

Artisanal coalho cheese in Sergipe, Brazil: Technological challenges, food safety strategies, and pathways for market valorization

Queijo coalho artesanal em Sergipe, Brasil: Desafios tecnológicos, estratégias de segurança alimentar e caminhos para a valorização de mercado

Queso artesanal coalho en Sergipe, Brasil: Desafíos tecnológicos, estrategias de seguridad alimentaria y vías para su comercialización

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Abstract

Artisanal coalho cheese is among the most prominent dairy products of Northeastern Brazil and holds considerable economic and sociocultural significance in the state of Sergipe. However, artisanal production frequently exhibits technological and microbiological variability, representing persistent challenges to standardization and food safety. The present review addresses this limitation by systematically examining the production techniques, regulatory challenges, and technological innovations associated with artisanal coalho cheese in Sergipe, aiming to propose an integrated strategy that improves product quality and food safety while preserving its cultural and regional identity. The study employed a systematic bibliographic survey guided by predefined inclusion and exclusion criteria. Results indicate that raw milk quality, hygienic-sanitary conditions, and standardization of technological stages directly influence the microbiological and physicochemical quality of the final product. Innovatively, the study proposes an integrated technological strategy combining Good Manufacturing Practices and systematic microbiological monitoring as essential tools to reduce contamination risks and improve product consistency — offering a structured, replicable framework applicable to similar artisanal dairy systems across Brazil. The implementation of current legislation and certifications is identified as essential to regularizing and enhancing the national market recognition of coalho cheese. Future research should address longitudinal assessments of the impacts of Good Manufacturing Practices on microbiological indicators, the use of geographical indication as a valorization tool, and consumer perceptions of sensory quality and cultural identity. The proposed methodology may help advance quality and food safety standards while preserving the authenticity of artisanal coalho cheese in Sergipe.

Keywords: Artisanal cheese; Food safety; Good manufacturing practices; Dairy technology.

Resumo

O queijo coalho artesanal está entre os produtos lácteos mais importantes do Nordeste brasileiro e possui considerável relevância econômica e sociocultural no estado de Sergipe. No entanto, a produção artesanal frequentemente apresenta variabilidade tecnológica e microbiológica, representando desafios persistentes. A presente revisão aborda essa limitação examinando sistematicamente as técnicas de produção, os desafios regulatórios e as inovações tecnológicas associadas ao queijo coalho artesanal em Sergipe, com o objetivo de propor uma estratégia integrada que melhore a qualidade do produto e a segurança alimentar, preservando sua identidade cultural e regional. O estudo empregou um levantamento bibliográfico sistemático guiado por critérios de inclusão e exclusão predefinidos. Os resultados indicam que a qualidade do leite cru, as condições higiênico-sanitárias e a padronização das etapas tecnológicas influenciam diretamente a qualidade microbiológica e físico-química do produto. De forma inovadora, o estudo propõe uma estratégia tecnológica integrada que combina Boas Práticas de Fabricação (BPF) e monitoramento microbiológico sistemático como ferramentas essenciais para reduzir os riscos de contaminação e melhorar a

consistência do produto. A implementação da legislação e das certificações vigentes é considerada essencial para regularizar e fortalecer o reconhecimento do queijo coalho no mercado nacional. Pesquisas futuras devem abordar avaliações longitudinais dos impactos das BPF sobre os indicadores microbiológicos, o uso da Indicação Geográfica como ferramenta de valorização e a percepção do consumidor em relação à qualidade sensorial e à identidade cultural. A metodologia proposta pode contribuir para o avanço dos padrões de qualidade e segurança alimentar, preservando a autenticidade do queijo coalho em Sergipe.

Palavras-chave: Queijo artesanal; Segurança alimentar; Boas práticas de fabricação; Tecnologia de laticínios.

Resumen

El queso coalho artesanal se encuentra entre los productos lácteos más importantes del noreste de Brasil y tiene una considerable relevancia económica y sociocultural en el estado de Sergipe. La presente revisión aborda esta limitación examinando sistemáticamente las técnicas de producción, los desafíos regulatorios y las innovaciones tecnológicas asociadas con el queso artesanal coalho en Sergipe, con el objetivo de proponer una estrategia integrada que mejore la calidad del producto y la seguridad alimentaria, preservando al mismo tiempo su identidad cultural y regional, el estudio empleó una búsqueda bibliográfica sistemática guiada por criterios de inclusión y exclusión predefinidos. Los resultados indican que la calidad de la leche cruda, las condiciones higiénico-sanitarias y la estandarización de los pasos tecnológicos influyen directamente en la calidad microbiológica y fisicoquímica del producto. De manera innovadora, el estudio propone una estrategia tecnológica integrada que combina las Buenas Prácticas de Manufactura (BPM) y el monitoreo microbiológico sistemático como herramientas esenciales para reducir los riesgos de contaminación y mejorar la consistencia del producto. La implementación de la legislación y las certificaciones vigentes se considera esencial para regular y fortalecer el reconocimiento del queijo coalho en el mercado nacional. Futuras investigaciones deberían abordar evaluaciones longitudinales del impacto de las BPM en los indicadores microbiológicos, el uso de la Indicación Geográfica como herramienta de valor agregado y la percepción del consumidor respecto a la identidad cultural. La metodología propuesta puede contribuir al avance de los estándares de calidad e inocuidad alimentaria, del queijo coalho en Sergipe.

Palabras clave: Queso artesanal; Inocuidad alimentaria; Buenas prácticas de manufactura; Tecnología láctea.

1. Introduction

Artisanal coalho cheese represents one of the most culturally and economically significant dairy products in Northeastern Brazil, with relevance in the state of Sergipe. Despite its sociocultural prominence, artisanal coalho cheese production is systematically affected by technological and microbiological variability, which compromises product standardization and poses persistent challenges to food safety assurance throughout the productive chain (Saraiva et al., 2023).

Despite its sociocultural prominence, artisanal coalho cheese production is systematically affected by technological and microbiological variability, which compromises product standardization and poses persistent challenges to food safety assurance throughout the productive chain (Duch et al., 2025; Pineda et al., 2021).

The characterization of artisanal dairy production systems in Brazil has gained increasing scientific attention in recent decades, particularly in response to growing demands for food safety regulation and market formalization (Queiroz et al., 2024).

In the specific context of Sergipe, the productive chain of coalho cheese is marked by regional particularities related to raw milk quality, hygienic-sanitary conditions at production sites, and the absence of fully standardized technological protocols (Oliveira & Sá, 2021).

These factors influence the microbiological and physicochemical composition of the final product, thereby determining its safety profile and sensory attributes.

Understanding the intersection between traditional production methods and contemporary quality standards is therefore essential to developing evidence-based strategies that improve product consistency without compromising cultural authenticity. (Wilcox et al., 2024).

From a regulatory standpoint, artisanal coalho cheese producers in Sergipe face considerable institutional challenges. The adaptation to current food safety legislation, including the implementation of Good Manufacturing Practices and the obtainment of certifications such as the Selo Arte, remains an ongoing obstacle for small-scale producers operating within

informal or semi-formal production structures.

The alignment between regulatory demands and the reality of artisanal production, therefore, constitutes a critical area of investigation, with direct implications for both producer livelihoods and consumer protection.

Technological innovation in artisanal cheesemaking has been increasingly recognized as a viable pathway to reconcile traditional production practices with contemporary quality and safety requirements (Moula Ali et al., 2022).

Systematic microbiological monitoring, the application of standardized technological stages, and the integration of Good Manufacturing Practices into artisanal production routines have been identified as essential tools for reducing contamination risks and improving product consistency (Charão et al., 2024; Oliveira et al., 2021).

At the same time, instruments such as geographical indication have emerged as strategic mechanisms for the protection and market valorization of regionally distinctive products, offering a framework for the formal recognition of coalho cheese as cultural heritage and a differentiated product in the national dairy market (Almeida et al., 2021).

In this context, comprehensive reviews of the historical, technological, and regulatory dimensions of artisanal coalho cheese production in Sergipe are scarce in scientific literature. Existing studies tend to address isolated aspects of the productive chain, such as microbiological contamination profiles or specific physicochemical parameters, without offering an integrated analysis of the technological strategies applicable to the artisanal production context.

The present review addresses this limitation by systematically examining the production techniques, regulatory challenges, and technological innovations associated with artisanal coalho cheese in Sergipe, aiming to propose an integrated strategy that improves product quality and food safety while preserving its cultural and regional identity.

2. Methodology

A documentary research was conducted using direct data from Sergipe State Laws, IBGE and ANVISA, and indirect documentary research using data from scientific articles (Risemberg et al., 2026; Pereira et al., 2018) in a study with a quantitative approach regarding the number of 27 (twenty-seven) articles selected to compose the research corpus, and a qualitative and narrative approach regarding the discussions about the selected articles.

In the preparation of the article, strategic research was conducted using the following descriptors: "artisanal coalho cheese", "artisanal coalho cheese Sergipe", "processing and production of artisanal coalho cheese", and "artisanal coalho cheese legislation".

3. Results and Discussion

3.1 Historical and Sociocultural Aspects of Artisanal Coalho Cheese in Sergipe

Cheese production has deep roots in human history, with records dating back to the medieval period. Significant advances in manufacturing techniques, however, occurred during the Roman Empire, between 27 BC and 476 AD, and the knowledge developed during that period was transmitted and refined over subsequent centuries, influencing cheese production across different regions of the world (Fox et al., 2017).

Coalho cheese, a traditional dairy product of Northeastern Brazil, has been produced for more than 400 years and has become a symbol of the region's culture and gastronomy (Saraiva et al., 2023) Its artisanal practice dates back to Portuguese colonization, when the first settlers introduced techniques for producing cheese from raw milk (Kothe et al., 2022).

The colonizers incorporated these cheeses into the local cuisine, thereby attributing value to agricultural and livestock products. As a result, traditional European taste merged with Brazilian food practices, and coalho cheese became a central element of the typical regional cuisine, widely appreciated throughout the national territory (Lima et al., 2022; Mansha Rafiq et

al., 2025).

During the colonial period and until the early twentieth century, the artisanal production of coalho cheese was predominantly domestic and oriented toward family consumption (Cavalcante, 2023). In the Sergipe hinterland, this practice persisted until the 1970s, when significant changes in the production model began.

During this period, artisanal production came to be regarded as a response strategy to the growing demand of the urban market, driven by migratory movements. Until then, dairy farming was low-productive, relying on rustic cattle known as "pé duro" that fed on native pastures (Roldan et al., 2023).

From the 1970s onward, improvements in infrastructure, such as the expansion of road networks, favorable climatic conditions for pasture development, reduction of cattle diseases, and access to agricultural credit policies in the semiarid region, collectively contributed to an accelerated growth in coalho cheese production (Oliveira & Sá, 2021).

This period marked the transition from family-based production to large-scale commercialization. Traditionally intended for self-consumption, coalho cheese began to be recognized as a source of income, and production, previously under the responsibility of women within the household, shifted its focus toward the market (Cavalcante, 2023; Saraiva et al., 2023).

Rural families in the Northeast dedicated themselves to selling the product in larger cities, frequently through relatives who had migrated to state capitals, thereby helping to circulate artisanal coalho cheese in bakeries, warehouses, markets, and street fairs, thereby preserving the region's culture and tradition (Santos et al., 2020).

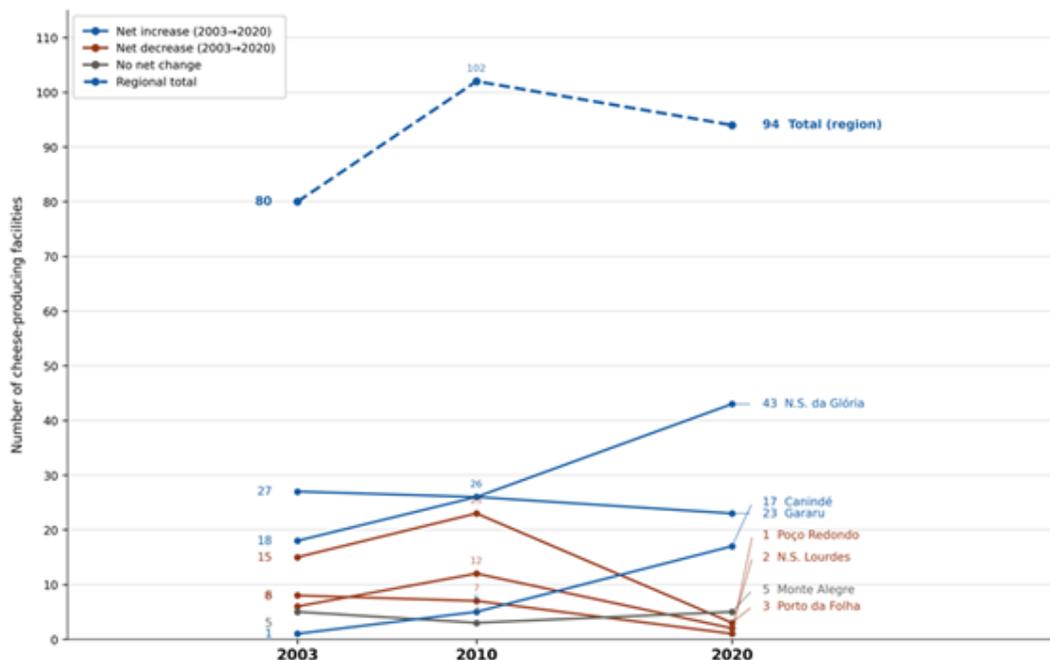
In the state of Sergipe, the Alto Sertão Sergipano region is the primary area for artisanal coalho cheese production, with prominent dairy farming. This territory is in the northwestern portion of the state, corresponding to the Sergipana microregion of the Sertão do São Francisco.

In the state of Sergipe, dairy farming stands out in the Alto Sertão region. The territory of Alto Sertão Sergipano is in the northwest of the state of Sergipe, corresponding to the microregion of Sergipana do Sertão do São Francisco.

According to data from the Brazilian Institute of Geography and Statistics (IBGE, 2025), the total population of the territory is estimated to be approximately 150,000 inhabitants distributed in a geographical area of 4,900,686 km², this region being made up of seven cities: Canindé de São Francisco, Gararu, Monte Alegre, Nossa Senhora da Glória, Nossa Senhora de Lourdes, Poço Redondo and Porto da Folha (IBGE, 2025).

The cities, in addition to being important producers of milk in the state of Sergipe, also have significant representation in the production of dairy products, especially artisanal curd cheese. Figure 1 shows, according to data provided by IBGE, 2025; the number of cheese factories and milk production in the cities of the Alto Sertão region of Sergipe.

Figure 1 - Change in the number of cheese-producing facilities (cheijarias) per municipality in the Sertão region, Sergipe, Brazil, between 2003 and 2020 (IBGE, 2025). Upward-sloping lines indicate growth; downward-sloping lines indicate decline. Line color encodes the direction of change: blue = net increase; red/coral = net decrease; gray = no net change. Values adjacent to each endpoint denote absolute counts. The regional total (all municipalities combined) is shown separately at the bottom. N.S. = Our Lady.



Source: Research data (2026).

From Figure 1, it is evident that in recent years there has been a drop of about 8% in the total number of cheese factories. This reduction in the number of establishments may be related, among other factors, to increased inspections by official bodies in the Sertão Sergipano region.

Among these bodies, the Federal Public Prosecutor's Office and the State Public Prosecutor's Office stand out, in an operation called the Integrated Preventive Action of the Triple Frontier (FPI), which reviewed and closed some establishments in the region that presented irregularities, among other reasons, for not meeting the hygienic-sanitary conditions provided for in current legislation.

Furthermore, the decrease in the number of artisanal Coalho cheese factories in the Sertão region of Sergipe underscores the importance of research to assess the implementation of Good Manufacturing Practices (GMP), thereby minimizing potential economic losses for small producers and ensuring the availability of safe, high-quality food for consumers.

3.2 Good Manufacturing Practices and Microbiological Monitoring as Quality Assurance Tools

Good Manufacturing Practices (GMP) constitute a fundamental regulatory and operational framework for ensuring the safety, hygiene, and quality of food products throughout the entire production chain.

In the context of artisanal cheese production, particularly coalho cheese manufactured in the state of Sergipe, Brazil, the implementation of GMP represents one of the most critical determinants of product safety and consumer health protection.

The consistent application of these practices encompasses a broad set of requirements related to facility infrastructure, personal hygiene of handlers, water quality, equipment sanitation, raw milk handling, and environmental conditions during processing and storage (Ibarra-Sánchez et al., 2026)

Artisanal dairy production systems in Sergipe are predominantly characterized by small-scale family-based operations in which milk processing occurs under conditions that often deviate significantly from the minimum hygienic-sanitary standards established by Brazilian regulatory agencies, including the Ministério da Agricultura, Pecuária e Abastecimento (MAPA) and the Agência Nacional de Vigilância Sanitária (ANVISA).

Studies conducted in the Northeastern region of Brazil have consistently documented the precarious state of infrastructure in many artisanal cheese-producing units, with inadequate drainage systems, absence of proper hand-washing facilities, lack of pest control measures, and insufficient separation between production areas and domestic environments (Oliveira & Sá, 2021; Silva & Costa, 2024; Sobreira et al., 2022).

Microbiological monitoring serves as an indispensable complementary tool to GMP, providing empirical evidence of the hygienic-sanitary conditions prevailing at critical control points throughout the manufacturing process.

Regular microbiological analyses of raw milk, water, production surfaces, equipment, handlers, and the final product enable producers and regulatory authorities to identify contamination sources, implement corrective measures, and track the effectiveness of hygiene interventions over time (Camargo et al., 2021; Pineda et al., 2021).

The most frequently identified microbial hazards associated with artisanal coalho cheese include thermotolerant coliforms, *Staphylococcus aureus*, *Salmonella* spp., and *Listeria monocytogenes*, all of which pose serious risks to consumers, particularly vulnerable populations such as children, the elderly, pregnant women, and immunocompromised individuals (Coelho Galafassi et al., 2026; de Albuquerque et al., 2024).

Furthermore, elevated somatic cell counts and total bacterial counts in raw milk have been frequently reported in studies from the region, reflecting inadequate milking hygiene, subclinical mastitis, and deficient refrigeration practices (Santos, 2024; Sobreira et al., 2022)

These conditions not only compromise the safety of the final product but also negatively affect its technological and sensory properties, as high microbial loads in raw milk accelerate acidification, alter coagulation dynamics, and affect the final texture and flavor profile of the cheese (Camargo et al., 2021).

Conversely, studies have demonstrated that the systematic implementation of GMP guidelines, even in small-scale artisanal settings with limited technological infrastructure, can significantly reduce microbial contamination levels and improve product safety without compromising the sensory and cultural identity of traditional cheeses (de Albuquerque et al., 2024; Pineda et al., 2021)

In addition to baseline GMP requirements, the Hazard Analysis and Critical Control Points (HACCP) system represents an advanced quality assurance methodology that can be adapted and progressively implemented in artisanal production contexts.

The integration of GMP and HACCP principles into accessible technical guidance materials and training programs directed at artisanal producers represents a strategic approach to simultaneously improving food safety standards and preserving traditional production knowledge (Balieiro & Sá, 2022; Ibarra-Sánchez et al., 2026).

Despite the growing body of evidence supporting the effectiveness of GMP and microbiological monitoring in improving the safety of artisanal coalho cheese, several critical knowledge gaps remain.

There is a notable scarcity of longitudinal studies evaluating the long-term impact of GMP training interventions on the microbiological quality of artisanal coalho cheese in Sergipe, as most available studies employ cross-sectional designs that

capture only a single point in time.

Furthermore, the molecular epidemiology of foodborne pathogens circulating in artisanal dairy production environments in the state remains poorly characterized, limiting the understanding of transmission routes and the identification of persistent contamination reservoirs.

The absence of validated rapid detection methods specifically evaluated for use in artisanal cheese matrices under Northeastern Brazilian conditions represents an additional gap that constrains the practical applicability of advanced microbiological monitoring approaches in this context.

3.3 Technological aspects of artisanal curd cheese production

The manufacture of artisanal coalho cheese in the state of Sergipe is deeply embedded in the cultural and socioeconomic identity of the Northeastern Brazilian population, representing a traditional food production system in which empirical knowledge accumulated across generations serves as the primary technological reference for producers (Filho et al., 2024).

The technological strategy employed in the manufacture of this product encompasses a series of interdependent steps, including raw milk selection and handling, coagulation, cutting of the coagulum, syneresis, molding, pressing, salting, and ripening or fresh consumption (Rosario et al., 2023), each of which exerts a decisive influence on the physicochemical, microbiological, rheological, and sensory characteristics of the final product.

Understanding the scientific basis underlying each of these technological steps is essential for establishing quality standards, ensuring food safety, and creating regulatory pathways that allow the product to be legally commercialized while preserving its artisanal identity.

At the same time, the variability associated with artisanal processing conditions, such as milk composition, salt concentration, temperature control, and processing time, can lead to significant differences in product quality between producers and production batches (Queiroz et al., 2024).

Despite the substantial body of knowledge on the technological, physicochemical, and microbiological characterization of coalho cheese in Brazil, important gaps persist regarding artisanal production systems specific to Sergipe.

The absence of comprehensive surveys mapping the diversity of technological practices across the state's micro-regions, including the Agreste, Sertão, and coastal zones, limits understanding of the extent and sources of product variability and precludes the development of regionally differentiated quality standards.

Furthermore, the molecular characterization of the indigenous microbiota associated with artisanal coalho cheese production in Sergipe, including the identification of technologically beneficial strains with potential for use as defined starter or adjunct cultures, remains underexplored compared to the microbiota of coalho cheeses from other Northeastern states, such as Ceará and Pernambuco.

Future research perspectives in this field should prioritize the application of multi-omics approaches, including metagenomics, metabolomics, and proteomics, to comprehensively characterize the microbial diversity and biochemical transformation pathways operative in artisanal coalho cheese from Sergipe, generating knowledge that can support both technological innovation and the scientific valorization of traditional production knowledge.

The development of standardized technological protocols that codify and formalize empirical artisanal practices without suppressing their diversity represents another critical research need, as does the investigation of the relationship between specific production territories, environmental conditions, and product characteristics, with a view to establishing the scientific basis for a geographical indication for Sergipe coalho cheese.

The incorporation of emerging technologies such as near-infrared spectroscopy for rapid compositional analysis, time-temperature integrators for cold chain monitoring, and digital traceability systems into the artisanal production chain also constitutes a promising avenue for simultaneously improving quality assurance and reducing production costs in small-scale dairy operations in the state (Solberg et al., 2023; Tarapoulouzi et al., 2026).

3.4 Legislation and Geographical Indication for Coalho Artisanal Cheese in the state of Sergipe

Regulatory frameworks governing artisanal cheese production in Brazil have undergone significant evolution in recent years, with the enactment of legislation that establishes a legal pathway for the production and commercialization of artisanal cheeses made from raw milk.

The consolidation of this regulatory evolution represents a critical enabling condition for the formal integration of artisanal coalho cheese producers from Sergipe into regulated markets, creating the institutional basis for developing and sustaining quality assurance systems, geographical indications, and territorial valorization strategies.

Understanding the current legislative landscape and its implications for artisanal cheese production in Sergipe is therefore an essential dimension of any comprehensive review of the technological and productive strategy of this traditional product.

At the federal level, the primary regulatory instrument governing the production of artisanal cheeses in Brazil is Law No. 13,680, enacted in June 2018, which amended Law No. 1,283 of 1950 and established the conditions under which artisanal cheeses produced from raw milk by registered family producers may be inspected, certified, and commercialized across state lines.

Prior to this legislative change, the interstate commercialization of raw milk cheeses was effectively prohibited under Brazilian sanitary law, which required that all cheeses submitted to federal inspection be manufactured from pasteurized or thermized milk, thereby excluding artisanal products from broader markets and perpetuating the informality that historically characterized this production sector.

The enactment of Law No. 13,680/2018 thus represents a landmark regulatory achievement that formally recognizes the legitimacy of artisanal raw milk cheese production and establishes a legal framework within which producers can operate under official supervision while maintaining their traditional manufacturing practices.

At the state level, Sergipe has developed its own regulatory instruments for the inspection and certification of artisanal food products through the Serviço de Inspeção Estadual (SIE), which operates under the coordination of the state agricultural secretariat.

According to Law No. 6,967, of October 25, 2010, of the state of Sergipe, artisanal curd cheese is that produced with fresh, raw milk from cattle and buffalo, presenting a firm texture, characteristic color and flavor, in which it must have a uniform mass and be free of dyes and preservatives, and may or may not include mechanical holes.

State Law No. 8,523, of April 29, 2019, establishes specific regulations for the production and marketing of artisanal cheeses, including traditional and innovative varieties, in the state of Sergipe.

The state inspection system applies standards harmonized with federal requirements while accounting for regional productive realities, including the scale of production, the infrastructure available to family producers, and the traditional technological practices that define the identity of coalho cheese in Sergipe.

However, the effective operationalization of state inspection for artisanal dairy producers in Sergipe faces persistent challenges, including the limited number of trained inspectors and the geographical dispersion of production units across the state.

In addition to these factors, there are financial constraints for small producers seeking to regularize their operations, and the complexity of administrative compliance requirements relative to the organizational and educational capacity of family businesses. Aiming to overcome some of these limitations, artisanal products employ strategies sought after by consumers, such as linking empirical and technical knowledge using geographical indications.

The concept of Geographical Indication (GI) constitutes a powerful instrument of territorial valorization that can simultaneously protect the authenticity of traditional products, differentiate them in competitive markets, generate price premiums for producers, and stimulate rural economic development in production regions (Li et al., 2024).

In Brazil, GIs are regulated by Law No. 9,279/1996, the Industrial Property Law, and administered by the Instituto Nacional da Propriedade Industrial (INPI), which recognizes two modalities of geographical indication: the Indication of Origin (IO), which certifies that a product originates from a specific geographic area known for the production of a particular good, and the Appellation of Origin (AO), which additionally requires that the quality or characteristics of the product be essentially or exclusively attributable to the geographic environment, including natural and human factors, of the delimited production area (Thalib, 2025).

Both modalities are potentially applicable to artisanal coalho cheese from Sergipe, depending on the scientific evidence that can be marshaled to demonstrate the relationship between the territorial environment and the product's distinctive characteristics.

The valorization of artisanal coalho cheese through GI certification has potential implications that extend beyond market access and price differentiation. The formalization of production specifications within a GI framework incentivizes registered producers to adopt minimum quality and hygiene standards, thereby contributing to food safety objectives that are aligned with, rather than antagonistic to, the preservation of traditional practices (Almeida et al., 2021).

Furthermore, GI recognition can stimulate investment in local productive infrastructure, training programs, and research activities focused on the product and its territory, creating a virtuous cycle of quality improvement, market recognition (Li et al., 2025), and territorial development that benefits the entire artisanal dairy production chain in Sergipe.

Notwithstanding these opportunities, significant knowledge gaps and structural challenges constrain the advancement of both regulatory compliance and GI development for artisanal coalho cheese in Sergipe.

The absence of a formally constituted and legally recognized producers' organization with sufficient representativeness and governance capacity to serve as the GI titleholder represents a critical institutional gap that must be addressed before a formal GI application can be submitted to INPI. Additionally, the low levels of formal education and administrative capacity among many artisanal producers in the state create barriers to regulatory compliance and active participation in collective quality management systems, underscoring the need for targeted capacity-building interventions.

Future research and policy perspectives in this domain should prioritize the systematic mapping of coalho cheese production territories in Sergipe, including the delineation of micro-regions with distinct agro-ecological characteristics and production traditions that could serve as the geographic basis for differentiated GI applications.

4. Conclusion

The systematic implementation of Good Manufacturing Practices and microbiological monitoring programs has been identified as the most immediate and effective strategy to reduce contamination risks and improve product consistency. These tools need to be adapted to the specific socio-technical reality of artisanal producers and supported by ongoing capacity-building efforts.

The development of a geographical indication for Sergipe coalho cheese emerges as a strategic instrument for product

protection, cultural heritage recognition, and territorial valorization. However, its consolidation depends on the fulfillment of substantial scientific, institutional, and governance conditions that remain incompletely addressed.

Future investigations should prioritize longitudinal assessments of quality interventions, multi-omics characterization of the productive microbiota, and consumer perception studies regarding the sensory and cultural identity of this traditional product, thereby generating the evidence base necessary to support both technological innovation and the sustainable development of the artisanal dairy sector in the state.

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