









Characterization of the Suero Costeño (Sour Cream) producing units of the department of Córdoba-Colombia

Caracterización de las unidades productoras de Suero Costeño (Sour Cream) del departamento de Córdoba-Colombia

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Abstract

Introduction: the project was executed in four agroecological regions of Córdoba, which are responsible for the highest levels of milk production and processing of derivatives in this department. Suero Costeño, a fermented milk product, is traditionally produced and consumed on the Colombian Atlantic Coast. However, there is a lack of documented information available on the characteristics of the processing units and their production process.

Objectives: the objective of the research was to characterize the production units of Suero Costeño in the department of Córdoba in Colombia.

Methodology: a comprehensive survey was conducted to assess the life stories, productive activity, and implementation of Good Manufacturing Practices (GMP) in 96 establishments producing Suero Costeño. These establishments were selected from four distinct agroecological regions of Córdoba: Sinú Medio, Centro, Bajo Sinú, and Sabanas.

Results: suero Costeño is produced by small-scale producers using two distinct production processes. The first process involves the spontaneous fermentation of milk, fat or both. The second process utilizes whey from the cheese factory. Most of the production units (78.8%) exhibit substandard hygienic conditions and demonstrate deficiencies in the implementation of Good Manufacturing Practice (GMP), with an unacceptable rating of (29.4%).

Conclusions: the artisanal production of Suero Costeño is carried out in establishments with deficient hygienic and sanitary conditions. Therefore, the implementation of quality and safety systems is required to improve the production process and compliance with GMP, in order to obtain a safe product with optimum quality.

Keywords: Agro-industrial Chain, Characterization, Good Manufacturing Practices, Suero Costeño.

Resumen

Introducción: el proyecto se llevó a cabo en cuatro regiones agroecológicas de Córdoba, las cuales concentran la mayor producción de leche y elaboración de derivados de este departamento. El Suero Costeño es un producto lácteo fermentado, que se elabora y consume tradicionalmente en la Costa Atlántica colombiana, pero no se dispone de información documentada acerca de las características de las unidades de transformación y de su proceso de elaboración.

Objetivos: el objetivo de la investigación fue la caracterización de las unidades de producción de Suero Costeño del departamento de Córdoba en Colombia.

Metodología: se realizaron encuestas sobre las historias de vida, la actividad productiva y la implementación de las Buenas Prácticas de Manufactura (BPM) en 96 establecimientos productores de Suero Costeño de cuatro (4) regiones agroecológicas de Córdoba (Sinú Medio, Centro, Bajo Sinú y Sabanas).

Resultados: el Suero Costeño lo elaboran artesanalmente pequeños productores, mediante dos procesos de producción, uno que fermenta espontáneamente leche, grasa o ambas, y otro que aprovecha el lactosuero de quesería. La mayoría de las unidades de producción (78,8%) presentan deficientes condiciones higiénicas y fallas en la implementación de las BPM, con una calificación no aceptable (29,4%).

Conclusiones: la producción artesanal de Suero Costeño se realiza en establecimientos con deficientes condiciones higiénicas y sanitarias, por lo que se requiere la implementación de sistemas de calidad e inocuidad, para mejorar el proceso de elaboración y el cumplimiento de las BPM, y así obtener un producto inocuo y con calidad óptima.

Palabras clave: Buenas Prácticas de Manufactura, Cadena Agroindustrial, Caracterización, Suero Costeño.

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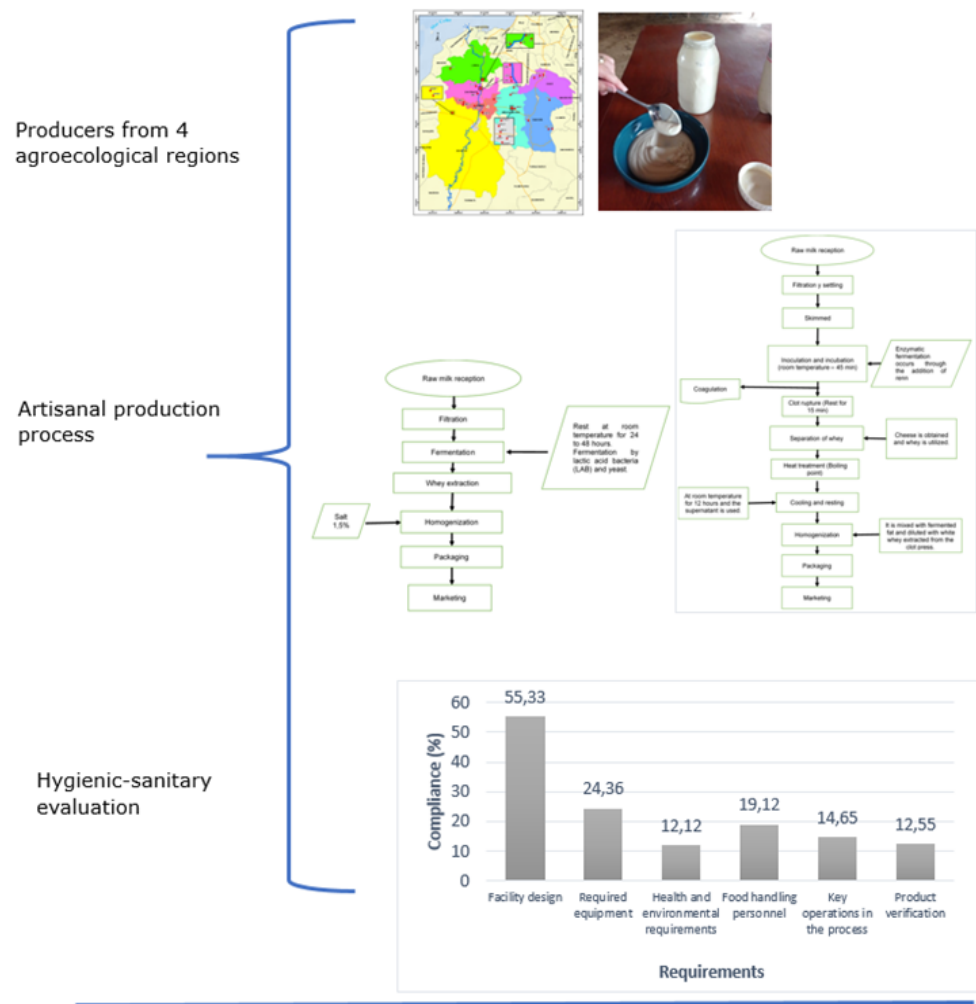
Spanish version



Why was this study conducted?
The research was conducted to document the first objective of the Minciencias-funded research project “Development of a roadmap for linking to the origin of Suero Costeño: a strategy for strengthening dairy producers in the department of Córdoba (Colombia)”- Funding contract 80740-902-2020, which refers to the sociocultural and productive characterization of the coastal whey production process in Córdoba.

What were the most relevant findings?
Suero Costeño is produced by small-scale producers using two distinct production processes, the first process involves the spontaneous fermentation of milk, fat or both, and the second process utilizes whey from the cheese factory.
The artisanal production of Suero Costeño is carried out in establishments with deficient hygienic and sanitary conditions.

What do these findings contribute?
The findings provide evidence of poor sanitary conditions in Suero Costeño production units in Córdoba and of the need to implement quality and safety systems to improve the manufacturing process and compliance with GMPs, thereby obtaining a safe product of optimal quality.



Production of Suero Costeño in Córdoba, Colombia

Introduction

The dairy production chain in Colombia is a complex system made up of six links: suppliers of goods and services, cattle farms, collection centers, processing units, marketers and consumers; where the basic product is the production of milk, from cattle of specialized or dual-purpose systems(1–3). The Department of Córdoba, located in the Colombian Caribbean region, is characterized by the production of milk under the dual-purpose system, in addition, within its production chain, among other actors, is the industry that transforms the raw material into various dairy derivatives, including Suero Costeño (4).

Suero Costeño is a fermented dairy product from the Colombian Caribbean coast, considered one of the most important traditionally made (5,6). It is produced by hand in rural areas of Córdoba, Sucre, Bolívar, in the lower Cauca of Antioquia and some municipalities of Santanderes; it has positioned itself as a gastronomic heritage of Colombia (7) and is consumed as a spreadable food at meals (8).

Suero Costeño is made with cow's milk, it has a thick viscous consistency due to the concentration of total solids, mainly protein and fat, as a result of lactic coagulation; in addition, salt is added to enhance its flavor (9,10). The origin and quality of the milk can affect the quality of the final product, but to a greater extent the production practices, equipment and utensils used, can have an impact on fermentation (11). Temperature is the factor that most influences the growth of microorganisms and together with the adequate concentration of inoculum, they allow us to obtain a product of good quality and great acceptance (5).

In the fermentation process of the product, two phases are formed, a solid one consisting of the Suero Costeño and a liquid phase – whey (5), the sensory attributes of flavor, aroma and texture are developed, in addition, the nutritional and functional characteristics are enhanced (12,13). The microbial consortium that acts in this process, ferments lactose and produces lactic acid (14), with the consequent enhancement of the established sensory properties, the improvement of consistency and the increase of the shelf life of the product, due to the reduction of pathogenic microorganisms (12,13)(14)(15).

In the literature it is found that various authors have addressed the physicochemical and nutritional value of Suero Costeño (6,9,16–17), the rheological characterization (10,17), the microbiological quality, the isolation and identification of the microorganisms responsible for fermentation, (8,15,17–20) as well as the kinetic and spontaneous fermentation studies of the product (5,7,21–23); but no interdisciplinary research has been carried out that addresses the description of the artisanal production system, the assessment of the hygienic and sanitary conditions of preparation to verify compliance with regulatory provisions in the production of food for human consumption; as well as collective narratives and the life stories of artisanal producers, which allow building a memory of the knowledge transmitted through generations.

Taking into account the importance of this product in the economy and gastronomic culture of Córdoba and the Caribbean region, as well as the approach by different authors in various descriptive aspects of the product, the characterization of the productive units of Suero Costeño in the department of Córdoba was proposed, in order to describe the production conditions and

compliance with Good Manufacturing Practices that allow improving the quality of the product.

Methodology

Study Area

The research is descriptive; the population was made up of Suero Costeño producers from four agroecological regions of the department of Córdoba: Bajo Sinú, Centro, Sinú Medio and Sabanas (Figure 1); who were selected because they provide more than 40% of the milk produced in the department and the production of Suero Costeño is outstanding. 96 productive units of Suero Costeño were selected, through a probabilistic sampling of the census of dairy processors of the Secretariat of Economic Development of Córdoba.

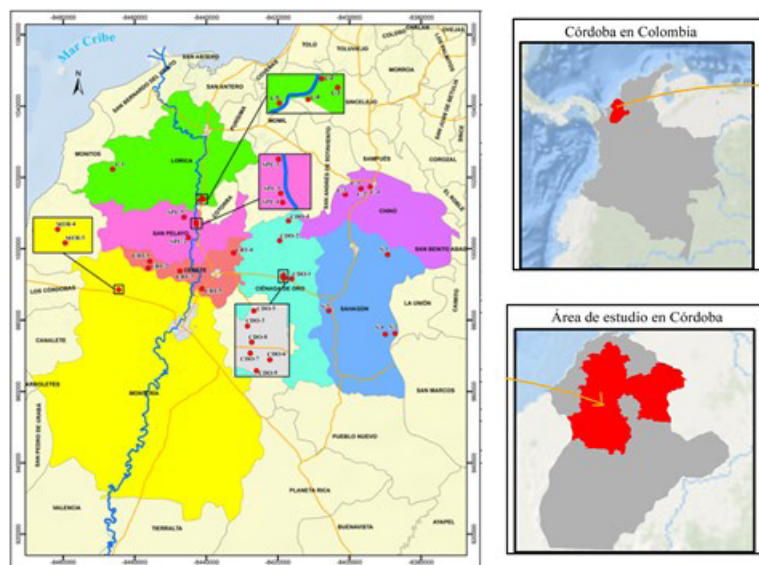


Figure 1. Georeferencing map of Suero Costeño producers in Córdoba. Source: Authors

Data collection

Observation visits and personalized interviews were carried out in the 96 selected establishments, using two tools: Life Stories (Profile of the small producer) and Collective Narratives for the definition of the productive activity of the product. Traditional knowledge was asked about the typical production of the spread, collecting information on the physical and human resources used in daily practices, in addition to the knowledge related to them, as well as the traditions learned from their ancestors. This evidence was collected through photographic and audiovisual evidence with prior signing of informed consent [\(24\)](#).

The sanitary diagnosis was carried out in 32 production units that voluntarily accepted the use of the checklist of the IVC-INS-FM 114 Invima document (version 5 of 2021) for sanitary verification with a risk approach in food factories, governed by Resolution 2674 of 2013 and Decree 616 of 2006. The instrument for capturing the information covered the parameters to determine the implementation of GMP in the production units, including the analysis of the location, facilities, process conditions and food handling personnel. Six (6) blocks of variables were evaluated with the

following safety risk weights: Facility Design (20%), Required Equipment (15%), Sanitary and Environmental Requirements (20%), Food Handling Personnel (10%), Key Process Operations (20%) and Product Verification (15%); In each block, weighted sub-criteria were evaluated, with a maximum compliance sum of 100.

Statistical analysis

The data obtained were cleaned, organized and tabulated in a spreadsheet. The analysis of the information was carried out using descriptive statistics, calculating the means and standard deviation for the continuous variables and the frequency for the categorical variables, using the Microsoft Excel statistical program.

Results

Description of the Suero Costeño Producer

According to the results of the life stories tool (Table 1) most (63.2%) are small producers who do not have university or technical studies, they belong to socioeconomic stratum 1 (74.7%), in addition, the production of Suero Costeño has been developed in a traditional way for more than five years (79%) as a job opportunity. There is a balanced participation by gender among producers, also the majority indicate that their source of financing is their own business resources (72.6%), others have inherited assets (10.5%) and to a lesser degree the economic support comes from salaries.

Table 1. Characteristics of the Suero Costeño Producers of Cordoba-Colombia

Feature	Variable	Quantity, %
Gender	Male	51,6
	Female	48,4
	Other	0,0
Socioeconomic status	1	74,7
	2	8,4
	3	3,2
	NS/NR	13,7
Profession of the head of the family	Small producers without another profession	63,2
	Technician	20
	University	7,4
	NS/NR	9,4
Main source of income	Business/Investments	72,6
	Inheritance	10,5
	Wage	8,4
	Several	2,1
	NS/NR	6,4
Accommodation conditions	Sanitary, large space and no amenities	53,7
	Sanitary and without ample space	19
	Deficiencies in sanitary conditions	14,7
	Sanitary facilities with luxuries	2,1
	NS/NR	10,5
Time in productive activity	< 5 years	19
	> 5 years	79
	NS/NR	2
Source of knowledge	Family	73,7
	Friends	11,6
	Empirical	11,6
	Several	3,1
Learning Place	Córdoba	98
	Other departments	2
Associativity	Yes	1
	No	99

Ns/Nr: does not know or does not respond

Most of the respondents do not belong to producer guilds (99%), they learned the trade of making Suero Costeño directly from a family member (73.7%); In addition, production is carried out in establishments with poor hygienic conditions and following a process that has been passed down through generations.

Description of Suero Costeño Production

Most of the production of artisanal Suero Costeño is carried out in family business units, and according to the information obtained from the surveys, an average of 3000 liters of milk per day from the local milk production system must be processed, and they produce an approximate volume of 835 liters of Suero Costeño. The milk is processed in the facilities, which are usually physical spaces that are shared with their home, and between 1 and 3 people are involved in the activity. The processed product is marketed in local points of sale or distributed directly or through intermediaries, in stores and in points of sale of typical products in the municipalities of the department of Córdoba.

The municipalities with the highest milk processing are Ciénaga de Oro, Lorica and Chinú, together processing more than 18,000 liters per day (Table 2). All of these volumes of milk are not used to make Suero Costeño, since in some production units Suero Costeño is made from the use of whey, a by-product of cheese production. Most producers (76.8%) buy milk from local suppliers and only 23.2% (16 production units) process the milk they produce.

Table 2. Suero Costeño Production in Cordoba-Colombia

Agroecological Region	Municipality	Milk volume (L)	Suero Costeño Volume (L)
Bajo Sinú	Lorica	5423	3146
	Chinú	4181	163
Sabanas	Sahagún	610	58
	Cereté	1425	1425
Sinú Medio	San Pelayo	315	23
	Ciénaga de Oro	8505	518
Centro	Montería	510	510

In the four agroecological regions, the product is obtained from two production methods; one where it is fermented spontaneously (milk, fat, whey), or the combination of one of these (Figure 2) in plastic containers or in dry totumos (*Crescentia cujete*). The process begins by adding the milk in the fermentation container and then it is palced at room temperature so that the process can be carried out spontaneously; as the totumo is a porous material and the plastic container is in constant use, they can preserve microorganisms from previous processes. Fermentation is completed in an average time of 24 to 48 hours, but it can vary according to the manufacturer’s considerations or environmental conditions.

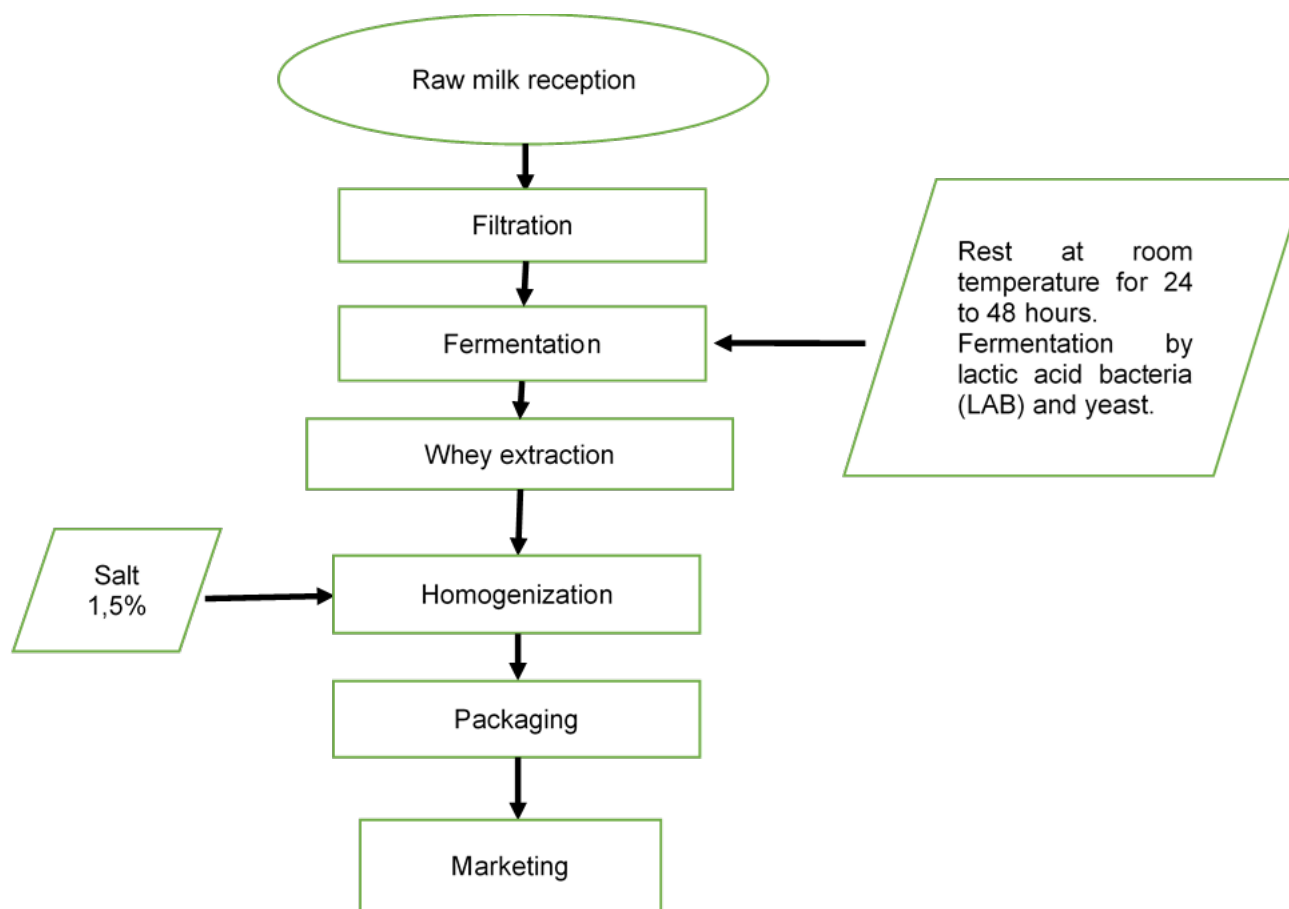


Figure 2. Preparation of Suero Costeño by spontaneous fermentation

The other form of production only takes advantage of the whey from the cheese factory, heating it in metal containers to form a clot, which is then extracted, salt is added, it is stored and marketed (Figure 3). In general, the production of Suero Costeño is carried out in places with deficient physical facilities, using rudimentary containers and tools, with no control of acidity, pH, temperature and no information recording systems.

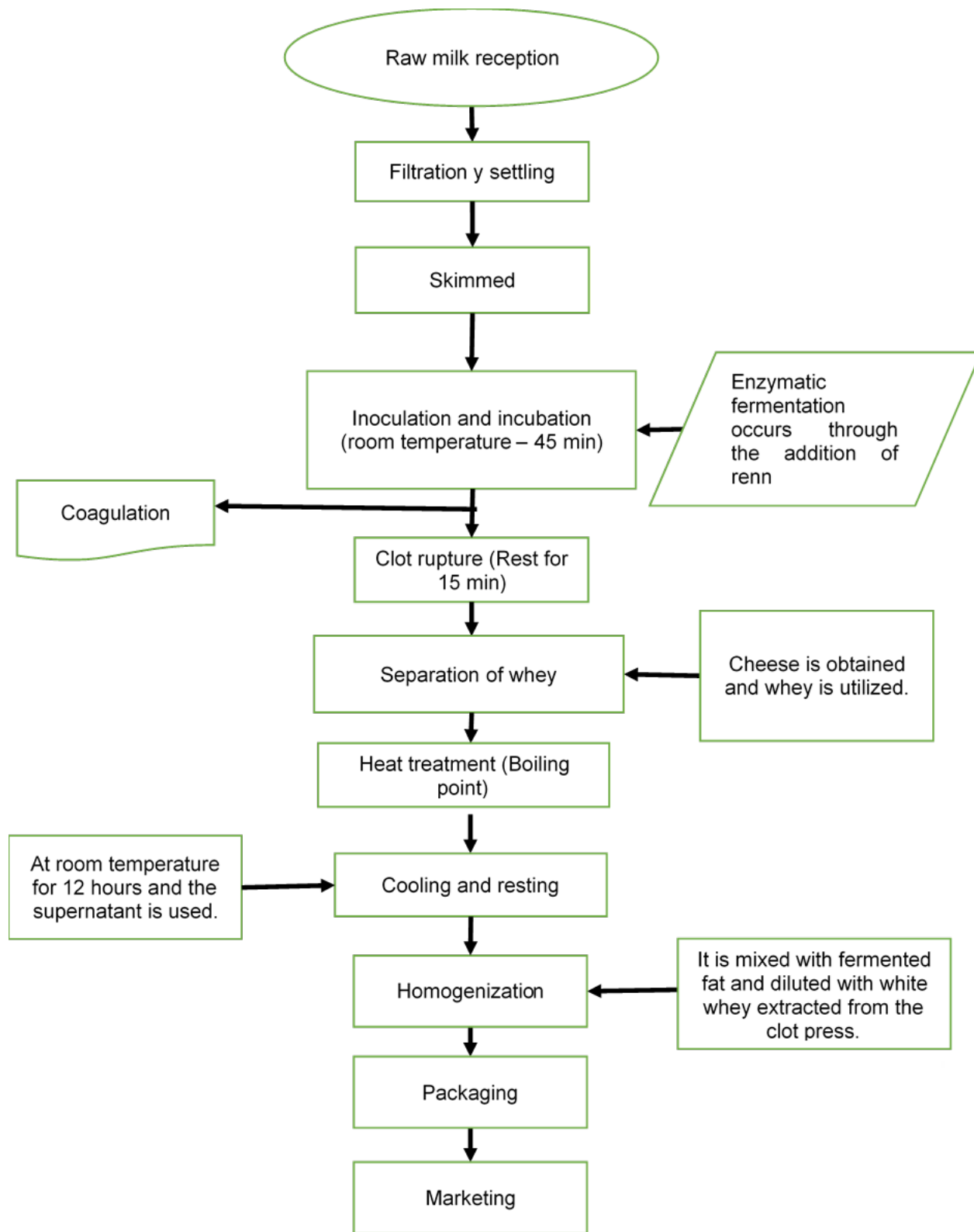


Figure 3. Production of Suero Costeño using whey

The final product has the appearance of acidic, sour and salty fermented milk with a creamy texture, in addition, it is used as a dressing to accompany almost all the meals of the inhabitants of the Colombian northern coast (Figure 4).



Figure 4. Suero Co steño made in Córdoba-Colombia

Hygienic-sanitary evaluation of Suero Costeño production

Of the establishments evaluated, 78.8% were classified in the category of “not acceptable” (compliance <29.4%), demonstrating weaknesses in sanitary requirements, handling personnel, key operations in the process and product verification; 21.2% of the processors were categorized as “acceptable with restrictions” (compliance between 29.5 and 59.9%) and belong to the municipalities of Ciénaga de Oro, Chinú and Montería (Figure 5). The CD4 establishment of Ciénaga de Oro presented the highest percentage of GMP compliance, its strengths being the aspects of design, characteristics of the facilities, equipment and requirements of the handling personnel.

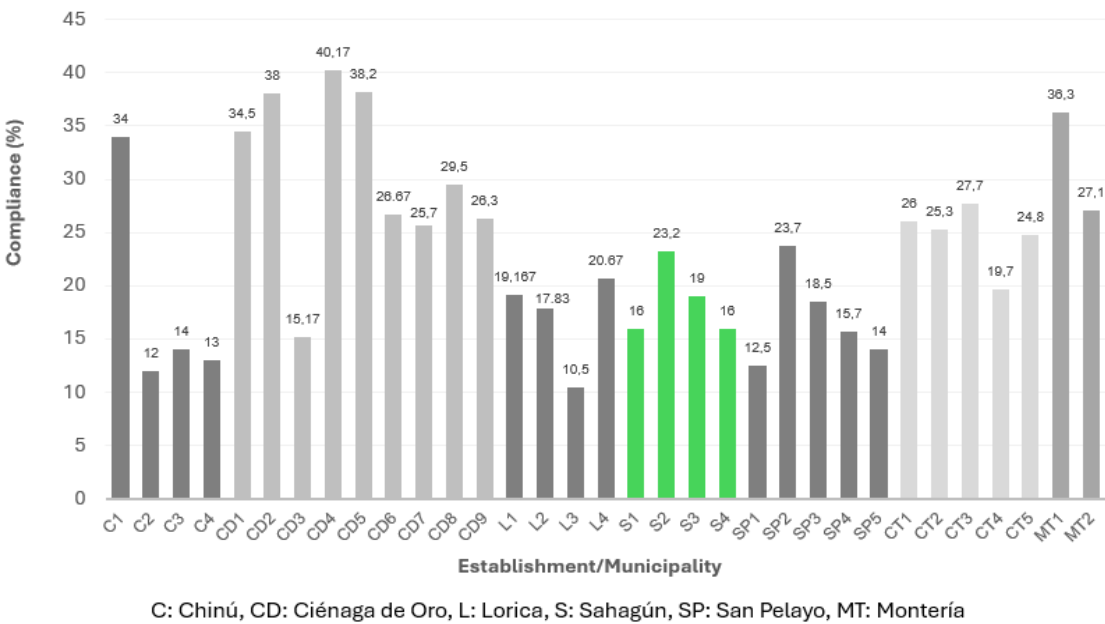


Figure 5. Evaluation of GMP in Suero Costeño Production Units in Córdoba-Colombia

Figure 6 shows the conditions to produce Suero Costeño, in terms of physical infrastructure, sanitary conditions and the availability of equipment and utensils, showing that improvements are required in all establishments to achieve compliance with sanitary regulations.

The results obtained from the evaluation of the different hygienic-sanitary criteria are presented in Figure 7, observing that all aspects, with the exception of the design of the characteristics of the facilities, have a compliance rate of less than 50%; therefore, they require the implementation of improvement plans for effective compliance with health regulations.



Figure 6. Physical facilities for the production of Suero Costeño in Córdoba-Colombia

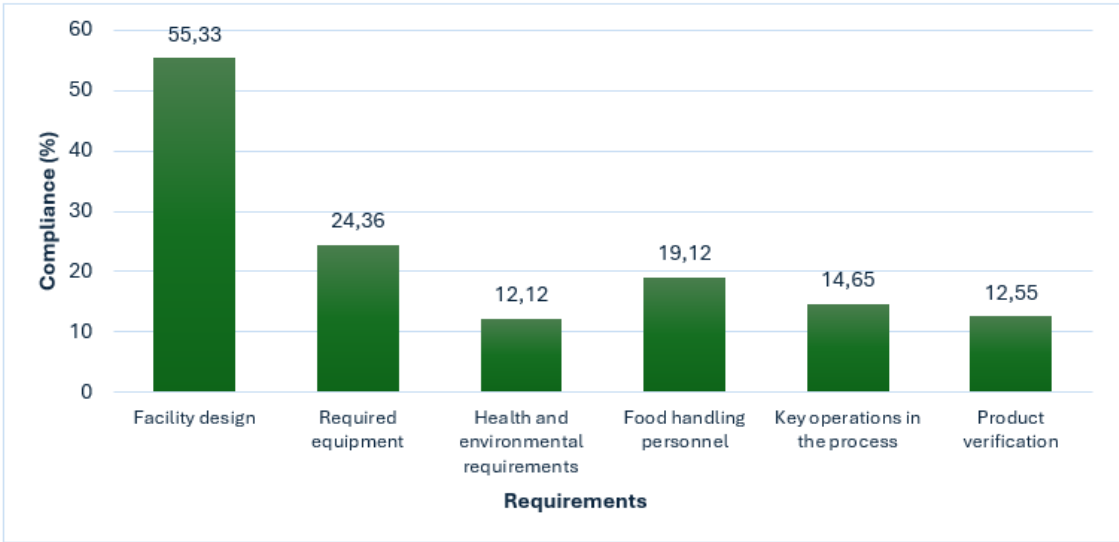


Figure 7. Compliance with hygienic and sanitary requirements in the production of Suero Costeño in Córdoba-Colombia

Compliance with the hygienic and sanitary requirements of the Suero Costeño production units detailed by municipality is shown in Figures 8 to 13. In relation to the design and characteristics of the facilities, the production units of Ciénaga de Oro, Sahagún, Chinú and Montería have

the highest compliance percentages, while in the municipality of Lorica, the lowest percentages of compliance and a few establishments with an unacceptable rating are observed (Figure 8). All the establishments in Sahagún and Montería presented an acceptable rating (>60%), mainly because they had a good location, access and surroundings with good maintenance; and among the weak aspects were the characteristics of the work surfaces that were not suitable for cleaning and the lack of adequate floors.

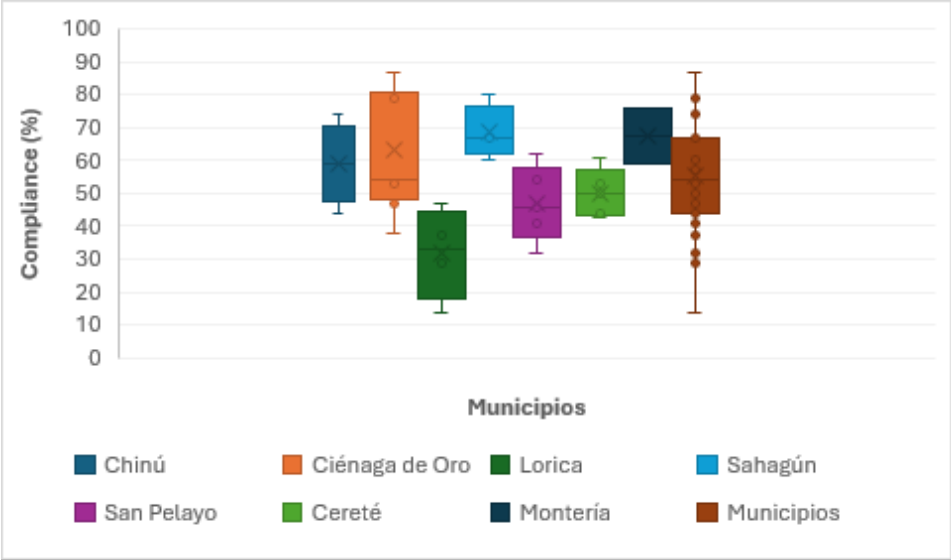


Figure 8. Compliance with the design and characteristics of the facilities of Suero Costeño production units in Córdoba

In relation to the equipment required, in general, the production units of all municipalities have compliance of less than 60%, and in the municipality of Ciénaga de Oro two production units register percentages of compliance close to 60, the minimum value to be considered acceptable (Figure 9). The most significant aspects of this criterion turn out to be the characteristics and hygienic conditions of the milk reception and processing containers, which are made of plastic, without lids and do not present a good hygienic condition.

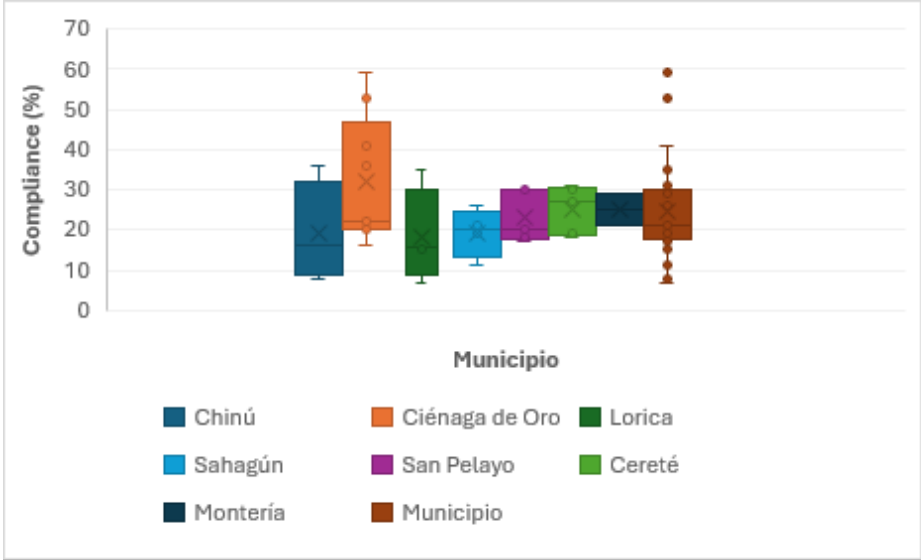


Figure 9. Compliance with the equipment required in the Suero Costeño production units in Córdoba

Regarding sanitary and environmental requirements, Figure 10 shows that no establishment has acceptable compliance (>60%); and the establishments in the municipalities of Chinú, Lorica, Sahagún and San Pelayo register compliance of less than 29.4%, so they are classified as not acceptable. The most important common aspect is related to the supply of drinking water, since there is no record of the treatments that ensure its quality.

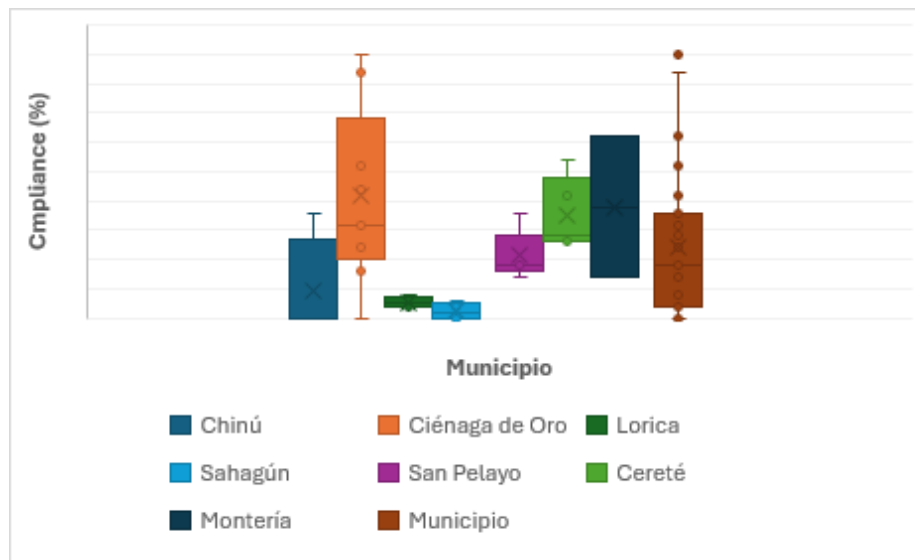


Figure 10. Compliance with sanitary and environmental requirements in the Suero Costeño production units in Córdoba

The handling personnel of the Suero Costeño production units of all municipalities have a compliance rating of less than 60% and it is noteworthy that all the production units of Lorica, Sahagún and San Pelayo are within the unacceptable category (Figure 11). In most production units, the handling personnel do not carry the necessary elements for the production process and are unaware of the risk factors for microbiological contamination.

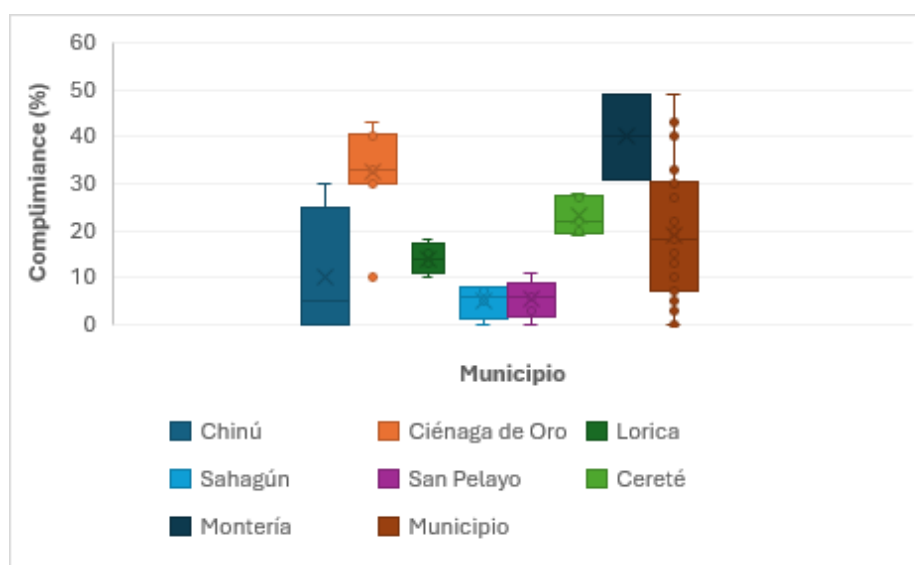


Figure 11. Compliance with the requirements for the food handler in the Suero Costeño production units in Córdoba

Regarding the key operations of the process, all the production units present an unacceptable rating with a compliance rate of less than 29.4%, except for two establishments in the municipality of Cereté that show a conditional favorable rating (Figure 12). It is important to note that most establishments carry out key operations of the process (fermentation, cooking, blending) in places shared with the family environment.

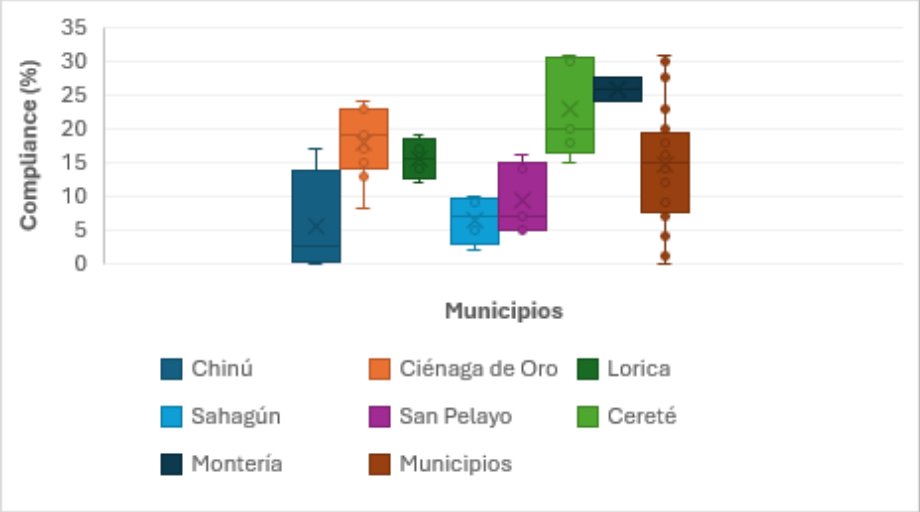


Figure 12. Fulfillment of key operations in the process in the Suero Costeño production units in Córdoba

In relation to the verification of the finished product in all Suero Costeño production units, unacceptable compliance was recorded, less than 29.4% (Figure 13); and weaknesses are observed in terms of the sampling program, determination of useful life and traceability.

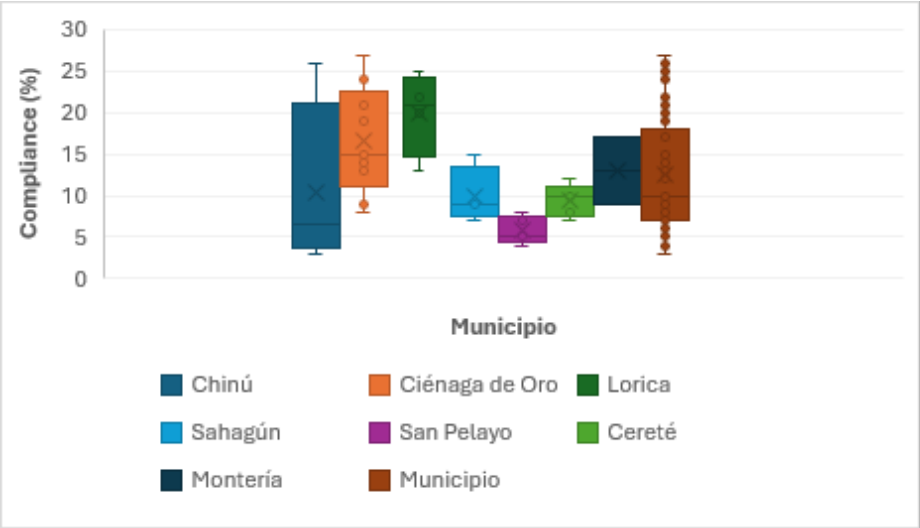


Figure 13. Compliance with the verification of the product in the Suero Costeño producing units in Córdoba

Discussion

The profile of the small producer of artisanal Suero Costeño in the department of Córdoba is comparable to that of the manufacturers of Queso Costeño (salted cheese) in the department of Atlántico, where the majority (82%) had between 6 and 20 years in production activities, which were developed as family-type business units, through the teaching of parents and grandparents to children and grandchildren respectively [\(24,25\)](#). Most of the cheese producers in the Atlántico are male (72%), with some degree of academic training (92%) basic, primary, vocational and technical studies. The descriptive characteristics of these producers of suero y queso costeño on the northern coast of Colombia demonstrate the roots in the production of these derivatives and the existence of opportunities for improvement in terms of the education and training of small producers [\(24\)](#)

Most of the manufacturers of Suero Costeño surveyed do not belong to producers' associations, this fact shows that they do not give value to associativity, nor do they take advantage of the benefit of economic stability that this collective activity can generate for them [\(26\)](#), such as the promotion of growth and the good image of the sector, or the representation and defense of the legitimate interests of their members before the authorities [\(27\)](#). Tibaduiza (2021) in his study of systematization of the Colombian dairy value chain in four milk producing associations in the high tropics, highlights the need to favor the associativity of companies to achieve the strengthening of the dairy sector, and in this way it can be reflected in the improvement of the living conditions of the population and the agricultural sector in general [\(3\)](#).

The production of artisanal Suero Costeño in the department of Córdoba is carried out following a process that has been transmitted through generations; where the inherited knowledge has allowed the consolidation of a proprietary, characteristic product, made through family learning, trial and error, perfected in practice. This situation is similar to the productive activity of small dairy companies in the industrial corridor of Boyacá, most of which are family business units, which present obstacles in their business development due to the absence of a defined organizational structure and the limited availability of both investment and operating capital. On the other hand, despite [\(28\)](#) the fact that the artisanal producers of Córdoba learned the trade of making Suero Costeño directly from a relative, differentiating quality characteristics have been evidenced that promise a regional identity, so it [\(29\)](#) is necessary to manage the protection of the product through a collective distinctive sign, designation of origin or collective brand, as an instrument for the opening of new markets and strengthening competitiveness [\(30,31\)](#); thus allowing economic and cultural development, in addition to promoting the consumption of the product [\(32\)](#).

The transformation link is made up of business units that produce small volumes of Suero Costeño, in infrastructures with poor sanitary hygienic conditions, using containers and rudimentary tools commonly used in the field. There is no use of information recording systems, so decision-making has no support, it is also evident that when producers do not use administrative tools or keep accounting records it is not possible to determine the profitability of production [\(33\)](#). This situation is comparable to the conditions in which the activities of reception and processing of milk, packaging and storage of derivatives from the informal raw milk chain are carried out in the municipality of Popayán, where it was reported that 84% of the transformation was carried out in home kitchens and 2% were carried out the processing in the courtyard or similar places. In

the same way, technical shortcomings in the processing that can affect the microbiological and compositional quality of the final product are indicated [\(34\)](#). Likewise, Valera et al (2018) in their study of the characterization of whey and Costeño cheese, indicated that the milk produced in the Department of Cesar is transformed by family businesses located in rural areas, who do not have adequate infrastructure or hygienic conditions, and do not carry out prior standardization processes [\(16\)](#).

The production of Suero Costeño has a great fluctuation in terms of the volumes produced, to the extent that producers establish cooperative relationships they could have a greater availability of the product to supply local markets and obtain a greater benefit. Integration could strengthen processes and shared experiences could improve product production conditions, as suggested by Bada et al., with the associativity model for small and medium-sized citrus agribusiness enterprises in the north of the state of Veracruz in Mexico [\(35\)](#).

During the process of making Suero Costeño the control of acidity, pH, temperature, and therefore bacterial growth is not carried out, for this reason the final product is not standardized, as happened with the artisanal cheese model in the Atlántico (25). Despite the lack of standardization of the process of making Suero Costeño, its sensory characteristics make it appetizing to consumers on the Colombian Caribbean coast, who include it in their main meals and snacks [\(11,36\)](#). Similar results are reported in relation to the influence on the quality and safety of Suero Costeño due to the lack of standardization of the production process and the deficiencies in its production conditions [\(9,16,20\)](#).

The artisanal production units of Suero Costeño must comply with the parameters and requirements established in Resolution 2674 of 2013 and Decree 616 of 2006 of the Ministry of Health and Social Protection of Colombia, regarding their location and access, physical facilities, equipment, sanitary facilities, sanitation conditions, food handling personnel, reception and storage conditions and verification of the product. The percentage of compliance of these factories is very low compared to those obtained in cheese outlets in the city of Florencia-Caquetá, where results are reported with acceptable compliance, so they only have to maintain the outstanding controls [\(37\)](#). Other authors report results of 45.7% compliance in dairy product outlets [\(38\)](#), while Puerto-Avenida et al., (2021) evaluated sanitary compliance between 74 and 95% in the process of making Paipa Cheese, a product with designation of origin [\(39\)](#); it was also evidenced that 10% of the companies belonging to the ASOQUESOPAIPA Association obtained an unfavorable result (49%) of the requirements demanded by the regulations.

Suero Costeño is a product that can be contaminated by the raw material used, bad marketing practices or hygiene in the outlets [\(40\)](#); For this reason, controlling the processes that involve manufacturing, transportation, storage and other stages are essential to avoid the growth of germs, bad odors, defects in taste and smell. The producers of Suero Costeño want to improve the conditions of production of the product, taking advantage of the technical assistance of the different entities participating in the research project; which also coincides with the interest evidenced in small-scale cheese factories in Argentina, to implement staff training programs and improve the conditions of elaboration based on the hygienic and sanitary diagnosis of their processes [\(41\)](#).

Conclusions

The production of Suero Costeño in Córdoba is carried out by small producers, without academic training or links to associations; they make the product in an artisanal way, through practices that they have learned through generations, constituting a means of family sustenance.

Suero Costeño is made using two procedures, one that spontaneously ferments milk, fat, or both, for a period of 24 to 48 hours; in addition, another that subjects the cheese whey to heating; to obtain a product with an acidic and salty flavor, with a creamy texture.

The diagnosis of the application of GMPs based on Resolution 2674 (2013), reveals deficiencies in the establishments, finding that 78.9% are in the “not acceptable”, and 21.2% in the “acceptable with restrictions”; therefore, it is necessary to implement an improvement plan, to ensure the conditions that allow obtaining a safe product with acceptable quality.

CrediT authorship contribution statement

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