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Artigo

Hygienic-sanitary quality of fresh Minas cheese: a review

Qualidade higienicossanitária do queijo Minas frescal: uma revisão

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Abstract: Fresh Minas cheese is na originally Brazilian product widely consumed by the population, which manufacture is, generally, of small scale and with little technology. The hygienic-sanitary condition of production is the first step in the manufacture of a product that guarantees food safety for consumers. Based on this, the need for information about food safety during processing was the premise for the present study, which aimed to conduct a survey on the hygienic-sanitary quality of fresh Minas cheese and if these products pose a risk to the consumer. This review was based on articles available in the SciELO database, CAPES journals, PubMed and MEDLINE and other publications of journals in databases in the area of Food Science and Technology and the respective legislation in force. Publications on microbiological quality of fresh Minas cheeses published between the years 2016 to 2020 were selected and in order to guide the research, the following terms were consulted: fresh Minas cheese, microbiological quality, public health, food safety, food pathogens and good manufacturing practices. With this study it was possible to identify that in all articles the evaluated parameters are in disagreement with the quality standards proposed by the current legislation, indicating that producers are not aware or are unaware of good manufacturing practices. Based on the results, it is suggested that producers of fresh Minas cheese adopt effective measures of good manufacturing practices in order to guarantee the safety of the product and the preservation of consumers' health.

Index terms: Dairy products, pathogens, quality control, public health.

Resumo: O queijo Minas frescal é um produto de origem brasileira e amplamente consumido pela população, sua fabricação é, geralmente, de pequena escala e com pouca tecnologia. A condição higienicossanitária de produção é o primeiro passo para a fabricação de um produto que garanta segurança dos alimentos para os consumidores. A necessidade de informações sobre a inocuidade dos alimentos durante seu processamento foi a premissa para o presente estudo que teve como objetivo realizar um levantamento sobre a qualidade higienicossanitária dos queijos tipo Minas frescal e se estes produtos oferecem risco ao consumidor. Esta revisão foi baseada em artigos disponíveis na base de dados SciELO, periódicos CAPES, PubMed e MEDLINE e outras publicações de periódicos em bases de dados na área de Ciências e Tecnologia de Alimentos e as respectivas legislações vigentes. Foram selecionadas publicações sobre qualidade microbiológica de queijos Minas publicadas entre os anos de 2016 a 2020 e a fim de orientar a pesquisa foram consultados os seguintes termos: queijo Minas frescal, qualidade microbiológica, saúde pública, segurança alimentar, patógenos alimentares e boas práticas de fabricação. Com este estudo foi possível identificar que em todos os artigos os parâmetros avaliados estão em desacordo com os padrões de qualidade propostos pela legislação vigente, indicando que os produtores não estão atentos ou desconhecem as boas práticas de fabricação. Baseado nos resultados sugere-se que os produtores de queijos Minas frescal adotem medidas eficazes de boas práticas de fabricação visando garantir a inocuidade do produto e a preservação da saúde dos consumidores.

Termos para indexação: Produtos lácteos, patógenos, controle de qualidade, saúde pública.

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Introduction

Cheese is one of the most consumed foods worldwide. As a product derived from milk, cheese has a favorable nutritional composition for the development of undesirable microorganisms (REGINATO et al., 2020).

Fresh Minas cheese is an originally Brazilian product. The Ministry of Agriculture, Livestock and Supply defines it as being the product obtained by milk enzymatic coagulation such as rennet and / or other adapted coagulating enzymes complemented or not with the action of specific lactic bacteria. It is a product that must be made with pasteurized milk (Brasil, 1996).

Cheese production is generally characterized by being small-scale, with little technology, of family and seasonal origin, contributing to the questioning of the product's safety for human consumption. The microbiological quality of cheese is a fundamental characteristic as it is directly related to public health (OLIVEIRA, 2014; CASTRO et al., 2016).

The hygienic-sanitary condition is the first step towards an adequate cheese production, which starts with the milking and goes to the production, storage and transportation of the milk (Vidal & Netto, 2018).

There were evidences that the commercialization and production of cheese by some rural and / or small industrial properties does not use good manufacturing practices, contributing to low microbiological safety due to the lack of care during the manufacturing and distribution process. Thus, the hygienic and sanitary control of food is a factor of great relevance in the prevention of foodborne diseases (YOON et al., 2016).

In view of the above, the need to guarantee food safety during its processing was the premise for the present study, which aims to survey the microbiological quality of fresh Minas cheeses through a literature review.

Methodology

For the bibliographic review, articles available in the SciELO database, CAPES, PubMed and MEDLINE journals and other publications in databases in different areas of Food Sciences and Technology and the respective current legislation were consulted. Publications on the microbiological quality of Minas cheeses were selected between the years 2016 to 2020.

In order to guide the search for the articles, the following terms were consulted: fresh Minas cheese, microbiological quality, public health, food safety, food pathogens and good manufacturing practices.

Data synthesis obtained from articles published in the last 5 years

In this bibliographic research, scientific articles that met the inclusion criteria previously established were analyzed. The data analysis and synthesis presented in the evaluated articles makes it possible to gather the knowledge produced on the subject of that review.

To facilitate the analysis and presentation of the results, Table 1 was elaborated with data on the year, objectives, results and / or author´s considerations of each study..

All articles presented in this review followed the microbiological parameters for fresh Minas cheese established by the National Health Surveillance Agency (NHSA) through Collegiate Board Resolution (CBR) No. 12 of January 2001. This legislation establishes the maximum parameters microorganisms present in cheeses for the purposes of registration and inspection, namely: coliforms at 45 ºC (5 x 10^3 MPN.g^{-1}), coagulase positive *Staphylococcus* (5 x 10^3 CFU.g^{-1}), absence of *Salmonella* spp. and *Listeria .monocytogenes* in 25 g, qualifying the products in satisfactory microbiological conditions or not (Brasil, 2001).

Table 1. Identification and presentation of the synthesis of the articles included in the literature review.

Authors	Objective(s)	Authors' results / considerations
Dias et al. (2016)	The authors evaluated the physical-chemical characteristics, analyzed the labeling and verified the hygienic-sanitary conditions regarding the presence of *Salmonella* spp.; *Staphylococcus aureus*, coliforms at 45 ° C and totals of fresh Minas cheeses, produced industrially and homemade in the southern region of Goiás	Five samples of industrialized fresh Minas cheeses and five of homemade fresh Minas cheeses were evaluated. 100% (10/10) of the analyzed samples were in disagreement with legislation regarding the counting of coliforms at 45 ° C. As for the presence of coagulase-positive *Staphylococcus*, 70% (7/10) were at odds, with the absence of *Salmonella* spp. Regarding labeling, 90% (4/5) of industrialized samples were in accordance with Ministry of Health's Law No. 10674/03 and 100% (5/5) of homemade were at odds. It was concluded that the cheeses were in disagreement with the current legislation, verifying possible failures in quality control during their processing and / or storage.

Authors	Objective(s)	Authors' results / considerations
	State, Brazil.	
Feitosa et al. (2016)	Identify and describe possible contaminants of fresh Minas cheeses sold in open markets in the city of Morrinhos, of Goiás State, Brazil.	Among the 37 cheese samples analyzed in the rainy season, 100% (37/37) were contaminated by total coliforms. For coliforms at 45 ° C and *Staphylococcus* post-coagulase, 78.38% (29/37) and 35.14% (13/37) of the samples were in disagreement with current legislation, respectively. In the dry season, 86.49% (32/37) of the samples contained total coliforms. 62.16% (23/37) and 27.03% (10/37) of the total samples were with counts above the permitted in legislation for Coliforms at 45 ° C and positive coagulase *Staphylococcus*, respectively. The cheeses analyzed were a matter of concern for health authorities because they represent a risk to the health of consumers.
Garcia et al. (2016)	Analyze the microbiological quality of homemade fresh Minas cheese marketed in the northern region of Minas Gerais State, Brazil.	Eighteen samples of homemade fresh Minas cheeses were evaluated. Values were found that did not comply with the legislation for coliforms at 45 ° C, coagulase positive *Staphylococcus* and the presence of *Salmonella* spp. in 63% (11/18) of the samples, making the product unfeasible for human consumption. High counts of aerobic mesophilic bacteria and total coliforms were found. The high counts of these microorganisms suggest inadequate hygienic-sanitary conditions during the processing of the product and the need to implement security guarantee systems in all stages of cheese production.
Vinha et al. (2016)	Relate the conditions of production and marketing of fresh Minas cheeses produced in informal family agribusinesses in the Municipality of Viçosa, Minas Gerais State, Brazil, with the hygienic-sanitary quality of the product.	77 samples of fresh Minas cheese from uninspected family agribusinesses were evaluated. The agro-industries showed a low degree of adequacy to Good Manufacturing Practices (GMP) and a high percentage of samples in disagreement with microbiological standards, which indicates a direct relationship between degree of compliance with GMP requirements and the quality of the final product. The hygienic-sanitary quality of the cheeses was unsatisfactory associated with the high rate of contamination by bacteria in the coliform group and by positive coagulase *Staphylococcus*. The presence of *Listeria monocytogenes* was detected in one of the

Authors	Objective(s)	Authors' results / considerations
		samples. The presence of *Salmonella* spp. was not found. The adoption of guiding measures, the fulfillment of GMP and the improvement of the commercialization conditions of the product are necessary measures to improve the quality of the cheeses produced, prevent the occurrence of diseases associated with the consumption of contaminated cheeses, reduce economic losses in order to guarantee the continuity of activity in small family agribusinesses.
Silvério et al. (2017)	To evaluate the microbiological and sensory quality of fresh Minas cheese sold in different supermarkets in the city of Curitiba, Paraná State, Brazil.	Twelve samples collected at random were evaluated. The counts of aerobic mesophilic bacteria ranged from 4 to 6.6 x 10^7 CFU.g^{-1}. For the values obtained in the coliform count at 45 ° C, 33.3% (4/12) of the samples were in disagreement with what was established by the legislation. Regarding the survey of *Salmonella* spp., its presence in 8.33% (1/12) of the samples disagrees with current legislation. Coagulase positive *Staphylococcus* was absent in all samples. *Escherichia coli*, *Hafnia alveii*, *Pseudomonas* spp. and *Shigella* spp. were also identified in the samples. The sensory analyzes showed that in 50% (6/12) of the samples the tasters liked the color a lot. As for odor and taste, 33.33% (4/12) of the samples showed low acceptance by the evaluators, while 75% (9/12) obtained the highest scores for texture. Regarding the purchase intention, it was observed that 57% (7/12) of the samples submitted to sensory analysis would probably be acquired by the tasters.
Oliveira et al. (2017)	To evaluate the hygienic quality of the production of mozzarella cheese and fresh Minas cheese produced in the Northern region of Paraná State, Brazil.	Fifty samples of cheese were analyzed, 14 of mozzarella and 36 of fresh Minas. For mozzarella cheese, it was observed that all samples had counts according to the recommended standards for coliforms at 45 ° C. However, it was observed that 55.6% (27/50) of fresh Minas cheese samples were with high total coliform counts. 27.8% (14/50) of sampels were contaminated with coliforms at 45 ° C with counts above the legal limit. These results indicate that the majority of fresh Minas cheeses present unsatisfactory hygienic conditions during the production stages and risk to consumers' health, making it necessary to adopt

Authors	Objective(s)	Authors' results / considerations
		good manufacturing practices, applying corrective and monitoring measures that allow the reduction of this contamination, compliance with microbiological quality standards established by legislation and guarantee of microbiological safety.
Souza et al. (2017)	To evaluate the microbiological quality of fresh Minas cheese marketed in the Zona da Mata region, Minas Gerais State, Brazil.	Fifty samples were evaluated, among which 43 were of industrial origin and 07 of homemade origin. All samples showed coliforms at 35 ºC, with values ranging from 1.5 x 10^1 to 1.1 x 10^6 MPN.g^{-1}. 40% (20/50) of the cheeses analyzed presented counts above the maximum legal limit for coliforms at 45 ºC, with an average of 1.2 x 10^5 MPN.g^{-1}. The presence of *Escherichia coli* was confirmed in 32% (16/50) of the analyzed samples. Coagulase positive *Staphylococcus* counts were also above the accepted limit in 32% (16/50) of the samples. There was no presence of *Listeria monocytogenes*, however, *Salmonella* spp. was confirmed in 40% (20/50) of the samples. It was found that only 22% (11/50) of the samples were in compliance with Brazilian legislation. Therefore, fresh Minas cheese marketed in the region presented problems in its microbiological quality, suggesting deficiencies in processing, transportation, storage and / or commercialization and danger to human health.
Queiroz et al. (2017)	To verify the hygienic-sanitary quality of fresh Minas cheeses marketed in the city of Botucatu, São Paulo State, Brazil on dates close to its manufacture and on the expiration date.	Fifty samples of fresh Minas cheese were evaluated. Coliforms at 45 ºC counts were detected above the legal limit in 36% (18/50) of the samples during the first analysis (on the day of manufacture) and, in the second (after expiration), in 44% (22 / 50). As for the count of positive coagulase *Staphylococcus*, 10% (5/50) did not meet the standard required by law on the date of production, and 14% (7/50), on the expiration date. *Salmonella* spp. it was only observed in a sample close to the date of production, whereas *Listeria monocytogenes* only in one sample on the expiration date. The hygienic-sanitary quality of these fresh Minas cheeses analyzed was unsatisfactory, implying risks to the consumer's health.
Vinha et al.	Quantify Positive Coagulase	Seventy-eight cheese samples were evaluated, 46 with pasteurized milk and 32 with raw milk. Cheeses

Authors	Objective(s)	Authors' results / considerations
(2018)	*Staphylococcus* in fresh Minas cheeses, produced in family agroindustries, in the city of Viçosa, Minas Gerais State, Brazil, six of which were uninspected cheeses, where three of them use raw milk and three use pasteurized milk.	produced with pasteurized milk showed low counts of *Staphylococcus* coagulase positive (1.0 x 10^1 to 2.0 x 103 CFU.g^{-1}) and 6.5% (5/78) of the samples showed non-compliance and were above the standards required in legislation. These may be justified by post-pasteurization contamination stemming from sanitary failures during the manufacture and marketing of the product. Cheeses manufactured with raw milk showed higher contamination (6.0 x 10^2 to 3.6 x 10^6 CFU.g^{-1}) and 75% (58/78) of non-compliant samples, which can be attributed to raw material contamination. Formal cheeses are potentially capable of causing gastroenteritis and offer a risk to public health. Family agro-industries must meet sanitary requirements in order to offer safe products to consumers, avoid outbreaks, regularize production and expand commercialization, providing the development and consolidation of this important activity in rural areas.
Silva et al. (2018)	Detect the presence of *Escherichia coli* using the Petrifilm^{TM} technique in fresh Minas cheese packed with vacuum.	Thirty units of fresh Minas cheese were evaluated. The results obtained indicated *Escherichia coli* values above that allowed by Brazilian legislationin 6.6% (2/30) of the samples, 63.3% (19/30) of the samples presented negative count and 30% (9/30) had a score within the allowed value. On the other hand, the tests for total coliforms showed a worrying result regarding hygienic quality in the manufacture of cheeses, where 43.3% (13/30) of the samples presented colony count in worrying values and 56.7% (17/30) of the samples were negative. These results show that there are still flaws in the manufacturing process, stressing the need for control at all critical control points in the industry in addition to an efficient inspection system.
Fraga et al. (2019)	Differentiate and biochemically identify species of *Staphylococcus* coagulase positive isolated from fresh Minas cheese marketed in the city of Itaperuna, Rio de	Forty samples of fresh Minas cheese were evaluated. The results found in the analyses revealed that the samples have characteristics unfit for human consumption, highlighting the presence outside the standards of legislation for coliforms at 45 °C in 80% (3/4) of the samples and *Staphylococcus* coagulase positive in 50% (2/4) of the samples. Thus, it was perceived the need to carry out a research of fresh Minas homemade cheese, with samples conditioned

Authors	Objective(s)	Authors' results / considerations
	Janeiro State, Brazil.	by hand and industrially from the same batch of the product, so that the contamination problem can be solved and traced.
Lima & Cardoso (2019)	To evaluate the microbiological profile of fresh Minas cheeses, handmade, sold at free fairs in the Federal District, Brazil, through the qualification and quantification of total coliforms, coliforms at 45 °C and *Salmonella* spp.	Twenty samples collected at four free fairs were evaluated. The presence of total coliforms and 45 °C were detected in 100% (20/20) of the analyzed samples and 95% (19/20) with presence of *Salmonella* spp. The presence of these microorganisms above that recommended by Brazilian legislation indicates poor quality of the product, making them unfit for human consumption, with the need for improvements in the production process of these homemade cheeses and an efficient inspection by the government agencies responsible.
Saleh et al. (2019)	Microbiologically analyze for total coliforms and at 45 °C, *Staphylococcus* coagulase positive and lactic acid bacteria in samples of fresh Minas cheese obtained in supermarkets in Duque de Caxias, Rio de Janeiro State, Brazil.	Among the samples analyzed, in 52.6% (10/19) coliform count was observed at 45 °C above that established in legislation, all confirming for *Escherichia coli*. In 100% (19/19) of the samples, positive coagulase *Staphylococcus* counts were observed higher than allowed in said legislation. Low lactic bacteria counts were evidenced in the samples analyzed. In view of the results obtained, it is necessary to adopt measures aimed at improving the microbiological quality of the food matrix and ensuring food safety.
Silva et al. (2019)	Evaluate the microbiological quality of 3 samples of fresh Minas cheese from different production processes.	The origins of the samples were: industrialized, produced in a neighborhood butcher's shop in Bauru, São Paulo State, Brazil and derived from homemade production. Of the 3 samples analyzed, the results were: homemade and butcher's showed coliforms at 45 °C growth above that allowed by legislation. All samples showed countless atypical colony growth in positive coagulase *Staphylococcus* analyses, making it impossible to count the microorganisms in question; none of them showed growth of *Salmonella* spp. Considering the microbiological quality, it was possible to conclude that only fresh Minas cheese industrialized was within the standards determined by Brazilian legislation, while the other samples presented unsatisfactory results, which may

Authors	Objective(s)	Authors' results / considerations
		compromise the health of the consumer.
Pinto et al. (2020)	Evaluate the presence of microorganisms harmful to human health, contaminants of fresh Minas cheeses, sold in commercial establishments in the municipality of Rolim de Moura, Rondônia State, Brazil.	Thirty samples of fresh Minas cheese were evaluated resulting in 10% (3/30) of samples with counts above the legal limit allowed for coliforms at 45 °C, of which 33.3% (1/3) were positive for *Escherichia coli*, and 100% (30/30) of the samples were positive for positive coagulase *Staphylococcus*. Through this microbiological analysis it was verified that the quality of fresh Minas cheese marketed in this city is not within the ideal sanitary quality standards and can generate public health problems.
Mota & Farias (2020)	Evaluate the physical-chemical and microbiological characteristics of fresh Minas cheeses homemade produced by eight rural producers in a city in the Zona da Mata region, Minas Gerais State, Brazil.	From the samples evaluated in the study, considerable variations in pH, acidity and NaCl content parameters were observed among the samples analyzed and among the results in triplicate of the same sample, demonstrating possible problems during mass homogenization. On the other hand, it was possible to conclude that all the cheeses analyzed presented high counts of all microorganisms, and all samples were in disagreement with the legislation. Considering the fact that fresh Minas cheese is widely consumed by the population, this study demonstrated that there is a need for greater attention and care with standardization and hygiene issues during the manufacture of this type of cheese, in order to ensure its quality and safety to consumers.

Updated legislation

The Collegiate Board Resolution (CBR) No. 12 was updated by CBR 331/2019 (Brasil, 2019a) and will be repealed on 12/26/2020. This new CBR deals with microbiological patterns of food and its application and covers the entire food production chain and all sectors involved in the stages of production, industrialization, storage, fractionation, transportation, distribution, import and marketing of food. To complement CBR 331/2019 the Normative Instruction (NI) No.60/2019 (Brasil, 2019b) was also published, which defines the lists of microbiological standards for food ready to offer to consumers.

Among the determinations, with respect to the general requirements, foods may not contain pathogenic

microorganisms, toxins or metabolites in amounts that cause damage to health. Thus, the sectors involved in the food production chain are responsible for conducting periodic evaluations regarding the adequacy of the process to meet the standards and determining the frequency of analyses, ensuring that, throughout the shelf life, food meets the microbiological standards established by NI 60/2019, in accordance with good manufacturing practices and other quality control programs. CBR 331/2019 and NI 60 establish new microorganisms researched and their maximum limits for fresh Minas cheeses, which are: absence of staphylococcal enterotoxins (ng/g), absence of *Salmonella* spp. and *Listeria monocytogenes* in 25g of sample, coagulase positive *Staphylococcus* (5×10^3 $CFU.g^{-1}$) and *Escherichia coli* (5×10^2 $MPN.g^{-1}$).

Fresh Minas cheese quality

Among the scientific articles evaluated, all presented results where the microbiological quality of the analyzed cheeses was outside the standards established by the current legislation, associating this fact with the lack of good manufacturing practices and the deficiency of hygienic sanitary quality of the raw material, manufacture, handling and storage of cheeses. The quality of milk used as raw material for the production of dairy products is a fundamental premise to ensure the success of the final product. In the manufacture of homemade cheeses the prevention and correction of defects is difficult because the main raw material, milk, cannot be standardized as it occurs in industries (SOBRAL et al., 2017).

There are three main sources of primary microbiological contamination of milk: herd health, outside the udder and milking management and hygiene of utensils involved in milking and pre- and post milking processes (Menezes et al., 2014). The adoption of good milking and management practices, as well as the maintenance of adequate cleaning equipment and procedures reduce the total bacterial load present in milk (ABREU & MOÉSIA, 2017).

Fresh cheese is considered as a vector of foodborne pathogens, especially those of clandestine origin that are devoid of sanitary supervision and are produced with raw milk and do not undergo maturation process (AMARAL et al., 2020).

The improvement of the manufacturing and marketing processes of cheeses are public health issues, since the market needs to offer products that ensure consumer safety (Fernandes et al., 2013). It is also important for supervisory bodies to take measures to clarify and make producers, traders and consumers aware in

order to curb the marketing of products that pose a risk to public health (SILVA et al., 2013).

Final considerations

The hygienic quality of fresh Minas cheeses is unsatisfactory in most studies evaluated representing their consumption, in these cases, risks to consumer health. Public policies should be implemented in order to empower producers on good manufacturing practices by ensuring the safety of the product so that the consumer has the table a cheese with quality and safety.

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