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Review Article

Application of disinfectants in the prevention and control of bovine mastitis

Aplicação de desinfetantes na prevenção e controle da mastite bovina

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Abstract

A literature review was conducted to assess global trends and scientific contributions related to the use of disinfectants in the control of bovine mastitis. Bovine mastitis, a major inflammatory disease affecting dairy cows, is predominantly caused by bacterial infections and remains a significant concern for global dairy production. Among the preventive and control measures, the application of disinfectants plays a crucial role, particularly in pre- and post-milking hygiene protocols. To provide a more structured overview, this work maps publication trends, regional contributions, and evaluates the efficacy and diversity of disinfectants tested *in vivo* and *in vitro.* This review aimed to explore and synthesize the current scientific knowledge regarding the use of disinfectants in the control and prevention of bovine mastitis, focusing on the main chemical classes, mechanisms of antimicrobial action, efficacy, and emerging alternatives. Scientific articles were selected from PubMed, Web of Science, Scopus, and SciELO databases up to December 2024. From a total of 309 initially identified records, 86 relevant studies were included based on thematic alignment with disinfectant application in dairy production. Most publications originated from developed countries, particularly the United States (34.9%) and Germany (3.6%), with Brazil (19.3%) standing out in the South American context. A steady annual growth of approximately 5.6% in publication volume was observed, with increased scientific attention to sustainable alternatives from 2007 onwards. Synthetic disinfectants such as iodophors, chlorhexidine, and sodium hypochlorite remain widely studied due to their high *in vivo* and *in vitro* efficacy. In contrast, natural and biotechnological alternatives—such as essential oils, silver nanoparticles, and polyhexamethylene biguanide (PHMB)—have shown promising potential but require further validation. Key challenges identified include the need for standardization of concentrations, clear application protocols, and comprehensive safety assessments. This review emphasizes the importance of broadening research efforts in diverse geographic regions and of developing standardized, cost-effective, and environmentally friendly disinfection strategies, contributing to both animal health and the sustainability of global dairy production. The combination of scientometric and analytical review approaches contributes to both understanding research dynamics and identifying gaps in disinfection strategies.

Keywords: animal health, mammary inflammation, milk production, antimicrobials.

Resumo

Foi realizada uma revisão de literatura para avaliar as tendências globais e as contribuições científicas relacionadas ao uso de desinfetantes no controle da mastite bovina. A mastite bovina, uma importante doença inflamatória que afeta vacas leiteiras, é predominantemente causada por infecções bacterianas e continua sendo uma preocupação significativa para a produção leiteira global. Entre as medidas de prevenção e controle, a aplicação de desinfetantes desempenha um papel crucial, especialmente nos protocolos de higiene pré e pós-ordenha. Para oferecer uma visão mais estruturada, este trabalho mapeia as tendências de publicações, contribuições regionais e avalia a eficácia e a diversidade dos desinfetantes testados *in vivo* e *in vitro*. Esta revisão teve como objetivo explorar e sintetizar o conhecimento científico atual sobre o uso de desinfetantes no controle e prevenção da mastite bovina, com foco nas principais classes químicas, mecanismos de ação antimicrobiana, eficácia e alternativas emergentes. Artigos científicos foram selecionados nas bases de dados PubMed, Web of Science, Scopus e SciELO até dezembro de 2024. De um total de 309 registros inicialmente identificados, 86 estudos relevantes foram incluídos com base na afinidade temática com a aplicação de desinfetantes na produção leiteira. A maioria das publicações teve origem em países desenvolvidos, particularmente os Estados Unidos (34,9%) e a Alemanha (3,6%), com destaque para o Brasil (19,3%) no contexto sul-americano. Observou-se um crescimento anual constante de aproximadamente 5,6%

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no volume de publicações, com maior atenção científica voltada para alternativas sustentáveis a partir de 2007. Desinfetantes sintéticos como iodóforos, clorexidina e hipoclorito de sódio continuam sendo amplamente estudados devido à sua elevada eficácia *in vivo* e *in vitro*. Em contraste, alternativas naturais e biotecnológicas—como óleos essenciais, nanopartículas de prata e biguanida poliexametileno (PHMB)—demonstram potencial promissor, mas ainda requerem validação adicional. Os principais desafios identificados incluem a necessidade de padronização das concentrações, protocolos de aplicação bem definidos e avaliações abrangentes de segurança. Esta revisão enfatiza a importância de ampliar os esforços de pesquisa em diferentes regiões geográficas e de desenvolver estratégias de desinfecção padronizadas, economicamente viáveis e ambientalmente sustentáveis, contribuindo tanto para a saúde animal quanto para a sustentabilidade da produção leiteira global. A combinação de abordagens de revisão cienciométrica e analítica contribui tanto para a compreensão da dinâmica da pesquisa quanto para a identificação de lacunas nas estratégias de desinfecção.

Palavras-chave: saúde animal, inflamação mamária, produção leiteira, antimicrobianos.

1. Introduction

Bovine mastitis is one of the most prevalent and economically significant diseases affecting dairy farming, characterized by inflammation of the mammary gland caused by pathogenic microorganisms, physical trauma, or irritating chemical agents (Gazzola et al., 2024; Yamauchi et al., 2022). It manifests clinically—with signs such as swelling, pain, and altered milk—or subclinically, detected through laboratory tests such as the California Mastitis Test and somatic cell count (SCC) (Sharun et al., 2021).

The disease compromises both the quality and volume of milk produced, resulting in considerable economic impact. The main etiological agents include *Staphylococcus spp., Streptococcus spp., Escherichia coli, Enterococcus spp., Corynebacterium bovis*, and opportunistic fungi and algae such as Candida spp. and Prototheca spp. (Kybartas et al., 2023; Alves et al., 2017).

In major milk-producing countries—such as the United States, India, Germany, and Brazil—mastitis is recognized as a leading cause of financial losses in the dairy sector. In Brazil, the average SCC in 2024 reached 531,000 cells/mL, and with an estimated annual production of 35.4 billion liters, losses from subclinical mastitis were projected at 2.12 billion liters/year (Brasil, 2024).

The global impact of mastitis has prompted scientific efforts aimed at developing new antimicrobials and improving prevention and control protocols (EMBRAPA, 2022; Langoni et al., 2017; Kybartas et al., 2023). Among these measures, the use of disinfectants stands out as a central strategy—particularly in pre- and post-milking routines—to reduce microbial contamination of teats, udders, and equipment. Compounds such as iodophors, chlorhexidine, and sodium hypochlorite are widely used and demonstrate high antimicrobial efficacy when properly applied *in vivo* and *in vitro* (Gonçalves et al., 2015; Medeiros et al., 2009).

However, the effectiveness of these compounds varies according to formulation, concentration, and target microorganism. For instance, iodine alone showed less than 50% efficacy, while combinations of Nonoxinol-9, iodine, and chlorhexidine surpassed 90% inhibition against *S. aureus* (El Behiry et al., 2012). Similarly, chlorhexidine showed variable results—from <50% to >90%—depending on the microbial strain (Kybartas et al., 2023).

Polyhexamethylene biguanide (PHMB) has demonstrated potent activity, with MIC_{90} values as low as 1 µg/mL against Prototheca spp. and excellent efficacy when incorporated into nanoparticle systems (Leite et al., 2021; Lu et al., 2023). Other alternatives—such as essential oils, silver nanoparticles, and probiotics like Lactococcus cremoris—have also shown promise, although further standardization and safety validation are required.

In addition to international efforts, Brazilian research has played a significant role in advancing sustainable and biologically inspired antimicrobial strategies. Peron (2020) emphasized the potential of natural agents in animal health, while Barbosa (2018) investigated microbiological practices particularly suited to tropical environments. Together, these contributions strengthen the pursuit of innovative and eco-friendly alternatives to conventional disinfectants.

Despite the growing number of options, the use of disinfectants still faces limitations related to standardization, application practices, and risks such as milk contamination and skin irritation in animals (Berg et al., 2014). Additionally, overuse or misuse can contribute to microbial resistance and environmental harm.

Given these challenges, this review aims to synthesize and critically discuss the current scientific knowledge on the use of disinfectants for the prevention and control of bovine mastitis, addressing their chemical classifications, mechanisms of action, effectiveness, advantages, and limitations. The goal is to guide the development of more effective and sustainable practices in dairy production.

2. Materials and Methods

Reviews typically comprise three main phases: planning, conducting, and reporting results. The protocol by Silva Neto et al. (2022) was adopted to guide this review (Figure 1), along with an analysis to assess trends and impact of the literature. The approach integrates scientometric indicators (geographical and temporal trends, database mapping) with structured qualitative assessment of article content. Scientific articles available in the databases were used, with no time frame up to December 2024.

In addition to descriptive statistics, the study followed key elements of systematic review structure, including: definition of inclusion and exclusion criteria, independent assessment by pairs of reviewers, and extraction of standardized data variables. However, it was not registered as a PRISMA review.

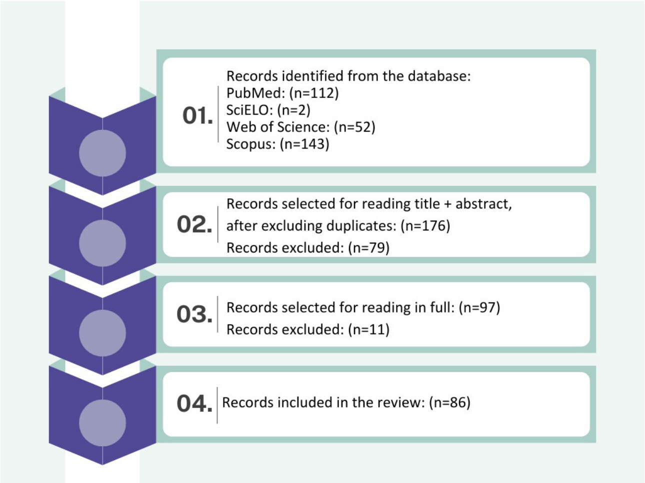

Figure 1. Methodological approach of the literature review on the use of disinfectants in the prevention and control of bovine mastites. Flowchart of the process for identifying and selecting the studies included in the review (n=86).

The following databases were used: Web of Science, Scopus, e *SciELO* and National Library of Medicine (PubMed). A set of keywords were used in the database search process: "Disinfectants," "Biocide," "Biocides," "Disinfectant," "Mastitis, Bovine," and "Bovine Mastitis" were combined using the Boolean operators AND and OR to refine the results. As a result, 143 studies were identified in Scopus, 52 in Web of Science, 112 in PubMed, and 2 in SciELO, totaling 309 articles. After removing duplicates and applying the inclusion criteria, 212 articles were excluded.

The inclusion criteria encompassed original research on the evaluation of disinfectants for the prevention and treatment of bovine mastitis, case reports, *in vitro* studies, and clinical trials, with no language restrictions. Studies unavailable in full text, those investigating disinfectants not directly related to bovine mastitis, and research evaluating products not classified as disinfectants were excluded.

After applying these criteria, 86 articles were selected for full-text review and data extraction. Each article was initially assigned a code, after which the specific information to be extracted was defined, including: year of publication, country where the study was conducted, type of study (*in vivo* and/or *in vitro*), compounds evaluated, concentrations and efficacy, sample collection sites, and microorganisms identified.

The assessment of the articles was conducted independently, in pairs, and blinded, using Excel software. In cases where consensus could not be reached between the reviewers, a third collaborator was consulted. Only articles that fully met the inclusion criteria were retained in the study.

Statistical analyses were performed using R software (R Core Team, 2024). To assess temporal trends in the number of publications and the association between different types of compounds (synthetic, animal, plant-based, and others), Pearson's correlation was applied using the perm.cor.test function from the RVAideMemoire package (Hervé, 2023). The significance of the correlation was estimated through Monte Carlo simulation with 999 permutations, considering a p-value < 0.05 as statistically significant.

A contingency table was constructed using the ftable function, and the Chi-square test was conducted with the chisq.test function, both from the stats package (R Core Team, 2024). In addition to these analyses, descriptive data such as mean, mode, and percentages were compiled, along with graphical representations of the results. The Chi-square test was also employed to determine whether the efficacy of the compounds varied across studies and to assess the association between compound types and the experimental strategy used (*in vivo* or *in vitro*).

3. Results and Discussion

The literature review examines the temporal and geographical evolution of research related to the different classes of disinfectants used in the control of bovine mastitis, strengthening the scientific consistency of the study by enabling a comprehensive understanding of the field and a critical synthesis of the available experimental evidence regarding their effectiveness.

Bovine mastitis remains one of the most critical diseases affecting dairy production worldwide, causing significant economic losses and compromising milk quality. Among the strategies adopted for its prevention and control, the use of disinfectants stands out, with their efficacy widely investigated, especially when associated with proper management and milking protocols.

3.1. Geographical distribution and temporal trends

Figure 2 presents the geographical distribution of studies on the use of disinfectants in the prevention and treatment of bovine mastitis, showing a predominance of publications from North America and Western Europe. The United States leads with 34.9% of the total studies, followed by Canada (7.2%), the United Kingdom (4.8%), Germany, Australia, Japan, and New Zealand (3.6% each). In Latin America, Brazil stands out with 19.3% of the publications,

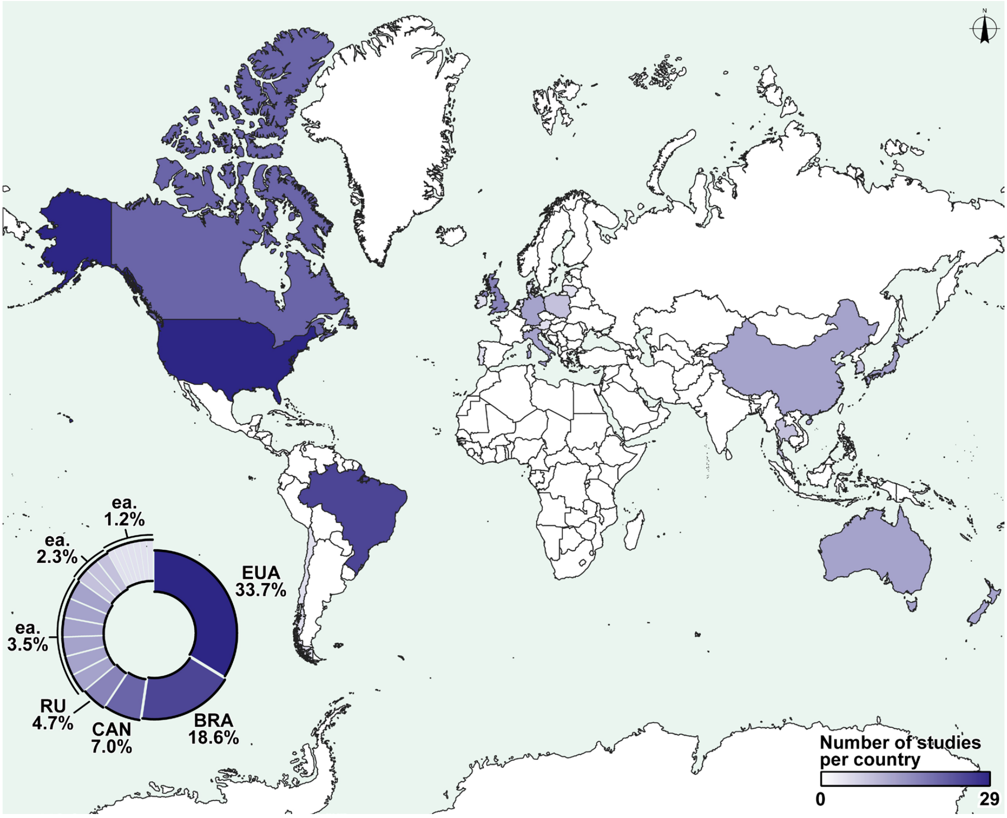

Figure 2. Geographical distribution of publications on disinfectants used in bovine mastitis control (1968–2024).

reflecting its global prominence in milk production and increasing investment in animal health research.

Although global milk production has expanded, research remains concentrated in developed countries with greater investments in science and technology. Regions such as Africa and parts of the Middle East are underrepresented, possibly due to limited research infrastructure or lower sanitary prioritization (Addis et al., 2024; Gazzola et al., 2024).

The temporal trend of publications is shown in Figure 3, revealing a progressive increase over time (rs = 0.46; $p < 0.004$), with an average annual growth rate of 2.90%. From 2007 onward, there is a significant inflection point ($p < 0.05$), marking the beginning of a new phase, likely driven by growing concerns about antimicrobial resistance and the pursuit of more sustainable practices (Castro et al., 2023).

3.2. Chemical classification, efficacy, and mechanisms of action

The compounds evaluated over the past decades include synthetic disinfectants (halogens, biguanides, quaternary ammonium compounds), natural products (essential oils, plant extracts), and biological agents (probiotics, bacteriocins, phages), applied in different concentrations and formulations. Table 1 summarizes the efficacy of each class against the main etiological agents, with inhibition rates classified as very high (>90%), high (75-90%), moderate (50-75%), or low (<50%).

No statistically significant differences were observed among compound types ($X^2 = 0.78$; $p = 0.99$), nor between in vitro and in vivo approaches ($X^2 = 3.35$; $p = 0.605$). However, in vivo studies have predominated since the 1960s, offering realistic evaluations under field conditions. In recent decades, the number of in vitro studies has grown, enabling controlled testing of novel compounds.

Among synthetic compounds, iodophors (0.25-5%) (Grindal and Priest, 1989), sodium hypochlorite (Park and Han, 2002), chlorhexidine (Schwenker et al., 2022), quaternary ammonium compounds (Arabe Filho et al., 2023), and metal nanoparticles (Fernandes et al., 2021) have been widely tested, with efficacy ranging from moderate to very high. In vivo studies involving direct application to udders and teats have shown high efficacy, especially against Staphylococcus aureus, Streptococcus agalactiae, and S. dysgalactiae (Lopez-Benavides et al., 2009; Justice-Allen et al., 2010).

Although natural and biological compounds are less represented, they have gained attention. Essential oils from Lippia origanoides, citronella, and basil (0.78-6.25 µL/mL) have demonstrated very high efficacy against S. aureus and Escherichia coli (Marcelo et al., 2020). Probiotics such as Lactococcus cremoris and phage therapy have also shown high antimicrobial potential (Gazzola et al., 2024; Xue et al., 2024).

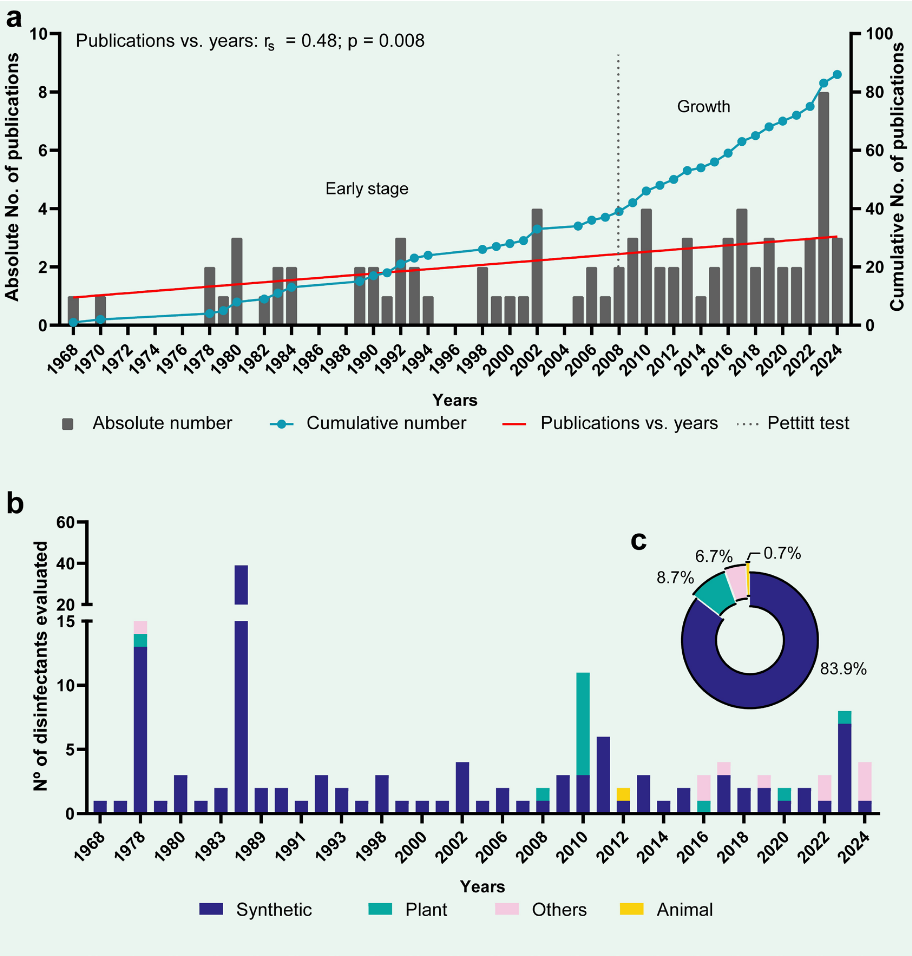

Figure 3. Temporal trend of publications on disinfectants used in bovine mastitis control (1968–2024). **(a)** Absolute and cumulative number of publications over the years, showing the early and growth stages of research development. **(b)** Annual distribution of publications according to the origin of disinfectants investigated, classified as synthetic, plant-derived, animal-derived, or others. **(c)** Percentage proportion of disinfectant categories evaluated, highlighting the predominance of synthetic compounds.

3.3. Efficacy variability and methodological challenges

Several studies reported discrepancies between in vitro and in vivo outcomes. For instance, chlorhexidine and quaternary ammonium compounds showed high efficacy in vitro but moderate results under field conditions, suggesting the importance of environmental factors and application protocol adherence (Schwenker et al., 2022).

Phenolic compounds and simple chlorine-based disinfectants, when applied without standardized protocols, showed low efficacy (<50%) (Oliver et al., 2001; Peters et al., 2000), reinforcing the need for proper concentration and application standardization.

3.4. Average costs, environmental impacts, and sustainability

Although specific economic data remain limited, synthetic compounds such as iodophors tend to be cost-effective and widely accessible. However, their indiscriminate use can generate significant environmental impacts, including selection of resistant strains and contamination of soil and water (Aiemsaard et al., 2023; Arabe Filho et al., 2023).

Natural and biological alternatives are less toxic to the environment but require higher investment in formulation stability, standardization, and scalability (Dias, 2019; Spilki, 2021). Balancing efficacy, cost-efficiency, and sustainability remains a growing challenge in dairy production systems.

3.5. Advantages and disadvantages of different approaches

Synthetic disinfectants: high efficacy, low cost, readily available, but associated with environmental toxicity and risk of antimicrobial resistance.

Natural disinfectants: environmentally safer, good efficacy, but higher production cost and limited standardization.

Biological agents: promising against multidrug-resistant strains, though still largely experimental and facing regulatory hurdles.

Table 1. Efficacy of disinfectant compounds against key mastitis-causing pathogens.

Type of Study	Evaluated Compounds	Tested Concentrations	Sample Collection Site	Evaluated Microorganisms	Efficacy	Authors
In vivo	Iodine	-	Bovine milk	*Staphylococcus aureus*, *Streptococcus dysgalactiae*	Very High	Sheldrake and Hoare (1980)
In vivo	Iodine	1000 mg avl/L and 5000 mg avl/L	Bovine udder	*Staphylococcus aureus*, *Streptococcus dysgalactiae*	Not specified	Sheldrake et al. (1980a)
In vivo	Iodine	-	Bovine udder	*Staphylococcus aureus*, *Streptococcus agalactiae*	Moderate	Grindal and Priest (1989)
In vivo	Iodine	0.25%	Bovine milk	*Staphylococcus aureus*, *Escherichia coli*	High	Oliver et al. (1991)
In vivo	Iodine	2.5% or 5% w/w; Chlorhexidine 0.3% w/w; Salicylic acid 0.1% w/w	Bovine milk/Bovine udder	*Streptococcus uberis*	Moderate	Lopez-Benavides et al. (2009)
In vivo	Iodine-containing gel	0.0002%	Bovine milk/Bovine udder	*Staphylococcus aureus*, *Streptococcus dysgalactiae*	Very High	Ingawa et al. (1992)
In vivo	Iodine, Iodine and glycerin, Iodine and emulsified paraffin	-	Bovine udder	*Staphylococcus aureus*, *Streptococcus dysgalactiae*	Very High	Sheldrake et al. (1980b)
In vivo	Iodine with a high level of free iodine	-	Bovine milk	*Streptococcus* spp., *Corynebacterium* spp.	Low	Martins et al. (2017)
In vivo	Iodine complex and skin conditioning agents	0.5% and 1.0% iodine	Bovine milk	*Staphylococcus aureus*, *Streptococcus agalactiae*	High	Fox et al. (2006)
In vitro	Iodine, Chlorhexidine	-	Bovine milk	Coagulase-negative *Staphylococcus* spp.	Very High	Tremblay et al. (2014)
In vitro	Iodine, Lactic acid, Chlorhexidine digluconate, Salicylic acid, Ammonium lauryl sulfate, Diamine, Chlorine dioxide, Didecyldimethylammonium, Povidone-iodine	Lactic acid 2.5% or 5% w/w, chlorhexidine 0.3% w/w or salicylic acid 0.1% w/w, Dichloroisocyanurate: ≥500 µg/mL; Povidone-iodine: ≥8,000 µg/mL	Bovine milk	*Enterococcus faecalis*, *Hafnia alvei*, *Serratia marcescens*, *Serratia liquefaciens*, *Aerococcus viridans*, *Lactococcus lactis*, *Staphylococcus chromogenes*, *Staphylococcus devriesei*, *Staphylococcus epidermidis*, *Staphylococcus haemolyticus*, *Staphylococcus hominis*, *Staphylococcus xylosus*	Low	Fitzpatrick et al. (2019)

Effectiveness of the tested products expressed as percentage of inhibition: < 50% – Low effectiveness; 50 to 75% – Moderate effectiveness; 75 to 90% – High effectiveness; > 90% – Very high effectiveness.

Table 1. Continued...

Type of Study	Evaluated Compounds	Tested Concentrations	Sample Collection Site	Evaluated Microorganisms	Efficacy	Authors
In vitro	Iodine, Sodium hypochlorite, Sodium dichloro-s-triazinetrione, Quaternary ammonium, Chlorhexidine, Cetylpyridinium chloride, Bronopol, 8-Hydroxyquinoline sulfate, Pine oil, Hexachlorophene, Udder antibodies	0.0390625–0.15625%	Not specified	*Staphylococcus aureus*, *Streptococcus agalactiae*	Very High	Philpot et al. (1978)
In vitro	Iodine, Quaternary ammonium	Lactic acid 2.5% or 5% w/w, and Chlorhexidine 0.3% w/w or Salicylic acid 0.1%	Bovine milk	*Prototheca zopfi*	Low	Lassa et al. (2011)
	Dodecylbenzenesulfonic acid				Very High	
In vivo	Iodine (post-milking), Chloramine-T (pre and post-milking)	-	Bovine milk	*Staphylococcus aureus, Streptococcus uberis, Corynebacterium* spp., and Coagulase-negative *Staphylococcus* spp.	Low	Williamson and Lacy-Hulbert (2013)
In vitro	Iodine, H_2O_2, Chlorine dioxide	Iodophors: 0.5% and 0.25%	Bovine milk	*Mycoplasma bovis*	Very High	Enger et al. (2015)
				Staphylococcus haemolyticus	High	
In vivo	Iodophor, Hexachlorophene, Chlorhexidine,		Bovine milk, Bovine udder	*Staphylococcus* spp.	Low	Edwards and Smith (1970)
In vitro	Iodophor, Hypochlorite, Chlorhexidine, Iodine (in oil), Sodium dichloro-s-triazinetrione, Quaternary ammonium, Dodecyl benzene sulfonic acid	Iodophor: 1% and 0.5%, Dodecyl benzene sulfonic acid 2%	Bovine milk	*Staphylococcus aureus*	High	Philpot and Pankey (1978)
				Streptococcus agalactiae	Moderate	
In vivo	Iodophor solution, Sodium hypochlorite solution	Iodophor solution: not specified; sodium hypochlorite solution: MIC between 0.25 and 8 mg/mL	Bovine milk/Bovine udder	*Staphylococcus aureus*	Very High	King et al. (1979)
In vitro	Iodophor, Chlorhexidine, Quaternary ammonium, Cetylpyridinium chloride, Benzyl alcohol	Iodophor (0.2%) / Chlorhexidine (0.2%) / Quaternary ammonium (0.2%) / Cetylpyridinium chloride / Benzyl alcohol	Not specified	*Staphylococcus aureus*, *Streptococcus agalactiae*	Very High	Watts et al. (1984)

Effectiveness of the tested products expressed as percentage of inhibition: < 50% – Low effectiveness; 50 to 75% – Moderate effectiveness; 75 to 90% – High effectiveness; > 90% – Very high effectiveness.

Table 1. Continued...

Type of Study	Evaluated Compounds	Tested Concentrations	Sample Collection Site	Evaluated Microorganisms	Efficacy	Authors
In vivo	Iodophor solution, Iodine	-	Bovine milk	*Streptococcus uberis*, *Staphylococcus aureus*, *Mycoplasma bovis*, Coagulase-negative *Staphylococcus*, *Escherichia coli*	Not specified	Hillerton et al. (1993)
In vivo	Iodophor (Full-Bac), Iodophor (Bovadine)	0.001 to 0.035%	Bovine milk/Bovine udder	*Staphylococcus aureus*, *Streptococcus agalactiae*	Low	Leslie et al. (2005)
In vitro	N, N-Dimethyldodecanamine 1	-	Not specified	*Streptococcus agalactiae*, *Escherichia coli*	High	Turck et al. (1982)
In vivo	Quaternary ammonium	-	Bovine milk	*Streptococcus agalactiae*	Moderate	Pankey and Watts (1983)
In vitro	Quaternary ammonium	8-35 ppm	Bovine milk	*Prototheca bovis*	-	Arabe Filho et al. (2023)
In vivo	Chlorous acid gel and chlorine dioxide	-	Bovine milk	*Staphylococcus aureus*, *Streptococcus dysgalactiae*	Moderate	Oliver et al. (1989)
				Streptococcus uberis, *Corynebacterium bovis*	Low	
In vivo	Chlorous acid - chlorine dioxide	-	Bovine milk/Bovine udder	*Staphylococcus aureus*	High	Drechsler et al. (1990)
				Streptococcus agalactiae	Moderate	
In vivo	Chlorous acid - chlorine dioxide, Sodium hypochlorite	0.5% and 0.25%	Bovine milk	*Staphylococcus aureus*, *Streptococcus agalactiae*	Very High	Boddie et al. (1998)
In vitro	Chlorine, Iodine, Chlorhexidine, Quaternary ammonium, Lactic acid	0.0024–0.0190%	Bovine milk	*Staphylococcus aureus*, Coagulase-positive *Staphylococcus*	Very High	Medeiros et al. (2009)
In vitro	Chlorine, Iodine, Chlorhexidine, Quaternary ammonium, Lactic acid	-	Bovine milk	*Staphylococcus aureus*, Coagulase-positive *Staphylococcus*	Very High	Medeiros et al. (2009)
In vivo	Chlorine dioxide (new formulation), Chlorine dioxide (established formulation)	-	Bovine milk	Not specified	Moderate	Krömker et al. (2023
In vivo	Chlorine, Hibitane, Iodovet, Iosan		Teat cup	*Staphylococcus* spp. and *Streptococcus* spp.	Very High	Saucier et al. (1968
In vivo	Chlorine dioxide, Glycerol	Glycerol 10% and chlorine dioxide 120 ppm	Bovine udder	*Streptococcus uberis*, *Staphylococcus aureus*	Low	Rasmussen and Larsen (1998)

Effectiveness of the tested products expressed as percentage of inhibition: < 50% – Low effectiveness; 50 to 75% – Moderate effectiveness; 75 to 90% – High effectiveness; > 90% – Very high effectiveness.

Table 1. Continued...

Type of Study	Evaluated Compounds	Tested Concentrations	Sample Collection Site	Evaluated Microorganisms	Efficacy	Authors
In vitro	Microspheres composed of poly dl-lactide-co-glycolide (DLPLGA) and povidone-iodine	-	Bovine udder	*Staphylococcus aureus*, *Streptococcus* spp., *Streptococcus uberis*	Low	Oliver et al. (1993)
In vivo	Phenol at 1.6%	MIC90 ≥0.312 g/L	Bovine milk/Bovine udder	*Escherichia coli*, *Staphylococcus aureus*	Low	Peters et al. (2000)
In vivo	Disinfectant based on a phenolic combination	MIC90 ≥0.019 g/L	Bovine milk	Gram-negative bacteria, *Streptococcus dysgalactiae*, Coagulase-negative *Staphylococcus*	Low	Oliver et al. (2001)
In vivo	Phenolic combination	MIC90 ≥0,625 g/L	Bovine milk	*Streptococcus uberis*, *Staphylococcus aureus*	Low	Oliver et al. (1999)
In vivo	Lactic acid and Sodium hypochlorite	0.0002%	Bovine milk	Not specified	Low	Park and Han (2002)
In vivo	Lactic acid, Lauricidin, Caprylic and Capric acids, Lauric acid	-	Bovine milk/Bovine udder	*Staphylococcus aureus*, *Streptococcus agalactiae*	High	Boddie and Nickerson (1992)
In vivo	Bismuth subnitrate (Teatseal and Cepravin Dry Cow)	-	Bovine milk	*Escherichia coli*, Enterobacteriaceae, Other pathogens	High	Huxley et al. (2002)
In vivo	Acidified chlorite with sodium dodecylbenzene sulfonic acid	-	Bovine milk/Bovine udder	*Staphylococcus aureus*, *Streptococcus agalactiae*	High	Oura et al. (2002)
In vivo	Hydrogen peroxide	0.5%	Bovine udder	*Staphylococcus aureus*, *Streptococcus agalactiae*	Low	Leslie et al. (2006)
In vivo	Acidified sodium hypochlorite disinfectant and iodine	-	Bovine milk	Not specified	Moderate	Hillerton et al. (2007)
In vitro	Decoction of Hypericum caprifoliatum Cham. and Schlecht. - Guttiferae	500 mg/L	Not specified	*Staphylococcus aureus*	Very High	Avancini and Wiest (2008)
In vitro	Biocitro ®, Eco Plus ®, Combicid ®, Prodip G ®	500 mg/L	Bovine milk	*Prototheca zopfii*	Very High	Lopes et al., 2008
In vitro	Essential oils of citronella grass, lemongrass, kaffir lime, holy basil, sweet basil, turmeric, and grapevine	MIC between 0.25 and 8 mg/mL	Not specified	*Pseudomonas aeruginosa*	Very High	Aiemsaard et al. (2010)

Effectiveness of the tested products expressed as percentage of inhibition: < 50% – Low effectiveness; 50 to 75% – Moderate effectiveness; 75 to 90% – High effectiveness; > 90% – Very high effectiveness.

Table 1. Continued...

Type of Study	Evaluated Compounds	Tested Concentrations	Sample Collection Site	Evaluated Microorganisms	Efficacy	Authors
In vivo	Essential oils of clove, citronella, and basil	MIC and MBC: 0.78–6.25 µL/mL; Citronella with 0.54% iodine	Bovine udder	*Staphylococcus aureus*, *Streptococcus agalactiae*, *Escherichia coli*	Very High	Aiemsaard et al. (2023)
In vivo	Essential oil of Lippia origanoides	120 µL/mL	Bovine milk	*Staphylococcus* spp., *Streptococcus* spp.	High	Marcelo et al. (2020)
In vitro	Sodium hypochlorite, Iodine	Sodium hypochlorite: 0.0390625–0.15625%; Iodine: 0.15625–0.625%	Bovine milk	*Prototheca zopfii*	Very High	Salerno et al. (2010)
In vivo	Sodium dichloroisocyanurate, Bronopol, Quaternary ammonium	Sodium dichloroisocyanurate (0.25%), Bronopol (0.1%), Quaternary ammonium (0.2%)	Bovine milk	*Staphylococcus aureus*, *Streptococcus agalactiae*	Moderate	Boddie and Nickerson (2002)
In vivo	Sodium hypochlorite in combination with other compounds	-	Bovine udder	*Staphylococcus aureus* *Streptococcus agalactiae*	Very High Moderate	Pankey et al. (1983)
In vitro	Silver ion	Less than 2 ppm	Bovine udder	*Staphylococcus aureus*	Very High	Seol et al. (2010)
In vitro	Silver nanoparticles, Silver nitrate	-	Bovine milk	*Staphylococcus aureus*, *Escherichia coli*	Very High	Fernandes et al. (2021)
In vitro	Nonoxinol-9 Iodine Complex, Chlorhexidine digluconate	MIC of 32 µM and MBC of 32 µM	Bovine milk/Bovine udder	*Staphylococcus aureus*	Very High	El Behiry et al. (2012)
In vitro	Marine sponges	MIC of 1.024 µg/mL	Bovine milk	Coagulase-negative *Staphylococcus* spp.	Moderate	Laport et al. (2012)
In vivo	Theratec Plus (Iodine)	-	Bovine milk	Not specified	Very High	Ceballos-Marquez et al. (2013)
In vitro	Peracetic acid, Sodium hypochlorite, Iodine solution	Peracetic acid: MIC90 ≥0.019 g/L; Sodium hypochlorite: MIC90≥0.312 g/L; Iodinesolution: MIC90≥0.625g/L	Bovine milk	*Prototheca zopfii*	High	Gonçalves et al. (2015)
In vivo	Peracetic acid (PAS), Plasma-activated buffered solution (PABS)	MS-TMC-Flusc: not specified, PAS: 0.5%, and PABS: not specified	Teatcup	*Escherichia coli*, *Staphylococcus aureus*, *Streptococcus uberis*, *Streptococcus agalactiae*	High	Scheib et al. (2023)
In vitro	Crude hydroalcoholic extract of *Achyrocline satureioides* (Asteraceae)	-	Bovine milk	*Candida albicans*, *Candida krusei*, *Candida rugosa*	Very High	Campos et al. (2016)

Effectiveness of the tested products expressed as percentage of inhibition: < 50% – Low effectiveness; 50 to 75% – Moderate effectiveness; 75 to 90% – High effectiveness; > 90% – Very high effectiveness.

Table 1. Continued...

Type of Study	Evaluated Compounds	Tested Concentrations	Sample Collection Site	Evaluated Microorganisms	Efficacy	Authors
In vivo	Glycolic acid, Iodine	-	Bovine milk	Not specified	Low	Godden et al. (2016)
In vivo	Glycolic acid, Iodine	0.6% diamine or 0.5% iodine	Bovine milk/Bovine udder	Coagulase-negative *Staphylococcus*, *Streptococcus* spp.	Moderate	Lago et al. (2016)
In vitro	Guanidine	-	Bovine milk	*Prototheca zopfi*	Very High	Alves et al. (2017)
In vitro	Slightly acidic electrolyzed water	-	Bovine milk, Hoses, jets, and water reservoir walls	*Pseudomonas* spp.	Very High	Kawai et al. (2017)
In vivo	Probiotic teat disinfectant based on lactobacilli	120 µL/mL	Bovine milk	*Pseudomonas* spp.	Very High	Yu et al. (2017)
				Acinetobacter spp., *Streptococcus* spp., *Bacillus* spp.	Low	
In vitro	SunSmile ® Fruit & Vegetal	0.0024–0.0190%	Bovine milk	*Prototheca zopfii*	Low	Grzesiak et al. (2018)
In vitro	Gentisaldehyde (2,5-dihydroxybenzaldehyde), 2,3-dihydroxybenzaldehyde	500 mg/L	Bovine milk	*Staphylococcus aureus*	Moderate	Schabauer et al. (2018)
In vivo	ZkinCu	-	Bovine milk/Bovine udder	*Streptococcus uberis*, *Corynebacterium* spp., Coagulase-negative *Staphylococcus*	Low	Vissio et al. (2020)
In vivo	Bactofencin A, Nisin, Reuterin, Bacteriocin	-	Bovine udder	*Staphylococcus* spp., *Streptococcus* spp.	Moderate	Bennett et al. (2022)
				Total bacteria	Low	
In vitro	Mannosylerythritol lipid-B	Above 10 ppm	Not specified	*Staphylococcus aureus*, *Escherichia coli*	Very High	Yamauchi et al. (2022)
In vitro	Polyhexamethylene biguanide	MIC90 ≥2 µg/mL and MBC90 ≥4 µg/mL for *P. bovis*; ≥1 µg/mL for *P. blaschkeae*	Bovine milk/Bovine udder	*Pseudoblasteskia blaschkeae*	Very High	Fidelis et al. (2023)
				Prototheca spp., *Prototheca bovis*	High	
In vitro	Polyhexamethylene biguanide (nanoparticles)	MIC <0.003 µg/mL	Bovine milk	*Staphylococcus aureus*	High	Leite et al. (2021)
In vitro	Polyhexamethylene biguanide	3 g/L	Chinese Veterinary Culture Collection Center	*Streptococcus agalactiae*, *Streptococcus dysgalactiae*, *Staphylococcus aureus*, *Escherichia coli*	Very High	Lu et al. (2023)

Effectiveness of the tested products expressed as percentage of inhibition: < 50% – Low effectiveness; 50 to 75% – Moderate effectiveness; 75 to 90% – High effectiveness; > 90% – Very high effectiveness.

Table 1. Continued...

Type of Study	Evaluated Compounds	Tested Concentrations	Sample Collection Site	Evaluated Microorganisms	Efficacy	Authors
In vivo	Chlorhexidine	8% and 50%	Bovine udder	*Staphylococcus aureus*, *Streptococcus uberis*, *Escherichia coli*, *Candida albicans*	Very High	Kybartas et al. (2023)
In vitro	Chlorhexidine	Chlorhexidine 2%	Teats	*Enterococcus faecalis*, *Enterococcus faecium*, *Staphylococcus intermedius*, *Streptococcus uberis*, *Streptococcus dysgalactiae*	Very High	Santos et al. (2023)
In vivo	Chlorhexidine	0.35%	Bovine milk/Bovine udder	*Streptococcus* spp., *Escherichia coli*, Coagulase-negative *Staphylococcus*	Low	Oliver et al. (1994)
In vitro	Chlorhexidine, Lactic acid	Chlorhexidine 0.215% and Lactic acid 3.5%	Bovine milk/Bovine udder	*Staphylococcus aureus*, *Staphylococcus epidermidis*, *Staphylococcus haemolyticus*, *Staphylococcus chromogenes*, *Staphylococcus equorum*, *Staphylococcus sciuri*, *Staphylococcus xylosus*, *Aerococcus viridans*, *Streptococcus uberis*, *Corynebacterium spp.*, Other coagulase-negative Staphylococci.	Moderate	Schwenker et al. (2022)
In vivo	Chlorhexidine	MIC of 1.024 µg/mL	Bovine milk/Bovine udder	*Streptococcus* spp., Coagulase-negative *Staphylococcus*, *Corynebacterium bovis*	Moderate	Oliver et al. (1990)
In vitro	Chlorhexidine gluconate solution and sodium hypochlorite	Chlorhexidine 2% and hypochlorite 0.5%	Recycled bedding sand	*Mycoplasma* spp., *Mycoplasma bovis*	Very High	Justice-Allen et al. (2010)
In vitro	Chlorhexidine, Quetocromin, Dihydroergocristine, Michellamine B, Toyocamycin, Emodin, Tanshinone IIA, Curcumol	β-lapachone: MIC 32 µM and MBC 32 µM	Bovine udder	*Streptococcus uberis*	Very High	Ferguson et al. (2019)
In vitro	Chlorhexidine, Quetocromin, Dihydroergocristine, Michellamine B, Toyocamycin, Emodin, Tanshinone IIA, Curcumol	β-lapachone: MIC 32 µM and MBC 32 µM	Bovine udder	*Escherichia coli*	Low	Ferguson et al. (2019)

Effectiveness of the tested products expressed as percentage of inhibition: < 50% – Low effectiveness; 50 to 75% – Moderate effectiveness; 75 to 90% – High effectiveness; > 90% – Very high effectiveness.

Table 1. Continued...

Type of Study	Evaluated Compounds	Tested Concentrations	Sample Collection Site	Evaluated Microorganisms	Efficacy	Authors
In vitro	Chlorhexidine	0.0002%	Bovine milk	*Staphylococcus aureus*	Very High	Azizoglu et al. (2013)
	Iodine	-			Dose-dependent	
In vitro	Chlorhexidine acetate	Linear dodecyl benzene sulfonic acid (1.94%) and iodine (1%), ethanol-iodine complex: not specified	Bovine udder	*Staphylococcus aureus*, *Streptococcus agalactiae*, *Escherichia coli*, *Nocardia asteroids*	Very High	Larocque et al. (1992)
	Linear dodecyl benzene sulfonic acid, Nonyl phenoxy poly (ethyleneoxy) iodine, Ethanol-iodine complex				Very High	
In vitro	Chlorhexidine, Alkyl Dimethyl Glycine Hydrochloride, Chlorine dioxide, Povidone-iodine, Sodium hypochlorous acid		Not specified	*Prototheca zopfii*	Very High	Sobukawa et al. (2011)
In vivo	Chlorhexidine gluconate, Dodecyl benzene sulfonic acid, Iodine, Sodium dichloro-s-triazinetrione, Povidone-iodine	1.94%	Bovine udder	*Staphylococcus aureus* *Streptococcus agalactiae*	High	Pankey et al. (1984)
In vitro	Neutral detergent, Acid detergent, Chlorinated alkaline detergent, Chlorinated alkaline detergent at 45°C, Distilled water at 45°C	-	Teats	*Enterococcus faecalis*, *Enterococcus faecium*, *Staphylococcus intermedius*, *Streptococcus uberis*, *Streptococcus dysgalactiae*	Low	Santos et al. (2023)
In vitro	*Lactococcus cremoris*	-	Bovine milk	*Staphylococcus* spp., *Streptococcus* spp., *Enterococcus* spp., *Escherichia coli*	High	Addis et al. (2024)
In vitro	*Lactococcus cremoris*	-	Bovine udder	*Staphylococcus aureus*, *Streptococcus* spp.	Very High	Gazzola et al. (2024)
In vivo	Phage cocktail named SPBC-SJ	0>10^7 CFU/mL	Bovine milk/Bovine udder	*Escherichia coli*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*	High	Xue et al. (2024)

Effectiveness of the tested products expressed as percentage of inhibition: < 50% – Low effectiveness; 50 to 75% – Moderate effectiveness; 75 to 90% – High effectiveness; > 90% – Very high effectiveness.

3.6. Final considerations

Disinfectant selection must consider the target pathogen, application method, appropriate concentration, and specific production context. Evidence-based protocols are essential to ensure efficacy, minimize environmental risks, and promote the sustainability of dairy production systems.

4. Conclusion

This review highlighted that the use of disinfectants is a key strategy in the prevention and control of bovine mastitis, contributing significantly to the reduction of microbial load on teats before and after milking. The diversity of compounds evaluated in the analyzed studies—including iodine, chlorhexidine, hypochlorite, lactic acid, peroxides, and biguanides—reflects the ongoing efforts of the scientific community and the dairy industry in the search for effective and safe solutions.

The literature review provides an in-depth scientific analysis of the applications of disinfectants in the control of bovine mastitis. Despite the wide variety of formulations and evaluation methods employed, many studies converge on the efficacy of certain active ingredients, especially iodine and chlorhexidine. However, the results also reveal significant gaps, notably the lack of research on alternative and natural compounds, as well as the need for methodological standardization in efficacy testing.

A predominance of studies conducted in North America and Western Europe was observed, with the United States and Brazil standing out as the main contributors to research in this area. Despite the wide variety of formulations and evaluation methods used, many studies converge on the efficacy of certain active ingredients, especially iodine and chlorhexidine, which are widely recognized for their consistent antimicrobial activity. However, the findings also reveal significant gaps, such as the lack of investigations into alternative and natural compounds, as well as the need for methodological standardization in efficacy testing.

The results emphasize the importance of a global and multidisciplinary approach that integrates microbiological, toxicological, and environmental aspects in the selection and use of disinfectants, also considering the risk of antimicrobial resistance. Therefore, further research is needed to explore sustainable and economically viable formulations that align with the demands of modern dairy production and animal welfare principles.

In conclusion, disinfectants remain an indispensable tool for managing bovine mastitis, but their selection and application should be guided by robust scientific evidence, contextualized to different regional and productive realities.

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Data Availability Statement

The research data analyzed in this study are not publicly available by any means. However, the essential data supporting the results are presented within the article itself, in the form of tables and figures. Additional information may be made available upon reasonable request to the corresponding author, considering potential ethical and institutional limitations.

References

ADDIS, M.F., MAFFIOLI, E.M., GAZZOLA, A., SANTANDREA, F., TEDESCHI, G. and PICCININI, R., 2024. Impact of a teat disinfectant based on Lactococcus cremoris on the cow milk proteome. *BMC Veterinary Research*, vol. 20, no. 1, pp. 447. http://doi.org/10.1186/s12917-024-04014-x. PMid:39363353.

AIEMSAARD, J., BORLACE, G.N., THONGKHAM, E. and JARASSAENG, C., 2023. Antibacterial efficacy of essential oil spray formulation for post-milking disinfection in dairy cows. *Veterinary World*, vol. 16, no. 7, pp. 1552-1561. http://doi.org/10.14202/vetworld.2023.1552-1561. PMid:37621533.

AIEMSAARD, J., AIUMLAMAI, J., TAWEECHAISUPAPONG, S., AROMDEEE, C. and KHUNKITTI, W., 2010 [viewed 10 June 2025]. Chemical composition, antioxidant activity and antibacterial action of eight essential oils against clinical isolates of mastitis pathogens. *International Journal of Essential Oil Therapeutics* [online], vol. 4, pp. 37-43. Available from: https://www.researchgate.net/publication/287557744_Chemical_composition_antioxidant_activity_and_antibacterial_action_of_eight_essential_oils_against_clinical_isolates_of_mastitis_pathogens#fullTextFileContent

ALVES, A.C., CAPRA, E., MORANDI, S., CREMONESI, P., PANTOJA, J.C.F., LANGONI, H., DE VARGAS, A.P.C., DA COSTA, M.M., JAGIELSKI, T., BOLAÑOS, C.A.D., GUERRA, S.T. and RIBEIRO, M.G., 2017. In vitro algicidal effect of guanidine on Prototheca zopfii genotype 2 strains isolated from clinical and subclinical bovine mastitis. *Letters in Applied Microbiology*, vol. 64, no. 6, pp. 419-423. http://doi.org/10.1111/lam.12737. PMid:28349671.

ARABE FILHO, M.F., JAGIELSKI, T., PROSKURNICKA, A., SANTOS, M.V., FIDELIS, C.E., GUIMARÃES, F.F., GUERRA, S.T., JOAQUIM, S.F., MIONI, M.S.R., PANTOJA, J.C.F., LANGONI, H., SANCHEZ, L.F.G. and RIBEIRO, M.G., 2023. In vitro activity of quaternary ammonium in Prototheca isolated from clinical bovine mastitis identified by mass spectrometry and PCR sequencing of the cytb gene marker. *Animals*, vol. 13, no. 20, pp. 3286. http://doi.org/10.3390/ani13203286. PMid:37894008.

AVANCINI, C.A.M. and WIEST, J.M., 2008. Disinfecting activity of the decocto of Hypericum caprifoliatum Cham and Schlechtend – Guttiferae ("escadinha/sinapismo") with different infecting doses of Staphylococcus aureus (infectious agent in bovine mastitis). *Revista Brasileira de Plantas Medicinais*, vol. 10, no. 1, pp. 64-69.

AZIZOGLU, R.O., LYMAN, R. and ANDERSON, K.L., 2013. Bovine *Staphylococcus aureus*: dose response to iodine and chlorhexidine and effect of iodine challenge on antibiotic susceptibility. *Journal of Dairy Science*, vol. 96, no. 2, pp. 993-999. http://doi.org/10.3168/jds.2012-5857. PMid:23261384.

BARBOSA, F.A.R., 2018. Research on antimicrobial agents and sustainability in neotropical environments. *Brazilian Journal of Biology*, v. 78, n. 4, p. 685-692.

BENNETT, S., FLISS, I., BEN SAID, L., MALOUIN, F. and LACASSE, P., 2022. Efficacy of bacteriocin-based formula for reducing staphylococci, streptococci, and total bacterial counts on teat skin of dairy cows. *Journal of Dairy Science*, vol. 105, no. 5, pp. 4498-4507. http://doi.org/10.3168/jds.2021-21381. PMid:35346465.

BERG, W., ROSE-MEIERHÖFER, S. and AMMON, C., 2014. Hygiene measures in milking parlors: impact on udder health and milk quality. *Journal of Dairy Science*, vol. 97, no. 1, pp. 789-795.

BODDIE, R.L. and NICKERSON, S.C., 1992. Evaluation of postmilking teat germicides containing Lauricidin, saturated fatty acids, and lactic acid. *Journal of Dairy Science*, vol. 75, no. 6, pp. 1725-1730. http://doi.org/10.3168/jds.S0022-0302(92)77930-2. PMid:1500569.

BODDIE, R.L. and NICKERSON, S.C., 2002. Reduction of mastitis caused by experimental challenge with *Staphylococcus aureus* and *Streptococcus agalactiae* by use of a quaternary ammonium and halogen-mixture teat dip. *Journal of Dairy Science*, vol. 85, no. 1, pp. 258-262. http://doi.org/10.3168/jds.S0022-0302(02)74075-7. PMid:11860119.

BODDIE, R.L., NICKERSON, S.C. and ADKINSON, R.W., 1998. Germicidal activity of a chlorous acid-chlorine dioxide teat dip and a sodium chlorite teat dip during experimental challenge with *Staphylococcus aureus* and *Streptococcus agalactiae*. *Journal of Dairy Science*, vol. 81, no. 8, pp. 2293-2298. http://doi.org/10.3168/jds.S0022-0302(98)75809-6. PMid:9749396.

BRASIL. Ministério da Agricultura e Pecuária – MAPA, 2024 [viewed 10 June 2025]. *MAPA do Leite* [online]. Brasília: MAPA. Available from: https://www.gov.br/agricultura/pt-br/assuntos/producao-animal/mapa-do-leite

CAMPOS, F.L., VALENTE, P., ETHUR, E.M. and AVANCINI, C.A.M., 2016. Disinfectant activity of the crude hydroalcoholic extract of Achyrocline satureioides (Asteraceae) on Candida spp. isolated in problem-situations of bovine mastites. *Acta Veterinaria Brasilica*, vol. 10, no. 4, pp. 327-333. http://doi.org/10.21708/avb.2016.10.4.6051.

CASTRO, L.B., PEREIRA, A.M. and RIBEIRO, D.L., 2023. Compostos de origem natural no controle da mastite bovina: avanços e desafios. *Journal of Veterinary Research*, vol. 58, no. 1, pp. 45-57.

CEBALLOS-MARQUEZ, A., HEMLING, T., RAUCH, B.J., LOPEZ-BENAVIDES, M. and SCHUKKEN, Y.H., 2013. Noninferiority trial on the efficacy of premilking teat disinfectant against naturally occurring new intramammary infections using a novel 2-step diagnostic process. *Journal of Dairy Science*, vol. 96, no. 12, pp. 8081-8092. http://doi.org/10.3168/jds.2013-7108. PMid:24210481.

DIAS, A.M.P.M., 2019. Advances in animal biology applied to tropical systems. *Brazilian Journal of Biology*, vol. 79, Suppl. 1, pp. 101-109.

DRECHSLER, P.A., WILDMAN, E.E. and PANKEY, J.W., 1990. Evaluation of a chlorous acid-chlorine dioxide teat dip under experimental and natural exposure conditions. *Journal of Dairy Science*, vol. 73, no. 8, pp. 2121-2128. http://doi.org/10.3168/jds.S0022-0302(90)78892-3. PMid:2229601.

EDWARDS, S.J. and SMITH, G.S., 1970. An experiment to test the value of hygienic measures in the control of staphylococcal infection of the dairy cow. *The British Veterinary Journal*, vol. 126, no. 2, pp. 106-112. http://doi.org/10.1016/S0007-1935(17)48515-0. PMid:5533966.

EL BEHIRY, A., SCHLENKER, G., SZABO, I. and ROESLER, U., 2012. In vitro susceptibility of *Staphylococcus aureus* strains isolated from cows with subclinical mastitis to different antimicrobial agents. *Journal of Veterinary Science*, vol. 13, no. 2, pp. 153-161. http://doi.org/10.4142/jvs.2012.13.2.153. PMid:22705737.

EMBRAPA. 2022. *Produção de leite bovino: cenários e desafios*. Brasília: Embrapa.

ENGER, B.D., FOX, L.K., GAY, J.M. and JOHNSON, K.A., 2015. Reduction of teat skin mastitis pathogen loads: differences between strains, dips, and contact times. *Journal of Dairy Science*, vol. 98, no. 2, pp. 1354-1361. http://doi.org/10.3168/jds.2014-8622. PMid:25497825.

FERGUSON, S.A., MENORCA, A., VAN ZUYLEN, E.M., CHEUNG, C.Y., MCCONNELL, M.A., RENNISON, D., BRIMBLE, M.A., BODLE, K., MCDOUGALL, S., COOK, G.M. and HEIKAL, A., 2019. Microtiter screening reveals oxygen-dependent antimicrobial activity of natural products against mastitis-causing bacteria. *Frontiers in Microbiology*, vol. 10, pp. 1995. http://doi.org/10.3389/fmicb.2019.01995. PMid:31555233.

FERNANDES, P.É., ALVES, R.B.T., PIMENTEL-FILHO, N.J., SÁ, J.P.N., MANTOVANI, H.C., PEÑA, W.E.L. and ANDRADE, N.J., 2021. Subinhibitory concentrations of silver nanoparticles and silver nitrate on the adaptive and cross-resistance to antibiotics on bovine mastitis pathogens. *Ciência Rural*, vol. 51, no. 12, e20200672. http://doi.org/10.1590/0103-8478cr20200672.

FIDELIS, C.E., LEITE, R.F., GARCIA, B.L.N., GONÇALVES, J.L., GOOD, L. and DOS SANTOS, M.V., 2023. Antimicrobial activities of polyhexamethylene biguanide against biofilm-producing Prototheca bovis causing bovine mastitis. *Journal of Dairy Science*, vol. 106, no. 2, pp. 1383-1393. http://doi.org/10.3168/jds.2022-22468. PMid:36526458.

FITZPATRICK, S.R., GARVEY, M., FLYNN, J., JORDAN, K. and GLEESON, D., 2019. Are some teat disinfectant formulations more effective against specific bacteria isolated on teat skin than others? *Acta Veterinaria Scandinavica*, vol. 61, no. 1, pp. 21. http://doi.org/10.1186/s13028-019-0455-3. PMid:31023344.

FOX, L.K., GRADLE, C. and DEE, A., 2006. Short communication: disinfectant containing a complex of skin conditioners. *Journal of Dairy Science*, vol. 89, no. 7, pp. 2539-2541. http://doi.org/10.3168/jds.S0022-0302(06)72329-3. PMid:16772572.

GAZZOLA, A., ZUCALI, M., ADDIS, M.F., BAVA, L., MORANDI, S., PISANU, S., PAGNOZZI, D., PASSERA, A., BRASCA, M. and PICCININI, R., 2024. Assessment of Lactococcus cremoris preparations for the pre- and post-milking teat disinfection. *BMC Veterinary Research*, vol. 20, no. 1, pp. 432. http://doi.org/10.1186/s12917-024-04290-7. PMid:39342256.

GODDEN, S.M., ROYSTER, E., KNAUER, W., SORG, J., LOPEZ-BENAVIDES, M., SCHUKKEN, Y., LEIBOWITZ, S. and FRENCH, E.A., 2016. Randomized noninferiority study evaluating the efficacy of a postmilking teat disinfectant for the prevention of naturally occurring intramammary infections. *Journal of Dairy Science*, vol. 99, no. 5, pp. 3675-3687. http://doi.org/10.3168/jds.2015-10379. PMid:26947287.

GONÇALVES, J.L., LEE, S.H., ARRUDA, E.P., PEDROSO GALLES, D., CAMARGO CAETANO, V., FERNANDES DE OLIVEIRA, C.A., FERNANDES, A.M. and VEIGA DOS SANTOS, M., 2015. Biofilm-producing ability and efficiency of sanitizing agents against Prototheca zopfii isolates from bovine subclinical mastitis. *Journal of Dairy Science*, vol. 98, no. 6, pp. 3613-3621. http://doi.org/10.3168/jds.2014-9248. PMid:25841971.

GRINDAL, R.J. and PRIEST, D.J., 1989. Automatic application of teat disinfectant through the milking machine cluster. *The Journal of Dairy Research*, vol. 56, no. 4, pp. 579-585. http://doi.org/10.1017/S0022029900029095. PMid:2674228.

GRZESIAK, B., KRUKOWSKI, H. and GŁOWACKA, A., 2018. The in vitro efficacy of SunSmile® Fruit & Vegetable Rinse against pathogenic strains of Prototheca algae that cause mastitis in cows. *Journal de Mycologie Médicale*, vol. 28, no. 2, pp. 300-304. http://doi.org/10.1016/j.mycmed.2018.03.008. PMid:29673770.

HERVÉ, M., 2023 [viewed 12 September 2024]. *RVAideMemoire: testing and plotting procedures for biostatistics. R package* *version 0.9-83-7* [software]. Vienna: R Foundation for Statistical Computing. Available from: https://cran.r-project.org/web/packages/RVAideMemoire/RVAideMemoire.pdf

HILLERTON, J.E., SHEARN, M.F., TEVERSON, R.M., LANGRIDGE, S. and BOOTH, J.M., 1993. Effect of pre-milking teat dipping on clinical mastitis on dairy farms in England. *The Journal of Dairy Research*, vol. 60, no. 1, pp. 31-41. http://doi.org/10.1017/S0022029900027321. PMid:8436665.

HILLERTON, J.E., COOPER, J. and MORELLI, J., 2007. Preventing bovine mastitis by a postmilking teat disinfectant containing acidified sodium chlorite. *Journal of Dairy Science*, vol. 90, no. 3, pp. 1201-1208. http://doi.org/10.3168/jds.S0022-0302(07)71607-7. PMid:17297095.

HUXLEY, J.N., GREEN, M.J., GREEN, L.E. and BRADLEY, A.J., 2002. Evaluation of the efficacy of an internal teat sealer during the dry period. *Journal of Dairy Science*, vol. 85, no. 3, pp. 551-561. http://doi.org/10.3168/jds.S0022-0302(02)74108-8. PMid:11949859.

INGAWA, K.H., ADKINSON, R.W. and GOUGH, R.H., 1992. Evaluation of a gel teat cleaning and sanitizing compound for premilking hygiene. *Journal of Dairy Science*, vol. 75, no. 5, pp. 1224-1232. http://doi.org/10.3168/jds.S0022-0302(92)77871-0. PMid:1597577.

JUSTICE-ALLEN, A., TRUJILLO, J., CORBETT, R., HARDING, R., GOODELL, G. and WILSON, D., 2010. Survival and replication of Mycoplasma species in recycled bedding sand and association with mastitis on dairy farms in Utah. *Journal of Dairy Science*, vol. 93, no. 1, pp. 192-202. http://doi.org/10.3168/jds.2009-2474. PMid:20059918.

KAWAI, K., SHINOZUKA, Y., UCHIDA, I., HIROSE, K., MITAMURA, T., WATANABE, A., KURUHARA, K., YUASA, R., SATO, R., ONDA, K. and NAGAHATA, H., 2017. Control of Pseudomonas mastitis on a large dairy farm by using slightly acidic electrolyzed water. *Animal Science Journal*, vol. 88, no. 10, pp. 1601-1605. http://doi.org/10.1111/asj.12815. PMid:28516730.

KING, J.S., NEAVE, F.K. and WILLIAMS, R.L., 1979. Effect of vacuum fluctuation during milking on the development of intramammary infection from teat duct colonization by Staphylococcus aureus. *The Journal of Dairy Research*, vol. 46, no. 4, pp. 607-611. http://doi.org/10.1017/S0022029900020665. PMid:536476.

KRÖMKER, V., ROTA, N., LOCATELLI, C., GUSMARA, C., MARINONI, A., MOLTENI, D., SCHMENGER, A., ERK, R.E. and MORONI, P., 2023. Randomized noninferiority field trial evaluating a postmilking teat dip for the prevention of naturally occurring intramammary infections. *Journal of Dairy Science*, vol. 106, no. 9, pp. 6342. http://doi.org/10.3168/jds.2022-22732. PMid:37479581.

KYBARTAS, M., VIRGAILIS, M., RUZAUSKAS, M., KLIMIENĖ, I., ŠIUGŽDINIENĖ, R., MERKEVIČIENĖ, L., ŠTREIMIKYTĖ-MOCKELIŪNĖ, Ž. and MOCKELIŪNAS, R., 2023. A study on the stability and antimicrobial efficacy of a newly modeled teat dip solution containing chlorhexidine. *Veterinary Sciences*, vol. 10, no. 8, pp. 510. http://doi.org/10.3390/vetsci10080510. PMid:37624297.

LAGO, A., BRUNO, D.R., LOPEZ-BENAVIDES, M. and LEIBOWITZ, S., 2016. Short communication: efficacy of glycolic acid-based and iodine-based postmilking barrier teat disinfectants for prevention of new intramammary infections in dairy cattle. *Journal of Dairy Science*, vol. 99, no. 9, pp. 7467-7472. http://doi.org/10.3168/jds.2015-10666. PMid:27320665.

LANGONI, H., SALINA, A., OLIVEIRA, G.C., JUNQUEIRA, N.B., MENOZZI, B.D. and JOAQUIM, S.F., 2017. Considerações sobre o tratamento das mastites. *Pesquisa Veterinária Brasileira*, vol. 37, no. 11, pp. 1261-1269. http://doi.org/10.1590/s0100-736x2017001100011.

LAPORT, M.S., MARINHO, P.R., SANTOS, O.C., DE ALMEIDA, P., ROMANOS, M.T., MURICY, G., BRITO, M.A. and GIAMBIAGI-DEMARVAL, M., 2012. Antimicrobial activity of marine sponges against coagulase-negative staphylococci isolated from bovine mastitis. *Veterinary Microbiology*, vol. 155, no. 2-4, pp. 362-368. http://doi.org/10.1016/j.vetmic.2011.09.004. PMid:21958748.

LAROCQUE, L., MALIK, S.S., LANDRY, D.A., PRESSEAULT, S., SVED, S. and MATULA, T., 1992. In vitro germicidal activity of teat dips against Nocardia asteroides and other udder pathogens. *Journal of Dairy Science*, vol. 75, no. 5, pp. 1233-1240. http://doi.org/10.3168/jds.S0022-0302(92)77872-2. PMid:1597578.

LASSA, H., JAGIELSKI, T. and MALINOWSKI, E., 2011. Effect of different heat treatments and disinfectants on the survival of Prototheca zopfii. *Mycopathologia*, vol. 171, no. 3, pp. 177-182. http://doi.org/10.1007/s11046-010-9365-7. PMid:20853028.

LEITE, R.F., GONÇALVES, J.L., BUANZ, A., FEBRARO, C., CRAIG, D., VAN WINDEN, S., GOOD, L. and SANTOS, M.V., 2021. Antimicrobial activity of polyhexamethylene biguanide nanoparticles against mastitis-causing Staphylococcus aureus. *JDS communications*, vol. 2, no. 5, pp. 262-265. http://doi.org/10.3168/jdsc.2021-0114. PMid:36338383.

LESLIE, K.E., PETERSSON, C.S., VERNOOY, E. and BASHIRI, A., 2005. Efficacy of an iodophore teat disinfectant against Staphylococcus aureus and Streptococcus agalactiae in experimental challenge. *Journal of Dairy Science*, vol. 88, no. 1, pp. 406-410. http://doi.org/10.3168/jds.S0022-0302(05)72701-6. PMid:15591406.

LESLIE, K.E., VERNOOY, E., BASHIRI, A. and DINGWELL, R.T., 2006. Efficacy of two hydrogen peroxide teat disinfectants against Staphylococcus aureus and Streptococcus agalactiae. *Journal of Dairy Science*, vol. 89, no. 9, pp. 3696-3701. http://doi.org/10.3168/jds.S0022-0302(06)72410-9. PMid:16899706.

LOPES, M.M., RIBEIRO, R., CARVALHO, D. and FREITAS, G., 2008. In vitro antimicrobial susceptibility of Prototheca spp. isolated from bovine mastitis in a Portugal dairy herd. *Journal de Mycologie Médicale*, vol. 18, no. 4, pp. 205-209. http://doi.org/10.1016/j.mycmed.2008.09.001.

LOPEZ-BENAVIDES, M.G., WILLIAMSON, J.H., LACY-HULBERT, S.J. and CURSONS, R.T., 2009. Heifer teats sprayed in the dry period with an iodine teat sanitizer have reduced Streptococcus uberis teat-end contamination and less Streptococcus uberis intramammary infections at calving. *Veterinary Microbiology*, vol. 134, no. 1-2, pp. 186-191. http://doi.org/10.1016/j.vetmic.2008.09.027. PMid:18952387.

LU, Y., WANG, D., ZHANG, Y., HU, Y., LU, J., ZENG, Z. and ZENG, D., 2023. Preparation and antimicrobial activity of a film-forming polyhexamethylene biguanide teat disinfectant. *International Journal of Molecular Sciences*, vol. 24, no. 24, pp. 17444. http://doi.org/10.3390/ijms242417444. PMid:38139273.

MARCELO, N.A., ANDRADE, V.A., SOUZA, C.N., MOURÃO, R.P., MOURTHE, M.H.F., SILVA, L.M.V., XAVIER, A.R.E.O., XAVIER, M.A.S., FARACO, A.A.G. and ALMEIDA, A.C., 2020. Efficacy of novel antiseptic product containing essential oil of Lippia origanoides to reduce intramammary infections in cows. *Veterinary World*, vol. 13, no. 11, pp. 2452-2458. http://doi.org/10.14202/vetworld.2020.2452-2458. PMid:33363341.

MARTINS, C.M.M.R., PINHEIRO, E.S.C., GENTILINI, M., BENAVIDES, M.L. and SANTOS, M.V., 2017. Efficacy of a high free iodine barrier teat disinfectant for the prevention of naturally occurring new intramammary infections and clinical mastitis in dairy cows. *Journal of Dairy Science*, vol. 100, no. 5, pp. 3930-3939. http://doi.org/10.3168/jds.2016-11193. PMid:28237594.

MEDEIROS, E.S., SANTOS, M.V., PINHEIRO JÚNIOR, J.W., FARIA, E.B., WANDERLEY, G.G., TELES, J.A.A. and MOTA, R.A., 2009. Avaliação in vitro da eficácia de desinfetantes comerciais utilizados no pré e pós-dipping frente a amostras de Staphylococcus spp. isoladas de mastite bovina. *Pesquisa Veterinária Brasileira*, vol. 29, no. 1, pp. 71-75. http://doi.org/10.1590/S0100-736X2009000100011.

OLIVER, S.P., KING, S.H., TORRE, P.M., SHULL, E.P., DOWLEN, H.H., LEWIS, M.J. and SORDILLO, L.M., 1989. Prevention of bovine mastitis by a postmilking teat disinfectant containing chlorous acid and chlorine dioxide in a soluble polymer gel. *Journal of Dairy Science*, vol. 72, no. 11, pp. 3091-3097. http://doi.org/10.3168/jds.S0022-0302(89)79463-7. PMid:2625499.

OLIVER, S.P., KING, S.H., LEWIS, M.J., TORRE, P.M., MATTHEWS, K.R. and DOWLEN, H.H., 1990. Efficacy of chlorhexidine as a postmilking teat disinfectant for the prevention of bovine mastitis during lactation. *Journal of Dairy Science*, vol. 73, no. 8, pp. 2230-2235. http://doi.org/10.3168/jds.S0022-0302(90)78903-5. PMid:2229606.

OLIVER, S.P., LEWIS, M.J., KING, S.H., GILLESPIE, B.E., INGLE, T., MATTHEWS, K.R., DOWLEN, H.H., DRECHSLER, P.A., WILDMAN, E.E. and PANKEY, J.W., 1991. Efficacy of a low concentration iodine postmilking teat disinfectant against contagious and environmental mastitis pathogens in two dairy herds. *Journal of Food Protection*, vol. 54, no. 9, pp. 737-742. http://doi.org/10.4315/0362-028X-54.9.737. PMid:31051569.

OLIVER, S.P., LEWIS, M.J., INGLE, T.L., GILLESPIE, B.E. and MATTHEWS, K.R., 1993. Prevention of bovine mastitis by a premilking teat disinfectant containing chlorous acid and chlorine dioxide. *Journal of Dairy Science*, vol. 76, no. 1, pp. 287-292. http://doi.org/10.3168/jds.S0022-0302(93)77348-8. PMid:8436679.

OLIVER, S.P., GILLESPIE, B.E., LEWIS, M.J., INGLE, T.L. and DOWLEN, H.H., 1994. Evaluation of chlorhexidine as a premilking teat disinfectant for the prevention of intramammary infections during lactation. *Journal of Food Protection*, vol. 57, no. 7, pp. 614-618. http://doi.org/10.4315/0362-028X-57.7.614. PMid:31121717.

OLIVER, S.P., LEWIS, M.J., GILLESPIE, B.E., IVEY, S.J., COLEMAN, L.H., ALMEIDA, R.A., FANG, W. and LAMAR, K., 1999. Evaluation of a postmilking teat disinfectant containing a phenolic combination for the prevention of mastitis in lactating dairy cows. *Journal of Food Protection*, vol. 62, no. 11, pp. 1354-1357. http://doi.org/10.4315/0362-028X-62.11.1354. PMid:10571330.

OLIVER, S.P., GILLESPIE, B.E., LEWIS, M.J., IVEY, S.J., ALMEIDA, R.A., LUTHER, D.A., JOHNSON, D.L., LAMAR, K.C., MOOREHEAD, H.D. and DOWLEN, H.H., 2001. Efficacy of a new premilking teat disinfectant containing a phenolic combination for the prevention of mastitis. *Journal of Dairy Science*, vol. 84, no. 6, pp. 1545-1549. http://doi.org/10.3168/jds.S0022-0302(01)70189-0. PMid:11417715.

OURA, L.Y., FOX, L.K., WARF, C.C. and KEMP, G.K., 2002. Efficacy of two acidified chlorite postmilking teat disinfectants with sodium dodecylbenzene sulfonic acid on prevention of contagious mastitis using an experimental challenge protocol. *Journal of Dairy Science*, vol. 85, no. 1, pp. 252-257. http://doi.org/10.3168/jds.S0022-0302(02)74074-5. PMid:11860118.

PANKEY, J.W. and WATTS, J.L., 1983. Evaluation of spray application of postmilking teat sanitizer. *Journal of Dairy Science*, vol. 66, no. 2, pp. 355-358. http://doi.org/10.3168/jds.S0022-0302(83)81797-4. PMid:6339578.

PANKEY, J.W., PHILPOT, W.N., BODDIE, R.L. and WATTS, J.L., 1983. Evaluation of nine teat dip formulations under experimental challenge to *Staphylococcus aureus* and *Streptococcus agalactiae. Journal of Dairy Science*, vol. 66, no. 1, pp. 161-167. http://doi.org/10.3168/jds.S0022-0302(83)81767-6. PMid:6339575.

PANKEY, J.W., NICKERSON, S.C. and BODDIE, R.L., 1984. Evaluation of linear dodecyl benzene sulfonic acid teat dip under experimental challenge. *Journal of Dairy Science*, vol. 67, no. 6, pp. 1327-1330. http://doi.org/10.3168/jds.S0022-0302(84)81441-1. PMid:6378996.

PARK, H.M. and HAN, H.R., 2002. Production and characterization of biodegradable povidone-iodine microsphere as a intramammary disinfectant. *The Journal of Veterinary Medical Science*, vol. 64, no. 8, pp. 739-741. http://doi.org/10.1292/jvms.64.739. PMid:12237524.

PERON, A.P., 2020. Microbiological approaches in sustainable biological systems. *Brazilian Journal of Biology, São Carlos*, vol. 80, no. 2, pp. 405-412.

PETERS, R.R., KOMARAGIRI, S., PAAPE, M.J. and DOUGLASS, L.W., 2000. Evaluation of 1.6% phenol as a premilking and postmilking teat dip in preventing new bovine intramammary infections. *Journal of Dairy Science*, vol. 83, no. 8, pp. 1750-1757. http://doi.org/10.3168/jds.S0022-0302(00)75045-4. PMid:10984151.

PHILPOT, W.N. and PANKEY, J.W., 1978. Hygiene in the prevention of udder infections. V. Efficacy of teat dips under experimental exposure to mastitis pathogens. *Journal of Dairy Science*, vol. 61, no. 7, pp. 956-963. http://doi.org/10.3168/jds.S0022-0302(78)83673-X. PMid:359605.

PHILPOT, W.N., BODDIE, R.L. and PANKEY, J.W., 1978. Hygiene in the prevention of udder infections. IV. Evaluation of teat dips with excised cows' teats. *Journal of Dairy Science*, vol. 61, no. 7, pp. 950-955. http://doi.org/10.3168/jds.S0022-0302(78)83672-8. PMid:100535.

R CORE TEAM, 2024 [viewed 12 September 2024]. *R: a language and environment for statistical computing* [software]. Vienna: R Foundation for Statistical Computing. Available from: https://www.R-project.org/&gt

RASMUSSEN, M.D. and LARSEN, H.D., 1998. The effect of post milking teat dip and suckling on teat skin condition, bacterial colonization, and udder health. *Acta Veterinaria Scandinavica*, vol. 39, no. 4, pp. 443-452. http://doi.org/10.1186/BF03547770. PMid:9926458.

SALERNO, T., RIBEIRO, M.G., LANGONI, H., SIQUEIRA, A.K., COSTA, E.O., MELVILLE, P.A., BUENO, V.F., YAMAMURA, A.A., ROESLER, U. and SILVA, A.V., 2010. In vitro algaecide effect of sodium hypochlorite and iodine based antiseptics on Prototheca zopfii strains isolated from bovine milk. *Research in Veterinary Science*, vol. 88, no. 2, pp. 211-213. http://doi.org/10.1016/j.rvsc.2009.08.001. PMid:19758668.

SANTOS, P.R., KRAUS, R.B., LADEIRA, S.L., PEREIRA, G.M., CUNHA, K.F., PALHARES, K.E., SILVA, A.C.A., DORS, G.C., LIMA, H.G., CERESER, N.D. and NASCENTE, P.S., 2023. Resistance profile and biofilm production of Enterococcus spp., Staphylococcus sp. and Streptococcus spp. from dairy farms in southern Brazil. *Brazilian Journal of Microbiology*, vol. 54, no. 2, pp. 1217-1229. http://doi.org/10.1007/s42770-023-00929-z. PMid:36811767.

SAUCIER, A., PLATONOW, I. and HÉBERT, C., 1968. Étude de l'action bactéricide de quatre désinfectants dans le contrôle de la mammite bovine. *The Canadian Veterinary Journal. La Revue Veterinaire Canadienne*, vol. 9, no. 2, pp. 41-45. PMid:5637391.

SCHABAUER, A., ZUTZ, C., LUNG, B., WAGNER, M. and RYCHLI, K., 2018. Gentisaldehyde and its derivative 2,3-dihydroxybenzaldehyde show antimicrobial activities against bovine mastitis *Staphylococcus aureus. Frontiers in Veterinary Science*, vol. 5, pp. 148. http://doi.org/10.3389/fvets.2018.00148. PMid:30050910.

SCHEIB, S., LEIMBACH, S., AVRAMIDIS, G., BELLMANN, M., NITZ, J., OCHS, C., TELLEN, A., WENTE, N., ZHANG, Y., VIÖL, W. and KRÖMKER, V., 2023. Intermediate cluster disinfection: which disinfection solution is most effective on milking liners? A comparison of microorganism reduction on liner inner surfaces using quantitative swab sampling technique. *Pathogens*, vol.

12, no. 4, pp. 560. http://doi.org/10.3390/pathogens12040560. PMid:37111446.

SCHWENKER, J.A., SCHOTTE, U. and HÖLZEL, C.S., 2022. Minimum inhibitory concentrations of chlorhexidine- and lactic acid-based teat disinfectants: an intervention trial assessing bacterial selection and susceptibility. *Journal of Dairy Science*, vol. 105, no. 1, pp. 734-747. http://doi.org/10.3168/jds.2021-20824. PMid:34756445.

SEOL, J.W., KANG, S.J. and PARK, S.Y., 2010. Silver ion treatment of primary cultured bovine mammary gland epithelial cell (BMEC) damage from Staphylococcus aureus-derived alpha-toxin. *Veterinary Research Communications*, vol. 34, no. 1, pp. 33-42. http://doi.org/10.1007/s11259-009-9330-4. PMid:20013051.

SHARUN, K., DHAMA, K., TIWARI, R., GUGJOO, M.B., IQBAL YATOO, M., PATEL, S.K., PATHAK, M., KARTHIK, K., KHURANA, S.K., SINGH, R., PUVVALA, B., AMARPAL., SINGH, R., SINGH, K.P. and CHAICUMPA, W., 2021. Advances in therapeutic and managemental approaches of bovine mastitis: a comprehensive review. *The Veterinary Quarterly*, vol. 41, no. 1, pp. 107-136. http://doi.org/10.1080/01652176.2021.1882713. PMid:33509059.

SHELDRAKE, R.F. and HOARE, R.J.T., 1980. Post-milking iodine teat skin disinfectants 2. New intramammary infection rates. *The Journal of Dairy Research*, vol. 47, no. 1, pp. 27-31. http://doi.org/10.1017/S0022029900020847. PMid:7189530.

SHELDRAKE, R.F., HOARE, R.J.T., CHEN, S.C. and MCPHILLIPS, J., 1980a. Post-milking iodine teat skin disinfectants 3. Residues. *The Journal of Dairy Research*, vol. 47, no. 1, pp. 33-38. http://doi.org/10.1017/S0022029900020859. PMid:7189531.

SHELDRAKE, R.F., HOARE, R.J.T. and HUTCHINSON, J.E., 1980b. Post-milking iodine teat skin disinfectants: 1. Bactericidal efficacy. *The Journal of Dairy Research*, vol. 47, no. 1, pp. 19-26. http://doi.org/10.1017/S0022029900020835. PMid:7189529.

SILVA NETO, S.R., OLIVEIRA, T., TEIXEIRA, I.V., OLIVEIRA, S.B., SAMPAIO, V., LYNN, T. and ENDO, P.T., 2022. Machine learning and deep learning techniques to support clinical diagnosis of arboviral diseases: a systematic review. *PLoS Neglected Tropical Diseases*, vol. 16, no. 1, e0010061. http://doi.org/10.1371/journal.pntd.0010061. PMid:35025860.

SILVA, A.F. and MOTA, G.C., 2020. Mastite bovina: etiologia e controle na produção leiteira. *Revista Brasileira de Medicina Veterinária*, vol. 42, no. 2, pp. 123-135. http://doi.org/10.29327/217559.

SOBUKAWA, H., WATANABE, M., KANO, R., ITO, T., ONOZAKI, M., HASEGAWA, A. and KAMATA, H., 2011. In vitro algaecide effect of disinfectants on Prototheca zopfii genotypes 1 and 2. *The Journal of Veterinary Medical Science*, vol. 73, no. 11, pp. 1527-1529. http://doi.org/10.1292/jvms.11-0256. PMid:21737962.

SPILKI, F.R., 2021. Biotechnological tools for environmental microbiology and health. *Brazilian Journal of Biology, São Carlos*, vol. 81, no. 3, pp. 623-631.

TREMBLAY, Y.D., CARON, V., BLONDEAU, A., MESSIER, S. and JACQUES, M., 2014. Biofilm formation by coagulase-negative staphylococci: impact on the efficacy of antimicrobials and disinfectants commonly used on dairy farms. *Veterinary Microbiology*, vol. 172, no. 3-4, pp. 511-518. http://doi.org/10.1016/j.vetmic.2014.06.007. PMid:24984943.

TURCK, P.A., BITMAN, J. and THOMPSON, M.J., 1982. Mastitis: effect of pH, temperature, and emollients on disinfecting action of N,N-dimethyldodecanamine. *Journal of Dairy Science*, vol. 65, no. 10, pp. 1987-1992. http://doi.org/10.3168/jds.S0022-0302(82)82448-X. PMid:6757291.

VISSIO, C., MELLA, A., AMESTICA, L. and POL, M., 2020. Noninferiority study evaluating the efficacy of a teat disinfectant containing copper and zinc for prevention of naturally occurring intramammary infections in an automatic milking system. *Journal of Dairy Science*, vol. 103, no. 2, pp. 1776-1784. http://doi.org/10.3168/jds.2018-16217. PMid:31864745.

WATTS, J.L., BODDIE, R.L., PANKEY, J.W. and NICKERSON, S.C., 1984. Evaluation of teat dips with excised teats. *Journal of Dairy Science*, vol. 67, no. 9, pp. 2062-2065. http://doi.org/10.3168/jds.S0022-0302(84)81545-3. PMid:6386907.

WILLIAMSON, J.H. and LACY-HULBERT, S.J., 2013. Effect of disinfecting teats post-milking or pre- and post-milking on intramammary infection and somatic cell count. *New Zealand Veterinary Journal*, vol. 61, no. 5, pp. 262-268. http://doi.org/10.1080/00480169.2012.751576. PMid:23441806.

XUE, Y., GAO, Y., GUO, M., ZHANG, Y., ZHAO, G., XIA, L., MA, J., CHENG, Y., WANG, H., SUN, J., WANG, Z. and YAN, Y., 2024. Phage cocktail superimposed disinfection: an ecological strategy for preventing pathogenic bacterial infections in dairy farms. *Environmental Research*, vol. 252, no. 1, pp. 118720. http://doi.org/10.1016/j.envres.2024.118720. PMid:38537740.

YAMAUCHI, S., FURUKAWA, M., KAWAHARA, A., SUGAHARA, T., YAMAMOTO, S., KITABAYASHI, M., SOGABE, A., SHIMODA, S., HATA, E., WATANABE, K., YONEYAMA, H., ASO, H. and NOCHI, T., 2022. Roles of mannosylerythritol lipid-B components in antimicrobial activity against bovine mastitis-causing Staphylococcus aureus. *World Journal of Microbiology & Biotechnology*, vol. 38, no. 3, pp. 54. http://doi.org/10.1007/s11274-022-03243-2. PMid:35149902.

YU, J., REN, Y., XI, X.X., HUANG, W.Q. and ZHANG, H.P., 2017. A novel *Lactobacilli*-based teat disinfectant for improving bacterial communities in the milks of cow teats with subclinical mastitis. *Frontiers in Microbiology*, vol. 8, pp. 1782. http://doi.org/10.3389/fmicb.2017.01782. PMid:29018412.