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Microbiological risks in unauthorized artisanal goat cheesemaking in Coquimbo, Chile

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Abstract. Artisanal goat cheese production in Chile is an activity of great cultural and economic value to rural communities; however, the use of raw milk and the lack of sanitary controls can pose risks to public health. This study aimed to identify the sanitary risks associated with artisanal goat cheese production in facilities operating without official sanitary authorization in the Coquimbo Region, Chile, during 2024. An observational, descriptive, and cross-sectional study was conducted in ten artisanal cheese-making facilities. Samples of raw milk, fresh cheese, 30-day-ripened cheese, and water used during processing were collected and analyzed. Microbiological analyses included the detection and enumeration of Enterobacteriaceae, *Escherichia coli, Staphylococcus aureus,* and detection of *Salmonella* spp. in accordance with current Chilean sanitary regulations and national and international technical standards. In addition, production conditions were assessed through structured questionnaires and on-site inspections of infrastructure, milking practices, and cheese-making procedures. Seventy-five percent of the milk and cheese samples exceeded the microbiological limits established by national regulations. Eighty percent of producers failed to meet the microbiological criteria for *E. coli* and *S. aureus,* and *Salmonella* spp. was detected in 70% of the cheese samples. Although the water samples met microbiological quality standards and showed no fecal coliform contamination, widespread deficiencies were identified in hygiene practices, production infrastructure, and process control, as well as the absence of pasteurization and inadequate ripening. Overall, the evaluated artisanal goat cheese production system represents a significant public health risk, compromising both product safety and consumer health.

Key words: Foodborne diseases, Artisanal cheese, *Salmonella*, *Staphylococcus aureus, Escherichia coli*, Goat cheese.

Riesgos microbiológicos en la elaboración artesanal no autorizada de queso de cabra en Coquimbo, Chile.

Resumen. La elaboración artesanal de queso de cabra en Chile es una actividad de gran valor cultural y económico en las comunidades rurales. Sin embargo, el uso de leche cruda y la falta de controles sanitarios pueden generar riesgos para la salud pública. El objetivo de este estudio fue identificar los riesgos sanitarios asociados a la producción artesanal de queso de cabra en queserías que operan sin autorización sanitaria oficial en la Región de Coquimbo, Chile, durante el año 2024. Se realizó un estudio observacional, descriptivo y transversal en diez queserías artesanales. Se recolectaron y analizaron muestras de leche cruda, queso fresco y queso madurado durante 30 días, y agua utilizada durante el proceso. Los análisis microbiológicos incluyeron la detección y recuento de Enterobacterias, *Escherichia coli*, *Staphylococcus aureus* y la detección de *Salmonella* spp. de acuerdo con la normativa sanitaria chilena vigente y las normas técnicas nacionales e internacionales. Además, se evaluaron las condiciones de producción mediante encuestas estructuradas e inspecciones en terreno de la infraestructura, las prácticas de ordeña y

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los procedimientos de elaboración del queso. El 75% de las muestras de leche y queso superó los límites microbiológicos establecidos por la normativa nacional. El 80% de los productores incumplió los criterios para microbiológicos para *E. coli* y *S. aureus*, y *Salmonella* spp. se detectó en el 70% de las muestras de quesos. Aunque las muestras de agua cumplieron los estándares de calidad microbiológica y no presentaron contaminación por coliformes fecales, se identificaron deficiencias generalizadas en las prácticas de higiene, la infraestructura productiva y el control del proceso, además de la ausencia de pasteurización y una maduración inadecuada. En conjunto, el sistema de producción de queso de cabra evaluado representa un riesgo significativo para la salud pública, ya que compromete tanto la inocuidad del producto como la salud de los consumidores.

Palabras clave: Enfermedad transmitida por alimentos, Queso artesanal, *Salmonella, Staphylococcus aureus, Escherichia coli*, Queso de cabra.

INTRODUCTION

Foodborne diseases (FBDs) constitute one of the leading causes of morbidity and mortality in low-and middle-income countries (Ochoa-Avilés et al. 2024). In high-income countries, although mortality is lower, FBDs continue to impose a substantial public health and economic burden due to healthcare costs, productivity losses, and the implementation and monitoring of food safety policies (Fernández et al. 2021). Among foodborne illnesses, zoonotic infections remain a major concern, particularly those associated with protein-rich foods such as dairy products, which provide favorable conditions for the survival and growth of pathogenic microorganisms (FAO and WHO 2023). Fresh and ripened goat cheeses, particularly those produced from raw milk, have been identified as potential vehicles for foodborne pathogens and have been implicated in foodborne disease outbreaks worldwide (Erhardt et al. 2022; EFSA and ECDC 2023).

Chile is one of the main goat cheese-producing countries in South America, with the Coquimbo Region accounting for approximately 53% of the national goat population (INE 2020). Consequently, goat milk production and artisanal cheese-making represent economically and culturally important activities in this region. Despite this economic and cultural significance, artisanal goat cheese is predominantly produced by small-scale producers using traditional processing methods. Limited sanitary infrastructure, restricted access to processing technologies, and inadequate implementation of Good Manufacturing Practices (GMP) may increase the risk of microbiological contamination and compromise food safety (Teherán-López et al. 2023).

Goat milk production is highly seasonal, concentrated in spring and summer in line with the goats' reproductive cycle (FIA 2009). Artisanal goat cheese is typically a fresh cheese with little or no ripening, usually shaped into cylindrical or rectangular forms, hand-salted, and occasionally flavored with local herbs. Traditional production involves manual milking, milk filtration through cotton cloths, coagulation using natural or commercial rennet, and whey drainage in homemade molds. Although these practices preserve the cultural and heritage value of artisanal goat cheese, they also pose challenges regarding hygiene, traceability, and access to appropriate processing technologies (Erhardt et al. 2022).

To minimize these risks, Chilean legislation establishes specific sanitary requirements for artisanal cheese production. According to the Chilean Food Sanitary Regulation (Reglamento Sanitario de los Alimentos, RSA; D.S. No. 977/1996), the production, processing, packaging, storage, distribution, and commercialization of cheese must comply with current regulations and with the technical guidelines for artisanal cheese production approved by the Ministry of Health (MINSAL 2024).

In Title V, Article 173 of the RSA establishes microbiological limits for fresh cheeses (MINSAL 2024). To ensure product safety, the manufacturing process must include hygienic milking, rapid cooling of the milk, and pasteurization if the milk is not used immediately. Likewise, the cheese processing facilities must have adequate infrastructure, such as sufficient lighting, washable surfaces, separate work areas, a changing room, and sanitary services. Utensils must be made of stainless steel, and personnel must wear appropriate sanitary clothing (Pineda et al. 2021).

Contamination of raw materials, inadequate storage conditions, deficiencies during transportation, and the indigenous microbiota of milk favor the proliferation of pathogenic microorganisms such as *S. aureus, Salmonella* spp., and *Listeria monocytogenes*, the principal causative agents of FBDs, which are a major public health concern worldwide (Alfonso-Vargas et al. 2024). Accordingly, artisanal goat cheese produced from raw milk under inadequate hygienic conditions may act as a vehicle for foodborne pathogens in Chile. Therefore, this study aimed to identify the sanitary risks associated with artisanal goat cheese production in unauthorized facilities located in the Choapa and Limarí provinces of the Coquimbo Region during 2024.

MATERIALS AND METHODS

Study design and sample selection. An observational, descriptive, and cross-sectional study was conducted involving ten small-scale Creole goat producers without sanitary authorization located in the Choapa and Limarí provinces of the Coquimbo Region, northern Chile. This semi-arid region is characterized by extensive and semi-intensive goat production systems, where goat farming constitutes one of the main traditional agricultural activities and an important source of income for rural families. The selected farms operated under semi-intensive production systems, in which goats grazed on natural rangelands and received supplementary feeding during periods of low forage availability. Cheese production was

carried out using traditional artisanal methods, including manual milking, milk filtration, coagulation with natural or commercial rennet, molding, manual salting, and the production of either fresh cheese or cheese ripened for approximately 30 days. Cheese-making facilities located in Canela, Ovalle, Monte Patria, Punitaqui, and Combarbalá (Figure 1) were evaluated, focusing on food safety factors related to handling practices and bacterial contamination of the final product. For laboratory analysis, samples of raw milk, cheeses at different stages of maturation, and water used in the production process were collected.

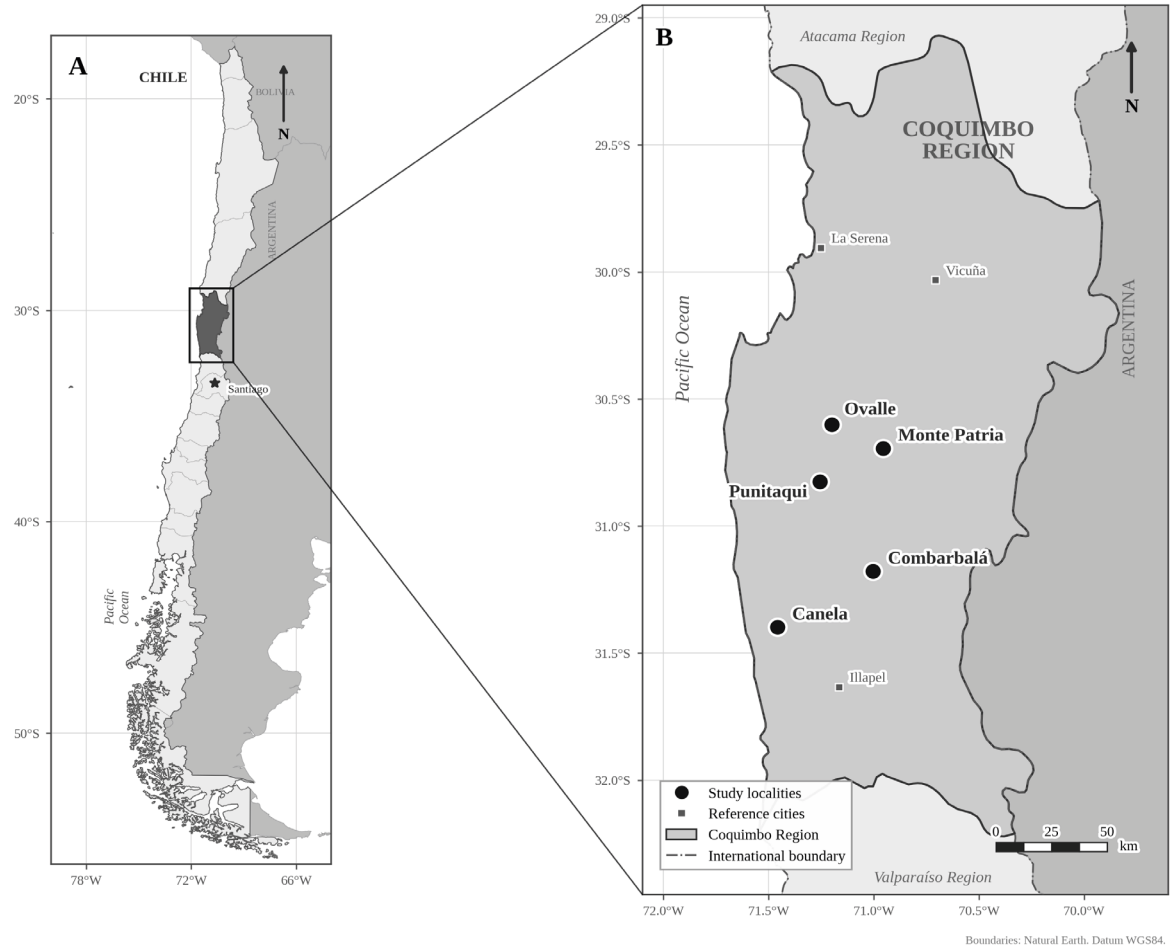


Figure 1. Study localities in the Coquimbo Region, Chile. Map created using QGIS version 4.0

Sample collection protocol. Sampling focused on three critical stages of the production process: the raw material, the finished product, and the water used during production. All samples were collected and transported the same day to the Las Cardas laboratory of the Centro de Estudios de Zonas Áridas (Center for Arid Zone Studies, CEZA) of the University of Chile, maintaining the cold chain at 4–8 °C (Figure 2). Raw milk samples (200ml) were collected directly after milking at ten different collection points, one per producer (n = 10). Likewise, two 100 g cheese samples were collected from each producer: one of fresh cheese and one of cheese ripened for 30 days (n = 20). Finally, ten 100 mL water samples were collected directly from the taps of the processing facilities, using sterile containers to prevent cross-contamination.

Microbiological analysis. All samples were processed at the CEZA laboratory, located in the commune of Ovalle, Coquimbo Region, within 6 h of collection.

Microbiological analyses were performed using standardized methods for the detection and enumeration of microorganisms in dairy products. Raw milk samples were analyzed directly, whereas cheese samples were homogenized before analysis. *Escherichia coli, Salmonella* spp., and *S. aureus* were detected and enumerated according to Chilean standards harmonized with International Organization for Standardization (ISO) (NCh-ISO): methods: ISO 16649-2, ISO 6579-1, and ISO 6888-1, respectively. Water samples were analyzed for fecal coliforms using the Most Probable Number (MPN) method.

Evaluation of manufacturing practices. A detailed inspection of the facilities of the selected producers was carried out to evaluate the hygiene and cheese-handling practices. The following data collection instruments were used:

1.-Structured questionnaire. A questionnaire was administered to each producer (Table Appendices) to collect information on personal hygiene practices, equipment used, product storage conditions, raw milk handling, and knowledge of GMP.

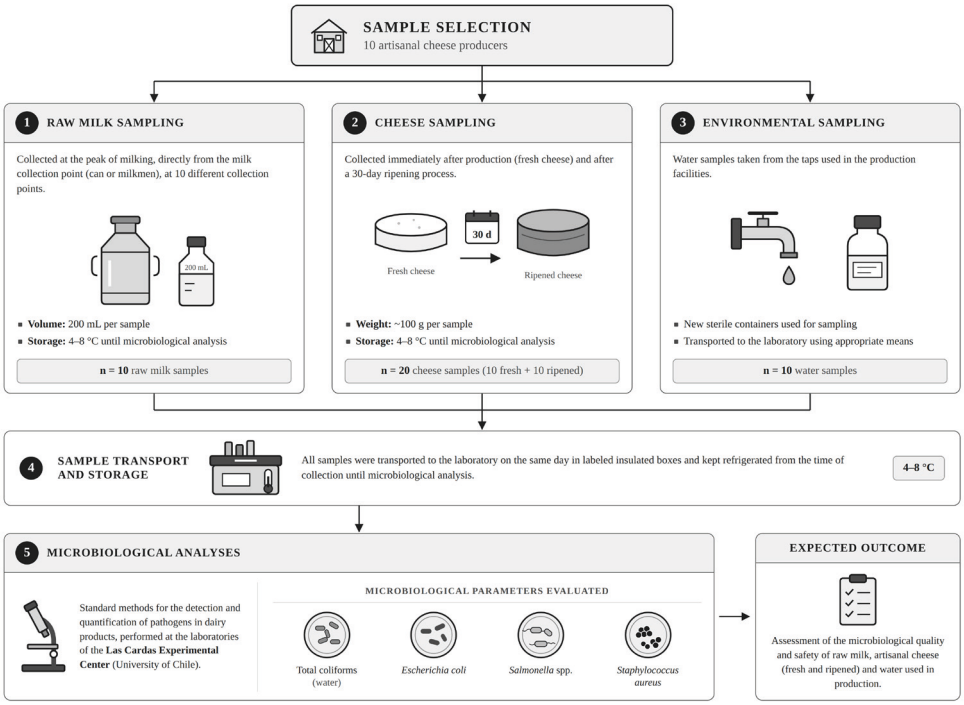


Figure 2. Sample collection procedure for the microbiological analysis of artisanal goat cheese, including the collection of raw milk, cheese samples at different stages of maturation, and water samples. Source: Authors' own work.

Table 1. Criteria for assessing good manufacturing practices and animal welfare in artisanal goat cheese production.

Category	Assessment criteria
Milking infrastructure	Availability of a dedicated milking parlor, adequate lighting and ventilation, presence of a milking platform, and use of mechanical milking equipment.
Milking procedures	Hand hygiene of milkers, use of dedicated clothing, segregation of sick animals, teat cleaning and drying, foremilk stripping, disposal of abnormal milk, California Mastitis Test (CMT), proper milking technique, immediate milk cooling or processing, post-milking teat dipping, and milk filtration.
Milking hygiene	Cleaning and disinfection of milk containers, utensils, equipment, and the milking area, as well as the implementation of cleaning, disinfection, and pest control programs.
Cheese processing infrastructure	Availability of a dedicated cheese processing room, washable floors and walls, footbath at the entrance, a designated processing area, appropriate ripening conditions, a changing room, a wastewater disposal system, and a potable water supply.
Cheese processing procedures	Personal hygiene of cheesemakers, use of dedicated protective clothing, milk pasteurization or cheese ripening for ≥30 days, appropriate use of rennet, restriction of unauthorized personnel from processing areas, and product packaging and labeling in accordance with current regulations.
Animal welfare	Animal handling during herding and post-milking resting conditions.

Note: The assessment checklist was developed based on the requirements established in the Chilean Food Sanitary Regulation (RSA; D.S. No. 977/1996) and the Technical Guidelines for Artisanal Cheese Production issued by the Chilean Ministry of Health (MINSAL 2024).

2.-Visual inspection. During the production process, direct observations were carried out and documented using standardized field data sheets to assess processing conditions, milk and cheese handling practices, the use of equipment and utensils and the hygienic status of food-contact surfaces. These observations were combined with the information obtained from the questionnaire administered to each producer for subsequent analysis.

Ethical implications. The study did not involve any manipulation of individuals. Participant anonymity was safeguarded, all participants provided informed consent, and data collection was limited to the minimum necessary, with transparent reporting of the results.

RESULTS

Fecal coliforms in water and microbial agents in goat milk and cheese. No fecal coliforms were detected in the water samples collected from the ten artisanal goat cheese producers. Raw milk and cheese samples were subsequently analyzed for Enterobacteriaceae, *E. coli,* and *S. aureus* (Figure 3), and for *Salmonella* spp. (Table 2). *Salmonella* spp. was detected in seven of the ten producers (70%; Table 2).

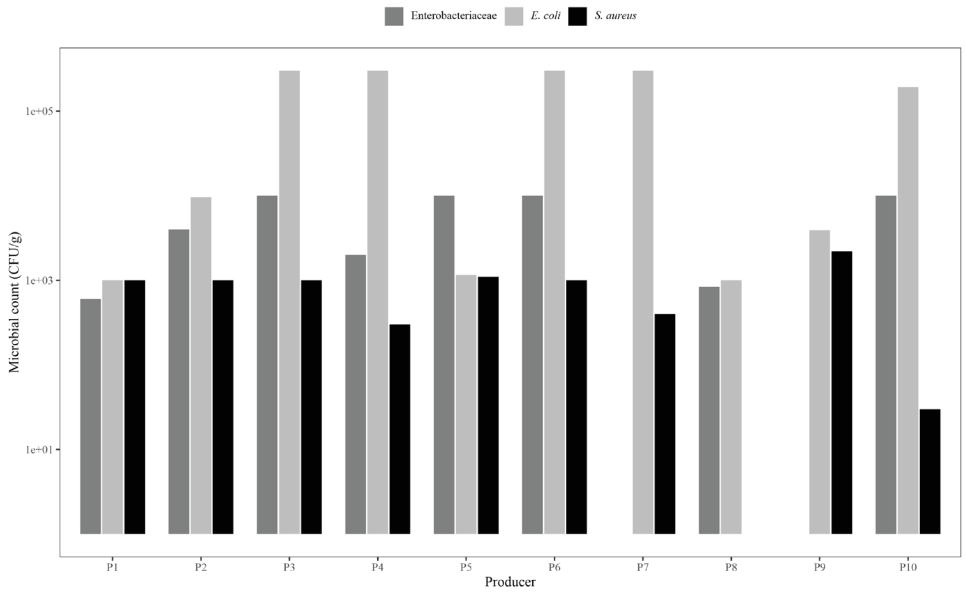


Figure 3. Microbial counts, expressed as colony-forming units per gram (CFU/g), in artisanal goat cheese samples collected from producers in the Coquimbo Region, Chile. Source: Prepared by the authors using R version 4.5.1.

Table 2. Presence/absence of *Salmonella* spp. in artisanal goat cheese samples from producers in the Coquimbo Region, Chile.

Producer	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Salmonella spp	+	+	-	+	+	+	+	-	-	+

Note: Results indicate the presence (+) or absence (-) of *Salmonella* spp. colonies in 25 g of sample.

Microbiological results for raw milk and artisanal goat cheese samples were interpreted according to the microbiological criteria of the RSA (D.S. No. 977/1996, Ministry of Health of Chile), and each sample was classified as "complies" or "does not comply" with current regulatory limits. CFU/g: colony-forming units per gram. Source: Culture and microbiological analyses performed at CEZA, University of Chile.

Characterization of hygienic and sanitary conditions of cheese production. The results regarding manufacturing practices (Table 3) showed a low level of implementation of good milking and cheese-making practices among producers. The main deficiencies were related to milking and cheese-processing processing infrastructure and to the implementation of hygiene measures, including hand washing, the use of dedicated clothing, cleaning and drying of teats, post-milking teat dipping, and the California Mastitis Test (CMT), all with compliance rates <30%. During cheese production, significant shortcomings were also identified in the availability of potable water, sewage systems, and processing and ripening rooms, as well as the absence of pasteurization, traceability, and control of access by unauthorized personnel. In contrast, the practices with the highest compliance rates were the separation of sick animals and the discarding of their milk, the exclusion of milk showing alterations compatible with mastitis, and the minimization of residual milk during milking, all with 100% compliance. The use of clean containers (80%) and approved rennet (80%) also showed relatively high compliance.

Table 3. Compliance with production, hygiene, animal health, and welfare practices among artisanal goat cheese producers.

Evaluation criterion	Average compliance (%)	Main observations
Milking infrastructure	27	Limited availability of dedicated milking parlors and mechanical milking equipment.
Milking hygiene	37	Low compliance with hand hygiene, teat preparation, and post-milking teat disinfection.
Equipment hygiene	58	Acceptable cleaning of containers was observed, but pest control programs were largely absent.
Processing infrastructure	24	Limited availability of dedicated processing rooms, potable water, and sewage systems.
Good manufacturing practices	34	Low implementation of hygiene measures, pasteurization, traceability, and biosecurity practices.
Animal welfare	50	Deficiencies were observed mainly during animal herding and handling.
Animal health management	70	High compliance with the separation of sick animals, but limited use of the California Mastitis Test (CMT).

DISCUSSION

The results of microbiological cultures showed that the water used to prepare artisanal goat cheese contained no fecal coliforms, which suggests that the water source is relatively safe, although it does not come from regulated systems. However, the milk and cheese analyses revealed significant non-compliance with the RSA (MINSAL 2024). The presence of Enterobacteriaceae, *S. aureus*, *Salmonella* spp., and *E. coli* is evidence of cross-contamination associated with inadequate handling practices during production (Ribeiro et al. 2024). The results revealed deficiencies across the different stages of the cheese-making process, from milking to ripening, indicating a low level of compliance with GMP (Erhardt et al. 2022). These findings are of particular importance, as goat cheese production is a traditional and long-established activity in the Coquimbo Region, supplying both household consumption and local markets in nearby urban centers (Arancibia-Flores et al. 2022).

Of the total producers evaluated, 75% exceeded the acceptable levels of Enterobacteriaceae, and 80% exceeded the permitted limits for *E. coli* and *S. aureus*. Additionally, 70% had positive cultures for *Salmonella* spp., one of the most relevant zoonotic pathogens, responsible for foodborne outbreaks worldwide and in Chile (FAO and WHO 2023). Salmonellosis primarily affects vulnerable groups, such as newborns, children, the elderly, and immunocompromised individuals, causing fever, abdominal pain, diarrhea, nausea, and vomiting 6 to 72 hours after ingestion, with symptoms lasting up to a week. Transmission occurs via the fecal-oral route, through direct contact with infected animals or through contaminated foods such as raw milk (WHO 2018). In Chile, between 2011 and 2021, *Salmonella* spp. accounted for 32% of confirmed foodborne illnesses (4,858 cases), and between 2016 and 2021 these cases were mainly related to prepared foods, including goat cheeses. During 2024, 66 cases of food poisoning associated with the consumption of goat cheese were reported (Riquelme Retamal 2025).

E. coli is a bacterium that is part of the intestinal microbiota of healthy animals; therefore, its detection in raw milk and/or fresh cheese constitutes an indicator of fecal contamination and poor hygiene practices during production. Within this species, Shiga toxin-producing strains (STEC) are especially relevant to public health because they are the main cause of hemolytic uremic syndrome (HUS) in children, and ruminants are one of their main reservoirs (Vargas-Salas and Toro 2023). Eighty percent of the producers exhibited *E. coli* levels exceeding the regulatory limits. This finding is consistent with the hygienic practices observed during cheese production, particularly the inadequate cleaning and disinfection of equipment and utensils, as only 50% of the producers performed these procedures immediately after processing. Collectively, these deficiencies may have contributed to the microbial contamination of the final product. In addition, the use of unpasteurized milk has been associated with a higher frequency of *E. coli* isolation, suggesting that pasteurization could substantially reduce the risk of contamination by this microorganism (Pereira et al. 2024).

This contamination can also originate during milking owing to the absence of handwashing protocols before and after milking, which allows microorganisms to be transferred to raw milk. Additionally, extensive reuse of water during processing was observed, which increases the risk of cross-contamination and compromises the safety of the final product (Balatti and Saparrat 2025).

S. aureus can cause subclinical mastitis in livestock, in which there are no visible clinical signs or changes in the milk. This bacterium can produce toxins that cause food poisoning in humans, and an estimated 30% of the human population carries it (Vargas-Salas and Toro 2023). The detection of *S. aureus* in 80% of the producers suggests post-milking cross-contamination and possible subclinical mastitis in the herds, a situation aggravated by the absence of periodic veterinary controls. Information on the occurrence and enteropathogenicity. The enteropathogenicity of these strains is fundamental for assessing risk and understanding the spread and distribution of isolated cases (Yuan et al. 2022). Studies conducted in Mozambique cheese factories have reported a high presence of *S. aureus* throughout artisanal cheese production, with up to 80% of samples testing positive, which is concerning because these cheeses are consumed directly without further heat treatment (Nhatsave et al. 2021).

The detection of *Salmonella* spp. and *E. coli* suggests direct fecal contamination, probably associated with milking practices lacking biosecurity measures, contact with free-roaming animals, or the presence of vectors such as flies (Yuan et al. 2022). The presence of Enterobacteriaceae also suggests deficiencies in the cleaning and replacement of utensils, such as the sponges and cloths used to filter the milk. More broadly, rural poverty and food systems are shaped by political economy, natural resources, and rural connectivity. Structural transformation implies a shift from economies based on primary production toward manufacturing and services, which changes food systems and could improve rural well-being (Woodhill et al. 2022).

The main limitation of this study is that *L. monocytogenes*, one of the major foodborne pathogens associated with goat cheese consumption, was not analyzed (EFSA and ECDC 2023; FAO and WHO 2023). Not assessing this pathogen limits a more comprehensive characterization of the microbiological risk and the animal health implications associated with contamination of artisanal goat cheese. In addition, this study did not include the microbiological analysis of utensils and equipment used during the cheese-making process. These surfaces may act as reservoirs of pathogenic microorganisms and promote cross-contamination, contributing to the persistence and dissemination of bacteria and yeasts (dos Santos Vieira et al. 2025). Consequently, the absence of this evaluation may have led to an underestimation of the microbial load and the health risk associated with the cheese production process. Therefore, future studies should include the detection of *L. monocytogenes* together with the microbiological assessment of food-contact surfaces, utensils, and processing equipment. Such studies would provide a more robust assessment of the microbiological hazard associated with artisanal goat cheese produced in the Coquimbo Region, thereby supporting evidence-based surveillance,

risk management, and public health protection.

The findings of this study suggest that inadequate milking and cheese-making practices are the main drivers of microbiological contamination in artisanal goat cheese, thereby increasing the risk of foodborne diseases. The recurrent detection of *E. coli, Salmonella* spp., and *S. aureus*, despite the adequate microbiological quality of the water used, suggests that contamination primarily originates from poor hygienic handling, inadequate infrastructure, and the absence of GMP. These risks are further exacerbated by structural constraints affecting small-scale producers, including limited infrastructure, insufficient technical training, and restricted access to veterinary services. Together with the limitations identified in this study, these findings underscore the need for further experimental research to better characterize the microbiological risks associated with artisanal goat cheese production and to support the development of evidence-based strategies that enhance food safety and the sustainability of artisanal goat farming in the Coquimbo Region.

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CRediT authorship contribution statement. Conceptualization: LLA, IBD, ECK; Methodology: LLA, IBD; Investigation: LLA; Data curation: LLA, TC; Formal analysis: IBD, ECK; Supervision: IBD; Writing - original draft: LLA, IBD; Writing - review and editing: all authors.

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REFERENCES

1. Alfonso-Vargas N, Aguilera-Becerra A, Jaimes-Bernal C, Pulido-Medellín M, Mosso-Arias J. Caracterización microbiológica de queso fresco artesanal distribuido en la Hoya del Río Suárez, Colombia. *Duazary: Revista de la Facultad de Ciencias de la Salud*. 2024; 21(1): 7-18. https://doi.org/10.21676/2389783X.5534
2. Arancibia-Flores M, Jorquera-Reyes N, Chacana-Ojeda M. Uso del análisis conjunto para estimar preferencias de consumo de leche de cabra en polvo en la Región de Coquimbo Chile. *Rev. Vértice Univ*. 2022; 24(93). https://doi.org/10.36792/rvu.v93i93.60
3. Balatti PA, Saparrat MCN. Los microorganismos y su rol en la producción agrícola. Editorial de la Universidad Nacional de la Plata (EDULP), colección Libros de Cátedra. 2025; Capítulo 8, pp: 161. https://doi.org/10.35537/10915/183350
4. dos Santos Vieira EC, Rabelo Evas ML, de Sousa Costa D, Machado Guimarães M, Alves Caldas JM, Pereira GJ, dos Santos de Jesus G, Mara Teles A, Chaves Bezerra NP, de Carvalho Neta AV. Microorganismos patogênicos em queijo de cabra artesanal: uma revisão sobre a segurança de alimentos no estado do Maranhão. In: Estudos Multidisciplinares em microbiologia: teoria e prática – volume 3. Editora Científica Digital. 2025; Cap 7. https://doi.org/10.37885/251020507
5. EFSA, ECDC (European Food Safety Authority, European Centre for Disease Prevention and Control). The European Union One Health 2022 zoonoses report. *EFSA Journal*. 2023; 21(12): e8442. https://doi.org/10.2903/j.efsa.2023.8442
6. Erhardt MM, Fröder H, de Castro Oliveira W, Ströher JA, Savergnini PR, dos Santos VZ, dos Santos Richards NS. Physicochemical and microbiological evaluation of artisan cheeses from raw milk and verification of good practices in rural properties in the Taquari Valley-RS. Res Soc Dev. 2022; 11(13): e253111335290. https://doi.org/10.33448/rsd-v11i13.35290
7. FAO, WHO (Food and Agriculture Organization of the United Nations, World Health Organization). Food safety aspects of raw milk cheeses. 2023. https://www.fao.org/newsroom/detail/fao-who-46th-session-of-the-codex-alimentarius-commission-adopts-new-standards/en
8. Fernández S, Marcía J, Bu J, Baca Y, Chavez V, Montoya H, Varela I, Cardona JR, Lagos S, Areche FO. Enfermedades transmitidas por alimentos (ETAs); una alerta para el consumidor. *Cien Lat Rev Cient Multidiscip*. 2021; 5(2): 2284-2298. https://doi.org/10.37811/cl_rcm.v5i2.433
9. FIA (Fundación para la Innovación Agraria). Resultados y lecciones en producción de queso de cabra con fermentos lácticos locales: proyecto de Innovación en Regiones de Coquimbo y Metropolitana. Santiago: FIA. 2009. 31 p. (Serie Experiencias de Innovación para el Emprendimiento Agrario; 100). URL: https://bibliotecadigital.fia.cl/handle/20500.11944/145597
10. INE. Agricultural and Forestry Census of Chile. National Institute of Statistics. 2020. Chile. Accessed June 29, 2025. URL: http://www.ine.cl
11. MINSAL (Ministry of Health). Food Sanitary Regulation, latest update. 2024. Chile. Accessed June 17, 2025. URL: https://www.minsal.cl/wp-content/uploads/2015/10/DECRETO_977_96_actualizado_-mayo-2024.pdf
12. Nhatsave N, Garrine M, Messa A, Jr, Massinga AJ, Cossa A, Vaz R, Ombi A, Zimba TF, Alfredo H, Mandomando I, Tchamo C. Molecular Characterization of *Staphylococcus aureus* Isolated from Raw Milk Samples of Dairy Cows in Manhiça District, Southern Mozambique. *Microorganisms*. 2021; 9(8): 1684. https://doi.org/10.3390/microorganisms9081684
13. Ochoa-Avilés A, Escandón S, Ochoa-Avilés C, Heredia-Andino O, Ortiz-Ulloa J. Incidencia de las enfermedades transmitidas por alimentos en Ecuador. *Rev Peru Med Exp Salud Publica*. 2024; 41(3): 273-280. https://doi.org/10.17843/rpmesp.2024.413.13456
14. Pereira IA, Finger RM, da Silva JR, de Freitas KB. Hygienic-sanitary quality in family farm goat milk

production. *Braz J Anim Environ Res*. 2024; 7(4): e73776. https://doi.org/10.34188/bjaerv7n4-021

15. Pineda A, Campos G, Filho N, Gombossy de Melo Franco B, Pinto U. Brazilian artisanal cheeses: Diversity, microbiological safety, and challenges for the sector. *Front Microbiol.* 2021; 12: 666922. https://doi.org/10.3389/fmicb.2021.666922
16. Ribeiro NL, Furtado DA, Chiodi JE, Mascarenhas NM, de Sousa Silva R, Rodrigues RC, Farias BJ, de Sousa Nobre R, Arruda TR, de Figueiredo CF, Porto Filho JM. Quality of native goat's milk from a multivariate perspective. *Food Sci Technol*. 2024; 44: e00305. https://doi.org/10.5327/fst.00305
17. Riquelme Retamal VH. Prevalencia y distribución de *Salmonella* spp. y *Listeria monocytogenes* en alimentos analizados en Chile entre los años 2015 y 2021 [Tesis de pregrado, Universidad de Chile]. Repositorio de la Universidad de Chile. 2025. http://repositorio.uchile.cl/handle/2250/204972
18. Teherán-López G, Palma-Parra C, Fonseca-Correa L, Gamba-Castillo C, Ocampo-Henao D, Torres-Beltrán H. Conceptos, métodos y procedimientos en el procesamiento de leches fermentadas. Servicio Nacional de Aprendizaje (SENA), Bogotá, Colombia. 2023. https://repositorio.sena.edu.co/bitstream/handle/11404/8346/Conceptos_metodos_procesamiento_leches.pdf?sequence=1&isAllowed=y
19. Vargas-Salas M, Toro M. Microbiological safety of dairy products. 2023. Chile. URL: https://consorciolechero.cl/libro-capitulo/LNS_SI_C5_Inocuidad.pdf
20. WHO (World Health Organization). *Salmonella* (no tifoidea). 2018. Accessed August 15, 2025, URL: https://www.who.int/es/news-room/fact-sheets/detail/salmonella-(non-typhoidal)
21. Woodhill J, Kishore A, Njuki J, Jones K, Hasnain S. Sistemas alimentarios y bienestar rural: desafíos y oportunidades. *Food Sec*. 2022; 14(5): 1099-1121. https://doi.org/10.1007/s12571-021-01217-0
22. Yuan H, Han S, Zhang S, Xue Y, Zhang Y, Lu H, Wang S. Microbial Properties of Raw Milk throughout the Year and Their Relationships to Quality Parameters. *Foods*. 2022; 11(19): 3077. https://doi.org/10.3390/foods11193077

APPENDICES

Questionnaire administered to producers

Tabulation of the cheese-making evaluation checklist

Cheese-making evaluation checklist

Mark each criterion with an "X" to indicate whether it is met. Provide observations to specify the criterion and/or justify the response when "No" or "N/A" is selected.

	Criterion	Complies		
		Yes	No	N/A
Infrastructure	An exclusive cheese-making room is available.			
	Walls and floors are made of materials that can be easily cleaned.			
	A footbath is available and used at the entrance to the processing room.			
	The cheese-making room is used exclusively for cheese production, with no eating, smoking, financial transactions, or other unrelated activities.			
	Cheese ripening is carried out under conditions that prevent contamination.			
	A changing room is available before entering the cheese-making room.			
	A sewage disposal system is available.			
	Potable water is available.			
Cheese-making procedure	The cheesemaker washes and scrubs their hands and forearms before entering and after leaving the processing room, after using the restroom, and after handling contaminated materials.			
	The cheesemaker does not wear jewelry, keeps fingernails short, clean, and free of nail polish.			
	The cheesemaker wears clean trousers, a jacket, a white cap, a face mask, and rubber gloves.			
	Milk is pasteurized and/or the cheese is ripened for at least 30 days before commercialization.			
	Commercial rennet is used according to the manufacturer's recommendations.			
	Access by unauthorized persons to the processing area is prevented. If entry is necessary, appropriate preventive measures, such as personal hygiene and protective clothing, are implemented.			
	The product is packaged and labeled with the manufacturer's name, sanitary authorization number, production date, expiration date, ingredients, and storage instructions.			