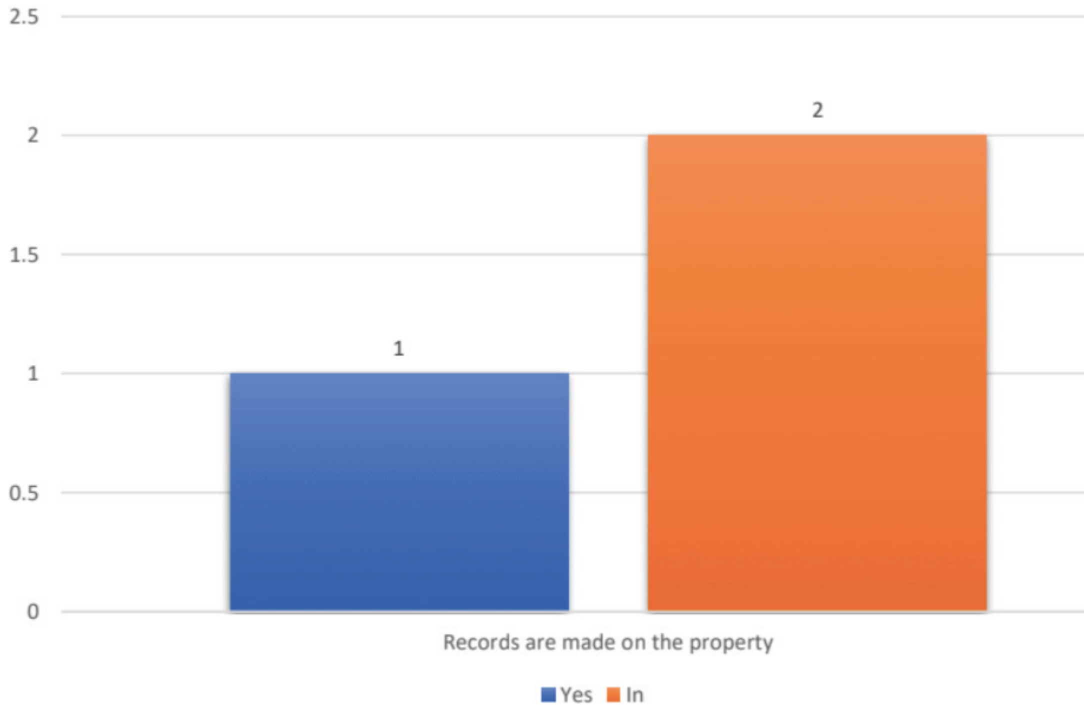
Keeping records is crucial for effective management, allowing detailed monitoring of daily operations, which contributes to informed decision-making and compliance with quality and safety standards in dairy production. Farms that keep records have the ability to monitor herd performance, identify areas for improvement and meet regulatory requirements. The discrepancy observed suggests the importance of promoting the implementation of records on farms that have not yet adopted this practice, with a view to improving operational efficiency, product quality and compliance with industry standards.

Gonçalves et al. (2014) report that regardless of the size of the property, they emphasize that decisions must be based on logical criteria, backed up by solid planning. In addition, they stress the importance of farmers having access to appropriate management tools and up-to-date data to improve their profitability, without the need to make significant investments.

FINAL CONSIDERATIONS

Milk production is a crucial activity, especially in developing countries and in family farming systems. The global growth of milk production in recent decades reflects its importance in food security. In the Brazilian context, the dairy agro-industrial activity plays a significant role, being an essential source of employment and income, encompassing an extensive network of producers and contributing substantially to the national economy.

The results showed that the microbiological tests carried out on the milk were positive, indicating the absence of bacterial growth on the selected culture media. With regard to the Checklist of Good Dairy Production Practices, the results reveal a varied panorama on the dairy farms analyzed. Positive points stand out, such as the hygiene of the milking facilities, the quality of the water used and the commitment to waste management. However, there are areas that require improvement, such as food management, disease prevention and the implementation of ongoing training.



Graph 8: Assessment of the use of records and documentation on the farm.

Source: Research data, 2023.

The evaluation of feed management highlighted the need for more elaborate nutritional planning, in line with professional recommendations, to ensure the nutritional efficiency of dairy cows. The lack of such a plan can have a negative impact on milk production, indicating an area of opportunity for implementing more effective practices.

When it comes to controlling diseases and parasites, the research highlights the importance of regular vaccinations, preventive treatments and segregating sick animals. Early identification and effective treatment of health problems are crucial to preserving the health of the herd and, consequently, the quality of the milk. Regarding waste management, there was a general commitment, but specific points, such as the regular removal of feces and the disposal of packaging, require more attention in order to promote more sustainable and responsible practices.

With regard to training and capacity building, there is recognition of the importance of training employees involved in dairy production, but the implementation of ongoing training programs still lacks more systematic approaches. As for the use of records and documentation, the discrepancy between the farms highlights the need to promote the implementation of this practice in order to improve operational efficiency, product quality and compliance with industry standards.

It therefore highlights the complexity of dairy production management in the context of the Paraibano Sertão. The study not only identifies areas of excellence, but also highlights specific challenges that can be addressed through improved practices, investments in training and capacity building, and an integrated approach to ensuring sustainability and quality in bovine milk production in the region.

Recommendations for improving the microbiological quality of milk include practices such as sanitizing water, adopting good management and hygiene practices during milking, and implementing simple procedures such as discarding the first jets of milk and properly cleaning equipment. The analysis concludes the crucial importance of microbiological analysis of bovine milk to guarantee the quality and food safety of milk as an essential measure to prevent public health risks associated with inadequate consumption of this highly perishable food.

Suggestions for future research include studies that could deepen the analysis with a larger number of farms. A promising field of research could focus on the implementation of more effective nutritional strategies, seeking to understand how more elaborate nutritional planning can optimize the productive efficiency of dairy cows. In addition, detailed investigations into innovative methods for controlling diseases and parasites, as well as promoting sustainable waste management practices, could make a significant contribution to improving dairy production in the region. These research suggestions have the potential to provide studies for specific interventions and for the positive evolution of the dairy sector in the region.

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