REVIEW
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Serrano Cheese: a cultural, quality and legal view

Queijo serrano: uma visão cultural, de qualidade e legal

Angelo Nardi Pretto[I]
Voltaire Sant'Anna*

ABSTRACT

Introduction: Serrano cheese is an artisanal product, from the region of *Campos de Cima da Serra* in the state of *Rio Grande do Sul* and from the *Planalto Sul* in the state of *Santa Catarina*. **Objective:** The objective of the present work is to discuss some cultural, legal and food safety aspects related to the quality of serrano cheese, a product made of raw milk. **Method:** This manuscript carries out a bibliographical review of the serrano cheese, using updated scientific and legal documents, to analyze the production, quality and cultural aspects of this product. **Results:** Results presented in the literature and current legislation indicate that the production of these cheeses can be safe for commercialization, having as main requirements: adoption of good manufacturing practices, care of the dairy herd and due maturation of the product. Current national legislation indicates that the minimum maturation time should be 60 days. The publication of a law that regulates the production of serrano cheese in *Rio Grande do Sul* allows it to be matured for a shorter time, if its microbiological safety is assured. **Conclusions:** Additionally to revisions in the laws for the production and marketing of cheeses such as serrano, legal reviews are essential in the area of science, technology and health surveillance to provide a scientific basis to the improvement of the production of those who live on the commercialization of these products.

KEYWORDS: Serrano Cheese; Raw Milk; Quality; Food Safety; Sanitary Surveillance

RESUMO

Introdução: Queijo serrano é o produto artesanal, originário da região dos Campos de Cima da Serra no Rio Grande do Sul e do Planalto Sul Catarinense. **Objetivo:** Discutir alguns aspectos relacionados à qualidade do queijo serrano, produto produzido com leite cru, a partir de uma visão sobre seus aspectos culturais, legais e de segurança do alimento. **Método:** O presente manuscrito se propõe a realizar uma revisão bibliográfica da produção de queijo serrano, utilizando documentos científicos e legais atualizados, para realizar uma análise da produção, qualidade e de aspectos culturais desse produto. **Resultados:** Resultados apresentados na literatura e as legislações vigentes indicam que a produção desses queijos pode se mostrar segura para comercialização, havendo como principais requisitos a adoção de Boas Práticas de Fabricação, os cuidados com o rebanho leiteiro e a devida maturação do produto. A legislação nacional atual indica que o tempo de maturação mínimo deve ser de 60 dias. A publicação da lei que regulamenta a produção de queijo serrano no Rio Grande do Sul permite que ele seja maturado por menor tempo, desde que assegurada a sua segurança microbiológica. **Conclusões:** Estudos técnicos em ciência, tecnologia e vigilância sanitária e constante revisões das leis são essenciais para fomentar o contínuo desenvolvimento e aprimoramento da produção daqueles que vivem da comercialização desses produtos.

PALAVRAS-CHAVE: Queijo Serrano; Leite Cru; Qualidade; Segurança dos Alimentos; Vigilância Sanitária

[I] Universidade Estadual do Rio Grande do Sul (UERGS), São Francisco de Paula, RS, Brasil

* **E-mail:** voltaire-santanna@uergs.edu.br

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INTRODUCTION

Serrano cheese is an artisanal product from the regions of Campos de Cima da Serra, in the state of Rio Grande do Sul (RS), and Planalto Sul, in the state of Santa Catarina (SC), Brazil. This cheese is obtained through the coagulation of unpasteurized milk, and the main producing municipalities are Bom Jesus, Cambará do Sul, Jaquirana, São Francisco de Paula and São José dos Ausentes. The production of serrano cheese dates back to the colonization of these regions, over 200 years ago, and the production process has not changed much since then. This type of cheese is produced from the milk of beef cattle raised in native pastures, especially in spring and summer, when the grass is green and rich in nutrients[1].

Artisanal cheeses are frequently handled and, therefore, subject to contamination, especially of microbiological origin. These conditions may be worsened in the case of products obtained from unpasteurized milk, so there has been much debate on this type of product. Several studies on the microbiological quality of artisanal cheeses have found important pathogenic bacteria in these products at the point of sale. Some of these bacteria include *Listeria monocytogenes*[2,3], *Escherichia coli*[4], *Staphylococcus aureus*[3,5] etc.

The concept of food quality is changing, signaling a quality turn, based inter alia on the construction and reproduction of short and decentralized chains linking food production and consumption[6]. In the case of food production, the quality of the products must take account of their cultural, social and environmental aspects as well[7]. In the particular case of serrano cheese, studies indicate that it is a food item with cultural characteristics in RS, with environmental importance for the region of Campos de Cima da Serra, and that it can be safe for human consumption, even though it is produced from raw milk[8,9,10], which leads several researchers to question the adequacy of its production to the law[3,11,12,13]. Although current legislation regulates the production of traditional cheeses made from raw milk[14,15,16,17,18], there are still questions about how safe it is to consume these products[2,3,5]. In this sense, in current scientific literature we can find references with a unilateral view: either social[1,11,12,13] or microbiological[2,3,10],. This fact demonstrates the need for a wide discussion on artisanal cheeses from a quality perspective. In this sense, the use of science and technology applied to the social issues of food production becomes very important for the marketing of artisanal and/traditional products that can be safe for the population.

Thus, the objective of the present work was to carry out an integrative review in order to reflect on the current production and marketing of artisanal cheese, with focus on its cultural and historical importance, its microbiological quality and the legal requirements in Brazil.

METHOD

The work was carried out as a bibliographical review on serrano artisanal cheese in Brazil, based on the legislation and updated scientific documents. We analyzed the production, quality and cultural aspects of cheeses produced from raw milk, with focus on serrano cheese. To that end, we searched the following databases: Portal de Periódicos da Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Capes), Scientific Electronic Library (SciELO), Scopus and Web of Science, with the following keywords: *queijo serrano, queijo leite cru*, raw milk cheese, inactivation pathogen raw milk cheese. We also searched for information in books, current legislation and websites of research institutions for theses and dissertations on the subject. The search in a broad source of bases aimed at a comprehensive discussion on the subject.

The search took place between March 2016 and February 2017. The criteria for inclusion and exclusion of materials were: complete articles published in indexed journals as of the year 2000 and *stricto sensu* postgraduate theses and dissertations recognized by Capes. Concerning the legislation, we considered all the laws in force that relate to the production of raw milk cheese.

RESULTS AND DISCUSSION

Serrano cheese

The region of Campos de Cima da Serra is located in the northeast of the state of RS. It also covers the southern part of the Santa Catarina Plateau. Its colonization dates back to the 18th century, when the first farmsteads were established through the donation of land. At that time, the region of Campos de Cima da Serra was characterized by the trade routes of drovers that took products from the South to be marketed in Southeastern Brazil[7,12]. Taking advantage of the local geographic characteristics of altitude fields, the productive activity was concentrated on beef cattle, and the families' livelihood depended on the combination of this activity with others to ensure the economic and social reproduction of the family[11]. Animals fed on the natural pastures of native fields give the product unique organoleptic characteristics (color, aroma, taste and appearance), with specific characteristics that distinguish this cheese from the other cheeses produced in the region[12]. That is the context where the serrano cheese production process was established. In the 19th century, this product was taken to other regions on the back of mules and used as bargaining chip for the acquisition of goods not produced on the farms[7,11]. The cheese production process was passed on from generation to generation, and the know-how was perpetuated over time, without major modifications, thus establishing its century-old tradition[12,13]. For the same reason, these products have variations in their production process and, consequently, they are often not uniform[12]. Additionally, since it is made from beef cattle milk, serrano cheese is preferably produced in summer and spring. Cruz[7], when analyzing serrano cheese producers in the southern part of the Campos de Cima da Serra region, reported that the production of the artisanal cheese begins with a well-kept and healthy herd and vaccines against foot-and-mouth disease and brucellosis. Tuberculosis control is done through the allergic tuberculin intradermal cervical test. Milking is preferably performed at dawn, since, according to producers' reports, it is important that, after

milking, cows feed on the pasture still wet with dew. Milk is then filtered and the rennet is added thereto.

The milk product must be heated to achieve greater efficiency in the coagulation process. It should be noted that the milk is not pasteurized or thermally treated for inactivation of bacteria. To keep it warm, producers put blankets around the tanks to keep the milk warm and make the coagulation process more effective. Then, the curd is cut so that whey is drained. At this step of the process, hot water may be added to the mass to help withdraw the whey, but this must be done carefully to avoid cooking the curd. Thereafter, the mass is put into the molds and pressed for complete separation of the whey, thus rendering it more or less solid and firm, with a clear shape and good commercial appearance[1,13]. Finally, the cheese is ripened. This stage is characterized by determining the flavor, aroma, texture and other characteristics of each type of cheese. In general, serrano cheese is marketed with 15 to 30 days of ripening, when the product is semi-hard, with intense flavor and yellowish color[1,7]. These procedures are in accordance with the law, which rules that the production must use milk coagulated by enzymatic rennet and a mass whose whey has been removed (the mass can be cooked) and ripened[14].

Since in this region serrano cheese is produced on farms, it is usually made on small scale: each family produces about 4-8 kilos of cheese in one day, which represents 40-80 liters of milk to be processed. There are currently about 2,500 to 3,000 family farms producing serrano[1,13], with an estimated annual production of 700 tons[11]. Because of the production characteristics, the merchandising of serrano by the farmers becomes a secondary activity: beef cattle is their main source of income1. The money earned with the cheese is reserved for monthly household expenses[11,12]. Even so, from the perspective of small farms, this economic activity is an important source of income.

Still, because it is strongly associated with cattle raising and management, the production of serrano contributes to the maintenance of the way of life of rural families1 and may represent an important tool to encourage young people to stay in the countryside through rural succession.

Moreover, insofar as it concerns social issues in the production of serrano, the process of cheese production after milking is predominantly a female domain. Only when women cannot take care of it is the activity performed by men[7]. This characteristic attaches value to females as workers and income generators for the families, a pressing matter in today's society.

As important as the social and economic role of this cheese is the environmental role it plays in the conservation of the vegetation and the landscape of the Campos de Cima da Serra. The fact that the production of serrano cheese uses beef cattle milk and native pastures makes producers committed to preserving the environment that supplies their raw material. Thus, it can be said about this product that the triad of sustainability is complete in every sense[7,12].

Legislation

Brazilian legislation for the production and marketing of milk and its derivatives began in 1950, through Law 1.283 of December 18[15]. The regulation began in 1952, through the Regulation of Industrial and Sanitary Inspection of Products of Animal Origin (RIISPOA)[16]. The production and marketing of raw milk cheese have been widely discussed recently, so the law was updated in 2017. Decree 9.013 of March 29, 2017, regulated Law 1.283 of December 18, 1950, and Law 7.889 of November 23, 1989, among other revisions, brought a new wording on the production of artisanal cheeses. This regulation recognizes "dairy farm" (*queijaria)* as the establishment located on a farm destined to the production of traditional cheeses with specific characteristics and elaborated exclusively with milk of the farm's own production. As regards the ripening period, it states that milk used in the preparation of cheeses that undergo a ripening process at a temperature of more than 5°C for a period of no less than 60 days is free of the pasteurization obligation. It also rules that this ripening period may be altered according to conclusive scientific studies on the safety of the product[17,18]. In the state of Rio Grande do Sul, Law 14.973 of December 29, 2016, regulated the production of artisanal serrano cheese[14]. The law establishes that artisanal cheese is the product obtained from the coagulation of raw whole milk, from healthy cattle, ripened and manufactured in micro dairy farms located in the mountain region of RS, comprising the municipalities of André da Rocha, Bom Jesus, Cambará do Sul, Campestre da Serra, Capão Bonito do Sul, Caxias do Sul, Esmeralda, Ipê, Jaquirana, Lagoa Vermelha, Monte Alegre dos Campos, Muitos Capões, Pinhal da Serra, São Francisco de Paula, São José dos Ausentes and Vacaria. According to the state regulation, the product must be manufactured from the milk of the farm itself and must not be added with preservatives[14].

A controversial point today is the ripening time of these cheeses. Cruz e Menasche1 verified that serrano cheese is ripened for 15 to 30 days. Today, cheese can only be made of raw milk if it is ripened at a temperature higher than 5°C for a period of no less than 60 days. This period may be reduced if conclusive scientific studies attest to the safety of the cheese[17,18]. For serrano artisanal cheese, ripening should occur at a temperature higher than 10°C, for a period long enough to produce the biochemical changes that are necessary to ensure the safety and physico-chemical characteristics of the product[14]. Cheeses in the process of ripening must be clearly and precisely identified as to their origin and control of the ripening period[14].

A third point of debate on the production of serrano cheese is Ordinance 368 of September 4, 1997, of the Ministry of Agriculture, Livestock Farming and Supply[19]. It rules that establishments that produce products of animal origin must fulfill hygienic-sanitary requirements of Good Manufacturing Practices (GMP). For this, among other conditions, these facilities, irrespective of their scale of production, must have walls covered in smooth, impermeable, light-colored and easily sanitized materials. Utensils and equipment must be in good condition (no corrosion or cracks), be made of non-toxic, smooth, washable and impermeable material. However, the marketing of serrano cheese is done on a small

scale, usually by family farmers, in places that do not fit hygienic-sanitary conditions under prevailing legislation, mainly because of wood material and utensils[7]. Cruz e Menasche1 pointed out that few farmers have the economic conditions to invest in new equipment and build structures to meet hygiene standards, so they are subject to fines and seizures by surveillance agencies. The discussion that ensues is that the laws in force are based on large-scale production systems, focused on technologies and controls to increase productivity and guarantee the distribution of food in large quantities[7]. Despite this discussion[1,7,12,13], the production of safe food must fulfill hygienic-sanitary requirements in their facilities, equipment and handling procedures according to the law. Therefore, the quality control of food produced through GMP and the guarantee of herd health are essential. The support of trained professionals that are able to perform such activities to ensure all health aspects of food production is an important point in the production and marketing of food.

Microbiological quality

The production of cheeses in Brazil must comply with the microbiological standards established by the General Technical Regulation for the Fixation of Microbiological Requirements of Cheeses20. Specifically in the case of cheeses made from raw milk, microbiological standards are shown in Table[18].

Carmo et al.5 identified that samples of artisanal minas cheeses in Brazil had enterotoxin-producing strains of *S. aureus*, which was reported as an alert for public health. Still in the same region, studies indicated that artisanal cheeses from the region of Minas Gerais (MG) were not compliant with the count of *E. coli*, coliforms at 35°C and *S. aureus*, although they were not contaminated with *Salmonella* sp. or *Listeria* sp.[4]. Similar results were found by Fava et al.[20] when analyzing the microbiological quality of colonial artisanal cheeses in RS. Pinto et al.21 evaluated the quality of artisanal minas cheeses in the state of Minas Gerais and verified that some samples were contaminated by *E. coli* and *S. aureus*. Similar problems are found abroad. Ombarak et al.[22] found that cheeses produced from raw milk were highly contaminated with *E. coli*, including potentially pathogenic strains; Dominguez et al.[23] found products contaminated with *Salmonella* Montevideo in France and Bille et al.[24] found *L. monocytogenes* in cheeses from Switzerland.

The cheese ripening process causes biochemical modifications such as proteolysis and lipolysis, leading to cheeses with various flavors and textures[25,26,27]. These modifications are intimately linked to substances produced by the microbiota present in the product, mainly lactic acid bacteria. Among the substances produced by lactic bacteria during ripening are those with antimicrobial properties, such as organic acids and bacteriocins, which decisively help control the growth of deteriorating and pathogenic microorganisms in cheeses. In the ripening of cheese made from raw milk, there are strong reductions in moisture and pH, and an increase in the concentration of sodium chloride, particularities that favor the control of undesirable bacteria and contribute to the permanence of desirable microorganisms that are responsible for imparting flavor, color and texture to cheeses[27].

Lactic bacteria are part of the natural microbiota of milk and play a decisive role in the process of manufacturing cheeses made from raw milk. The biodiversity of these microorganisms is related to the conditions of milk production, region, climate, herd feeding, resulting in variable product-to-product microbiotas, but which provide cheeses with particular characteristics from region to region[26,27,28].

Specific studies on serrano artisanal cheese are not found in recent literature, particularly about the influence of the ripening time on the microbiological, sensory and physico-chemical quality of the product. Regarding artisanal minas cheese, Dores[29] remarked that ripening is an important step in the cheese-making process: it is responsible for the reduction of undesirable microbiota and is a practice that should be widely adopted by artisanal cheese producers. The 22-day ripening period of the artisanal minas cheese helps reduce aerobic mesophiles, fecal coliforms, *E. coli, S. aureus*. For Sales[28], the ripening period of Araxá's artisanal minas cheese directly influences the behavior of the microbiota, since it presented a reduction in the undesirable microbial counts, indicating the time of 14 days as sufficient for the ripening of this type of product.

Callon et al.[30] remarked that the biodiversity of lactic acid bacteria in cheese made from raw milk presented 41 strains of lactic acid bacteria, including *Lactococcus lactis, Lactococcus garrigues, Leuconostoc pseudomesenteroides, Leuconostoc citreum, Lactobacillus sp, Carnobacterium mobile, Enterococcus faecalis, Enterococcus faecium, Macrococcus caseolyticus*, which exhibited antagonist activity against *E. coli* O26:H11 and O157:H7. Furthermore, the study showed that the development of these bacteria did not impair the sensory quality of the cheese[30]. The work of Carafa et al.[9] also pointed out that the native biodiversity of raw milk cheeses has great potential for use in improving quality in food processing technology. Bellio et al.[31] remarked that the counts of artificially inoculated *L. monocytogenes* and *S. aureus* decreased during the ripening of cheese produced from raw milk. Shrestha et al.[32] reported the importance of lactic bacteria in ripened cheeses in the growth and survival of *L. monocytogenes* due to their competition with the pathogens in the food. Souza et al.[10], when analyzing the ripening time of cheeses produced from raw milk, observed the influence in the microbiota of

Table. Limits for microorganism count in the production and marketing of cheese from raw milk[18].

Parameter	Coliforms at 35°C	Coliforms at 45°C	*Staphylococci* positive	*Salmonella* sp.	*Listeria monocytogenes*
Maximum limit	$5x10^3$ UFC/g	$5x10^2$ UFC/g	10^3 UFC/g	Absence in 25 g	Absence in 25 g

UFC/g: Colony-Forming Units per gram.

artisanal cheeses and that the product must ripen for at least 30 days so that the microbiota is stabilized. The authors also remarked that lactic bacteria are the main group of microorganisms in the product, and the high concentration of bacteria of the *Lactobacillus* genus plays an important role in cheeses produced from raw milk. Despite the use of raw milk and the use of low cheese-cooking temperatures, *Listeria* spp., *S. aureus* and clostridium spores were not detected in any of the cheese samples. This result was closely related to the presence of lactic acid bacteria strains[9]. An important factor during cheese ripening is the temperature at which the process occurs. Higher temperatures may reduce the ripening time of cheeses, but may also lead to undesired, deteriorating or pathogenic microbiota growth. Thus, the ripening temperature is a factor that must be carefully chosen33. In this sense, Souza et al.[10] remarked that cheeses made from raw milk had a smaller reduction of the microbial load of fecal coliforms, total coliforms and molds and yeasts during the winter, since the lower room temperature hinders the growth of lactic bacteria, which are mainly mesophilic microorganisms (with optimum growth at temperatures in the range of 25-35°C)[34].

Scientific studies for the validation of the ripening process of this class of cheese over a wide temperature range should be carried out, especially considering the growth of pathogenic and beneficial microbial counts, which may be different and influence the maintenance period of the food in the ripening chamber. It should be noted that the update of RIISPOA[17] establishes that cheeses should be ripened at temperatures above 5°C. In the state of RS, the current legislation allows ripening at temperatures higher than 10º C[14].

Considerations of cultural, legal and microbiological aspects

Traditional food production practices that value people's traditional know-how have been gaining importance, because they create products with organoleptic characteristics that are different from those of products made on large scale[7,13]. However, although it is an agri-food system involving environmental and cultural aspects[11], the production of serrano cheese must guarantee the safety of the products as well. Pinto et al.[21] related their negative results in the quality of artisanal minas cheeses to the lack of GMP in the units producing the items analyzed. Yoon et al.[35] also related the quality of cheeses made from raw milk to GMP, with ripening being a tool to control undesirable microorganisms. The reduction of moisture, the concentration of salt and the increase in the acidity of the product, which occur in the product during this period, contribute to its adaptation to food safety standards. GMP are procedures that must be adopted with the purpose of guaranteeing the hygienic-sanitary quality of food. To ensure these conditions, Standard Operating Procedures, with details on equipment hygiene, handlers' health, water potability, among others, are important documents to be adopted. These documents, in addition to legal requirements, are simple practices that can be deployed even in small enterprises like most cheese-producing initiatives.

The ripening process is a critical period that must be complied with in the production process, since there is a reduction of the deteriorating and pathogenic microbial load in the product[35]. Lempk[4] also noted that the cheeses analyzed in their study showed a high variation in physico-chemical parameters, demonstrating the need for standardization in cheese production. This can significantly influence the production process and product quality. In this sense, studies on the manufacture of serrano cheeses should be critically applied, since regulations rule that this product should have a ripening time of 60 days[14,17,28], but it is marketed after 30 days on average[7].

The food culture of a population and region must be valued. However, public health safety should be preserved and placed first. The implementation and deployment of GMP and good milking practices is essential for obtaining safe products, besides controlling the ripening process. Moreover, the legalization of agribusinesses that process this type of product is important for the sanitary safety of food. With the regularization of these businesses, young people can be encouraged to stay in rural areas, because this activity gives them a source of legal income and value to their productive system. Therefore, that can be a tool for this national problem, subject to much debate today.

CONCLUSIONS

Artisanal cheese is a historic and cultural heritage of the Campos de Cima da Serra region. In addition to its social and economic importance, artisanal serrano cheese plays an environmental role in the conservation of the vegetation and landscape of the Campos de Cima da Serra.

The safe production of artisanal serrano cheese is possible, even from raw milk, as long as there is hygienic-sanitary control of the herd and production process. The information presented in this review indicates that artisanal producers must adapt to some technological developments and include GMP techniques in the traditional process. They should also care for and pay attention to the health of the herd through tuberculosis and brucellosis-free certificates, and also by implementing a mastitis control program, good milking practices, in addition to chlorination and control of potable water.

Although it presents a differentiated agri-food system, this family farming sector must guarantee microbiological quality conditions for the food consumed by the population in order to guarantee the safety of the products marketed to the population. Scientific works that seek the convergence of public health, taking into account the know-how, quality and legal aspects of artisanal products, are essential for these food producing sectors. Regarding the adequacy of serrano cheese-producing facilities to GMP - an aspect that is widely questioned today - we highlight that it is essential that farmers comply with the existing laws. Finally, bringing scientific methodologies closer to the production of serrano cheese, combined with agricultural extension, is of paramount importance in farmers' training and education in quality food production.

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Conflict of Interest

The authors certify they have no potential conflict of interest with peers and institutions, nor any political or financial conflicts in this study.