MILKING HYGIENE AND PHYSICOCHEMICAL QUALITY OF MILK

HIGIENE DE ORDENHA E QUALIDADE FÍSICO-QUÍMICA DO LEITE

HIGIENE DE ORDEÑO Y CALIDAD FISICOQUÍMICA DE LA LECHE

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ABSTRACT

The present study consists of a narrative literature review that analyzes the relationship between milking hygiene and the physicochemical and microbiological quality of bovine milk. This study was based on the analysis of scientific publications indexed in the PubMed database, selecting articles published between 2021 and 2023, using descriptors related to milking hygiene and physicochemical quality. The results demonstrate that the implementation of control systems, such as Hazard Analysis and Critical Control Points (HACCP), positively impacts milk quality, increasing physicochemical compliance to 78% in the evaluated units. In contrast, a direct correlation was observed between sanitary deficiencies (inadequate cleaning of udders and milking equipment) and the increase in coliform load and pathogens such as Staphylococcus aureus and Listeria monocytogenes, compromising food safety and the processing of dairy products. It is inferred that, to ensure industrial quality and mitigate public health risks, the adoption of good farm management practices, strict equipment hygiene, and control technologies in dairy product processing is essential.

Keywords: Dairy Products. HACCP. Food Microbiology. Public Health. Pathogens.

RESUMO

O presente trabalho consiste em uma revisão bibliográfica narrativa que analisa a relação entre a higiene de ordenha e a qualidade físico-química e microbiológica do leite bovino. Este estudo foi fundamentado na análise de produções científicas indexadas na base de dados PubMed, sendo selecionados artigos publicados entre 2021 e 2023, utilizando descritores relacionados à higiene de ordenha e qualidade físico-química. Os resultados demonstram que a implementação de sistemas de controle, como a Análise de Perigos e Pontos Críticos de Controle (HACCP), impacta positivamente a qualidade do leite, elevando a conformidade físico-química para 78% nas unidades avaliadas. Em contraste, evidenciou-se uma correlação direta entre as deficiências sanitárias (limpeza inadequada dos úberes e

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dos equipamentos de ordenha) e a potencialização da carga de coliformes e patógenos como Staphylococcus aureus e Listeria monocytogenes, comprometendo a segurança alimentar e o processamento de derivados. Infere-se que para garantir a qualidade industrial e atenuar riscos à saúde pública é indispensável a adoção de boas práticas de manejo na fazenda, higiene rigorosa de equipamentos e tecnologias de controle no processamento dos produtos lácteos.

Palavras-chave: Laticínios. HACCP. Microbiologia de Alimentos. Saúde Pública. Patógenos.

RESUMEN

El presente trabajo consiste en una revisión bibliográfica narrativa que analiza la relación entre la higiene de ordeño y la calidad fisicoquímica y microbiológica de la leche bovina. Este estudio se fundamentó en el análisis de producciones científicas indexadas en la base de datos PubMed, seleccionando artículos publicados entre 2021 y 2023, utilizando descriptores relacionados con la higiene de ordeño y la calidad fisicoquímica. Los resultados demuestran que la implementación de sistemas de control, como el Análisis de Peligros y Puntos Críticos de Control (HACCP), impacta positivamente la calidad de la leche, elevando la conformidad fisicoquímica al 78% en las unidades evaluadas. En contraste, se evidenció una correlación directa entre las deficiencias sanitarias (limpieza inadecuada de las ubres y de los equipos de ordeño) y el aumento de la carga de coliformes y patógenos como Staphylococcus aureus y Listeria monocytogenes, comprometiendo la seguridad alimentaria y el procesamiento de productos lácteos. Se infiere que, para garantizar la calidad industrial y atenuar los riesgos para la salud pública, es indispensable la adopción de buenas prácticas de manejo en la finca, higiene rigurosa de los equipos y tecnologías de control en el procesamiento de productos lácteos.

Palabras clave: Lácteos. HACCP. Microbiología de Alimentos. Salud Pública. Patógenos.

1 INTRODUCTION

The quality and specificity of bovine milk are modulated by the dynamic interaction between climate, animal breeds and environmental microbiology. These attributes are decisive for obtaining dairy products with specific physicochemical, microbiological, and sensory characteristics (Penna et al., 2021). Therefore, the evaluation of this product of animal origin should not be limited to the basic nutritional value (fat and protein contents) but should also cover critical parameters such as acidity, thermal stability, and hygienic indicators of total bacterial count and somatic cells (Brodziak et al., 2021).

However, the valorization of products with raw milk as raw material and the search for organic production systems coexists in a scenario of critical microbiological vulnerabilities (Sakaridis et al., 2022). Despite the market appreciation of raw milk productions and their traditionality, the control of their microbial load represents a constant concern in the sector, requiring special attention due to the risks associated with contamination. In addition, it is noteworthy that the identification of failures in the sanitary control of these systems demonstrates the need to support producers, especially in small-scale productions, through training in good hygiene practices, to align nutritional quality with microbiological safety (Brodziak et al., 2021; Penna et al., 2021).

In addition, it is notorious that the evaluation of dairy products from small producers highlights the absence of standardization and failures in hygienic control during milking, leading to critical oscillations in physicochemical parameters, such as acidity and fat content, favoring contamination by pathogens such as Salmonella and coliforms, negatively impacting the safety and sensory quality of the food offered (Januś et al., 2021). It is emphasized that this scenario becomes even more serious in the informal marketing sector, since the absence of heat treatment and sanitary control exposes consumers to high risks. Investigations in non-regulated sales circuits point to the commercialization of non-standard samples in addition to indications of adulteration by the addition of water, which compromises both the nutritional value and the suitability of the milk for processing (Ariri et al., 2023). In this way, the imperative need for strict implementation of good hygiene practices and government inspection to ensure the quality of milk from the moment it is obtained is made explicit (Penna et al., 2021).

2 METHODOLOGY

This work is a bibliographic review of a narrative nature, elaborated with the aim of compiling and examining contemporary scientific evidence about milking hygiene and its correlation with the physicochemical quality of milk. Data mining was conducted on the PubMed platform, using the descriptors "Milking hygiene" and "Physicochemical quality",

consortium by the Boolean operator AND, in strict compliance with the terminology established in the Medical Subject Headings (MeSH). Articles published between 2021 and 2023, available in full access and written in Portuguese or English, which had direct adherence to the central theme, were included in the corpus of this research. The exclusion criteria were studies that were not related to the theme, duplicate manuscripts, reviews without clear methodological grounds, and non-indexed articles. The selection process was structured in two phases: analysis of titles and abstracts, followed by exhaustive reading of the full texts to ratify their relevance. The findings were synthesized and presented in a descriptive manner.

3 RESULTS AND DISCUSSION

The implementation of strict hygiene protocols and monitoring systems such as HACCP has a direct and positive impact on raw milk quality indicators. In collection units that adopted the HACCP system, it was observed that 78% of the samples achieved full physicochemical compliance, demonstrating that the control of critical points reduces the incidence of unwanted changes (Mannani et al., 2023). Physicochemical parameters such as density (ranging between 1.023 and 1.032 g/cm³) and titratable acidity are sensitive indicators not only of hygiene, but also of possible adulteration of milk in the informal circuit (Ariri et al., 2023).

Regarding composition, milk from organic systems tends to present significant variations when compared to the conventional system, especially in the fatty acid profile and protein content, which directly influences the industrial yield for cheese production (Brodziak et al., 2021). Poor hygiene during milking is the main route of entry for pathogens such as *Staphylococcus aureus* and *Listeria monocytogenes*, microorganisms that have a high survival capacity even in artisanal cheeses with prolonged maturation (Sakaridis et al., 2022; Penna et al., 2021).

Studies carried out in direct sales circuits and informal markets reveal that microbiological contamination, characterized by high counts of total and thermotolerant coliforms, is often associated with inadequate cleaning of udders and milking equipment (Ariri et al., 2023; Januś et al., 2021). In addition, the quality of the final product, such as curd cheese or the "tvarog" type, is severely compromised when the original raw material presents physicochemical deviations, resulting in sensory changes and reduced shelf life (Januś et al., 2021). Thus, the integration between hygienic management on the farm and technological control in processing is indispensable for consumer safety (Penna et al., 2021).

In addition, it is known that the way milk is produced, that is, intensively, traditionally/conventionally or organically, has a direct and significant impact on the quality of raw milk, especially with regard to hygienic, physicochemical, nutritional and technological parameters. According to Hanuš et al. (2021), this is mainly due to feed management, the level of production intensification, access to grazing, and animal welfare conditions, resulting in milk with a composition within the parameters of legislation and the suitability of this product for industrial processing. In this sense, one of the main aspects of hygienic milk quality, the Total Bacterial Count (TBC), was slightly higher, but still within the parameters of the legislation, when the organic production system was analyzed. This is due to the restricted use of antimicrobials and greater access of animals to places with organic matter and clay, which makes it difficult to control mastitis and clean the teats (Hanuš et al., 2021).

The results presented by Ariri et al. (2023) reinforce what has been described above, especially with regard to the physicochemical and technological parameters of milk, which should be mainly related to the interaction between feeding, lactation stage, mammary gland health, and environmental conditions. It is highlighted that the classical parameters of analysis in dairy and processing industry, such as pH, density, cryoscopic index and titratable acidity present low variability between different production systems when milk is obtained through hygienic production methods.

The results obtained by Ariri et al. (2023) regarding the microbial load in milk are suggestive of non-compliance with appropriate procedures during milk processing, from collection to transport. In their research, Mannani et al. (2023), when visiting collection centers and cooperatives, observed failures in the areas of team hygiene, cleaning, and disinfection, resulting from the absence of a control plan.

The authors Mannani et al. (2023) found that it would be necessary to invest in supervision, education, and training, as proposed by Ariri et al. (2023), in addition to raising awareness about the importance of milk quality, aiming to reduce contamination levels and strengthen the production chain.

Still on the work of Sakaridis et al. (2022), the milk analyzed had a bacterial count above the established limits. However, after changes on the farm, from the milking process to the storage of milk, combined with the updating of biosafety practices, improvements were observed in the microbiological quality of the product, reinforcing the adoption of good practices throughout the production chain.

The nutrition and energy balance of lactating animals is a fundamental factor for mammary gland health, milk production and composition of total solids and defatted solids, that is, fat, protein and lactose. This can be observed mainly in intensive systems, in which

diets are more energy-dense and this favors higher levels of total protein and casein, positively impacting industrial yield. On the other hand, grazing-based systems, although they may have lower protein content, tend to produce milk with a differentiated lipid profile, with a higher concentration of unsaturated fatty acids.

Hanuš et al. and Ariri et al. also converge their studies regarding the impact of mammary gland health on milk quality, since the elevation of somatic cells is directly related to the physicochemical composition of milk, such as the reduction of lactose content and changes in the protein fraction, especially in casein.

According to Brodziak et al (2021), specific characteristics of the production environment, including the type and quality of feed offered to the animals, exert a significant influence on the quality of raw milk, which directly impacts the quality of dairy products.

According to Brodziak et al (2021), studies show that the quality of milk when its production is organic is more valuable, in its composition in terms of vitamins, fatty acids, whey proteins and minerals, attributing it to the fact that these animals are raised free and with access to pasture, however, the quality of this raw milk is a cause for concern.

According to the findings of Sakaridis et al (2022), it shows that after the advent of pasteurization, the cheese sector started to adopt the heat treatment of milk, this measure aims to eradicate pathogenic microorganisms, to ensure a quality product for the consumer.

4 CONCLUSION

Based on the literature presented, it was found that hygiene in milking is determinant for the quality of milk and its derivatives. This quality is directly related to the microbiological and sanitary safety of food, since the physicochemical indicators of milk also act as sanitary markers. In addition, it is essential to emphasize that animal health, especially of the mammary gland, is a factor that directly impacts the quality and physicochemical composition of milk, so the evaluation of these parameters must be done holistically and globally by the veterinarian.

With the application of the HACCP system, it becomes possible for the problems identified to be corrected in a more assertive way, whether they are due to hygiene failures or adulteration, thus preventing these products from reaching consumers and causing them losses.

It is the responsibility of the veterinarian and the multiprofessional team to correct and prevent failures in the inspection of food intended for human consumption, ensuring the quality and food health of the consuming public. In this context, they work on rural properties

providing guidance on the standardization of good milking practices, training and recycling of labor, as well as continuous monitoring to identify and correct failures.

Thus, the implementation of good milking practices represents not only a technical criterion, but also an ethical commitment to food safety and the sustainability of the milk production chain.

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