Chapter 16
Latin American-Style Cheeses

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16.1 Introduction

Latin American-style cheeses are often referred to as *Hispanic cheeses* in the United States due to the way in which production of this type of cheeses is tracked. The term *Hispanic* was coined as an ethnic category in 1976 with the passing of a federal law that mandated the collection of data for "the ethnic group comprised of Americans of Spanish origin or descent" by the US Census Bureau, which began using it during the 1980 census. For the next two decades, *Hispanic* slowly morphed from "pertaining to Spain, its people, and the Spanish language" to the official way to refer to the people, things, and concepts associated with most countries of the Americas that are not Canada or the United States. The term *Latino*, popular in California and other southern states in the 1980s and 1990s to refer to people of Latin American descent living in the United States, was not officially used in government forms until the 2000 census (Tienda & Mitchell, 2006). Thus, only the term Hispanic was officially available in 1993, when the State of Wisconsin began tracking specialty cheese production, including that of "Queso Blanco and other Hispanic cheeses" (Groves, 2016). Same thing in 1996, when the US Department of Agriculture (USDA) National Agricultural Statistics Service (NASS) began tracking the production of "Hispanic cheese," which until then had been included in the "all other types" category. However, when referring to Hispanic cheese, most

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people in the United States are more likely to be referring to cheeses that are commonly made not in Spain, but in countries of Latin America, that is, countries of the Americas in which Spanish or Portuguese is the dominant language. So, it would be more correct to call the cheese category *Latin American style*.

Interest in Hispanic, or more accurately, Latin American foods in the United States began in earnest in the 1990s and truly expounded around the time when the 2000 US Census showed that the Hispanic or Latino population was the largest and fastest growing ethnic population. As the Hispanic or Latino population increases in the United States, so does the market potential for Latin American cheeses. The combination of Hispanic population growth and increased interest in Latin American food has allowed production of Latin American-style cheeses in the United States to grow from 30.6 thousand metric tons (67.4 million lb) in 1996 to 159.4 thousand metric tons (351.5 million lb) in 2021 (Fig. 16.1).

One last but very important fact to remember is: Latin America is *not* a single, uniform political, economic, and cultural entity. Latin America refers to an area that covers Mexico, Central America, South America, and most of the islands in the Caribbean. As of 2021, that includes 20 countries and 6 non-sovereign territories containing >658 million people (The World Bank, 2022) spread over ~19.2 million km^2 (7.4 million mi^2) (The World Bank, 2020), each with its own culture, ideology, cuisine, political leanings, economy, demographics, and history.

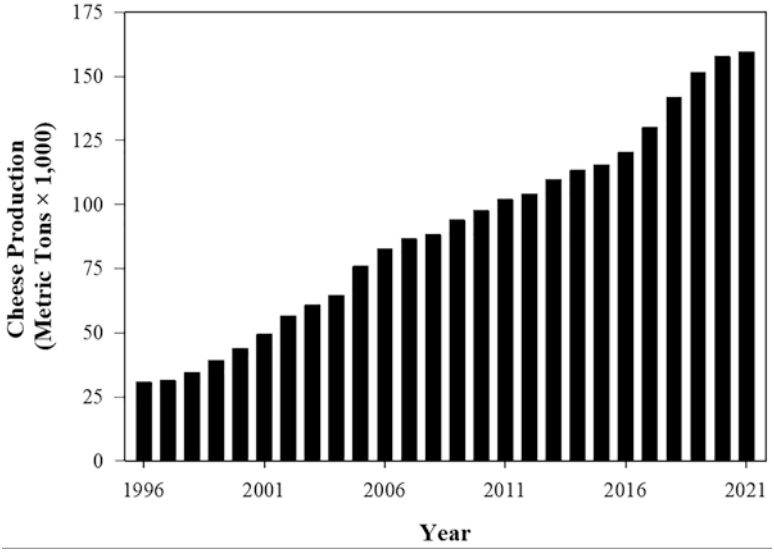

Fig. 16.1 Annual production trend for Hispanic cheeses in the United States. (NASS, 2022)

16.2 A Brief History of Cheese in Latin America

Before the arrival of Europeans to the Western Hemisphere, there was no domesticated livestock from which to obtain sufficient milk to sustain cheese production. And although the Incas in South America domesticated the llama, they were primarily used as beasts of burden and for the production of fiber and meat. Llamas produce ~1.9–2.3 l (64 – 78 oz) of milk per day (Tibary et al., 2014), but hand milking llamas is difficult due to their short teats, limited udder storage capacity, and frequent milking time requirements of every 2–3 h to reach that level of daily production (Riek et al., 2007), not to mention their poor disposition toward milking (Morin et al., 1995). There are few historical documents mentioning the consumption of llama milk. The earliest appear to be a letter from the Bishop of Cuzco, Vicente de Valverde, to the Holy Roman Emperor Charles V in 1553, where he lists the tithe collected that includes "[…] wool from the sheep from here, cheese and milk […]" (Torres Saldamando et al., 1888), and the book *Desengaño y reparo de la guerra del Reino de Chile* by Alonso González de Nájera, who completed it in 1814, where he mentions that the natives in Chile round up "some sort of rams […] that our people call sheep of the land […] the natives use their wools to dress and their bones for arrowheads […]" and that they "obtain as much milk from a female animal as they do blood from the head of a male animal, which in times of hunger they bleed from time to time" (González de Nájera, 1889), which can be interpreted as implying that both the milk and the blood obtained are a very small amount. Valverde calls the animals tithed in the region of what is now Peru "the sheep from here," so there are questions among historians if he was actually referring to llamas. Nájera uses the term "ground sheep" to refer to herd animals with long wool in the region of what is now Chile, which is thought to be llamas or alpacas. Both accounts are several decades after the Spanish had conquered the regions, so it is also possible they refer to some animal brought by the Europeans that had established in the area.

Latin American cheeses were developed using milk from Eurasian animals brought to the region during the Colonial Era, and European cheesemaking techniques that were then adapted to the local tropical and subtropical climates, and the emerging cultures of the different regions of the Americas. They are the outcome of several centuries of culinary cultural exchange and adaptation, resulting in unique cheeses that are both culinary and cultural icons of their countries of origin.

16.3 Latin American Cheeses: Overview

The production of Latin American cheeses in the United States primarily focuses on cheese varieties of Mexican origin, in part because Mexicans form the largest group of Hispanics or Latinos in the United States (Table 16.1) and in part due to the popularity of Mexican and Tex-Mex food.

Table 16.1 Estimated Hispanic or Latino population in the United States by origin for year 2021

Hispanic or Latino by origin	Estimated population year 2021	Percentage (%)
Hispanic or Latino	62,529,064	100.0%
Mexican	37,235,886	59.5%
Puerto Rican	5,798,287	9.3%
Cuban	2,400,152	3.8%
Dominican (Dominican Republic)	2,393,718	3.8%
Central American	6,306,931	10.1%
Costa Rican	188,054	0.3%
Guatemalan	1,771,850	2.8%
Honduran	1,148,209	1.8%
Nicaraguan	457,005	0.7%
Panamanian	237,706	0.4%
Salvadoran	2,473,947	4.0%
Other central American	30,160	<0.1%
South American	4,348,015	7.0%
Argentinean	297,155	0.5%
Bolivian	131,424	0.2%
Chilean	187,572	0.3%
Colombian	1,401,720	2.2%
Ecuadorian	812,838	1.3%
Paraguayan	29,389	<0.1%
Peruvian	720,626	1.2%
Uruguayan	65,571	0.1%
Venezuelan	659,631	1.1%
Other south American	42,089	0.1%
Other Hispanic or Latino	4,046,075	6.5%
Spaniard	995,583	1.6%
Spanish	905,797	1.4%
Spanish American	92,282	0.1%
All other Hispanic or Latino	2,052,413	3.3%

Made with data from US Census Bureau (2021)

However, a great diversity of other cheese varieties can be found throughout Latin America and the Caribbean that are only produced locally in their countries of origin (Table 16.2). These regions (excluding Mexico) exhibited an increase of ~14% between years 2010 and 2019, reaching levels of production of nearly two million metric tons per annum, which represents nearly 22% and 8% of the Americas and worldwide production, respectively (FAO, 2022). In this book chapter, we will discuss about the diversity of major cheeses found in Latin American and the Caribbean, with emphasis on several cheeses that trace their origin to Mexico due to their significance in the US market, and we will describe some of the most representative cheese varieties from countries that exhibit either the largest records of cheese production or the largest increase in cheese production rate in the region (e.g.,

Table 16.2 Statistics of total cheese production with emphasis on Latin American countries and the names of their more recognized cheese varieties

Region/country	Cheese production in year 2019 (metric ton × 1000)	Variation since year 2010 (%)	Main cheese varieties
North America	*6927*	*+21.1*	
United States	6159	+20.9	
Canada	592	+25.1	
Mexico	175	+20.0	Añejo, Asadero (Oaxaca), Cotija, Panela, Queso de bola, Chihuahua, Manchego, Ranchero (Fresco), Sierra
South America	*1841*	*+10.3*	
Brazil	798	+35.6	Catupiri, Coalhada, Quartirolo, de Coalho, de Manteiga, Minas, Prato, Reino, Requijao
Argentina	429	−17.5	Crema, Gaucho, Goya, Quartirolo, Reggianito, Sardo, Tafi, Patagras
Chile	101	+41.5	Chanco, Mantecoso, Quesillo, Queso Fresco
Uruguay	67	−11.4	Colonia, Yamandu, Goya
Ecuador	121	+12.0	Quesillo, Andino
Colombia	62	+5.6	Bernian, Pera
Peru	27	+37.0	Mantecoso, Andino, Requesón
Bolivia	10	+0.7	Altiplano, Quesillo, Benianco, Chaqueño
Venezuela	225	+4.1	Cuajada, Guayanes, Llanero, Queso de Cavallo, Queso de Cincho, Queso de Mano
Paraguay	N/A	N/A	Campesino, Paraguay (Quesillo)
Central America	*118*	*+31.1*	
Costa Rica	26	+105.0	Maduro, Turrialba, Palmito, Suero
Panama	14	+7.0	Queso Blanco
Honduras	15	−3.1	Quesillo de Honduras
Nicaragua	48	+43.3	Queso Blanco (Quesillo)
Guatemala	14	3.0	Queso Fresco
El Salvador	2	−20.6	Coyotlio, Duro Blando, Majado, Petacones, Prunera
The Caribbean	*21*	*−0.8*	
Cuba	12	−26.6	Patagras
Dominican Republic	8	+105.0	Queso de Freir
Puerto Rico	N/A		Queso de crema, Queso de Hoja, Queso del Pais, Queso de Prensa, Queso de Puna

(continued)

Table 16.2 (continued)

Region/country	Cheese production in year 2019 (metric ton × 1000)	Variation since year 2010 (%)	Main cheese varieties
Latin America (excluding Mexico) and the Caribbean (total)	*1980*	*+13.8*	
World (total)	*23,321*	*+13.0*	

Made with data from Path (2008), FAO (2022), (ODEPA-Chile, 2022), and USDA (2020, 2022)
N/A Not available

Brazil, Argentina, and Chile) between the years of 2010 and 2019 (before the COVID-19 outbreak, Table 16.2).

16.3.1 Diversity of Latin American Cheeses and General Factors Affecting Their Sensory Properties

The most common type of cheeses produced and consumed in Latin America are fresh cheeses, and they most often have the name Queso Fresco (fresh cheese) or Queso Blanco (white cheese). These cheeses are produced from rennet or acid-heat coagulation, most commonly using cow's milk and less commonly goat's or sheep's milk. They are generally high in moisture, range in pH between 5.5 and 6.4, undergo no ripening, and consequently have a very short shelf life and are highly susceptible to microbial contamination.

Each region and country have specifically adapted cheese manufacture protocols to obtain products with desirable shape, appearance, flavor, texture, functionality, and shelf life according to their culture and climate conditions. Hence, a variety of fresh cheeses with varying names and characteristics can be identified (Table 16.3).

For example, fresh cheeses produced in Chile may have two names: Queso Fresco or Queso Chacra. But they only differ in their shape: the former is round, and the latter is square. However, these names are commonly used interchangeably by cheese manufacturers and retailers due to the lack of standards of identity for fresh cheeses. Similarly, Mexican and Venezuelan fresh cheeses are often named after the region where they are produced and do not necessarily differ in their cheesemaking or physicochemical properties. Additionally, there are fresh cheeses with major differences in their composition that will impact their sensory properties. Increasing levels of salt not only affect the flavor (saltiness) and texture of the cheese (brittle body and crumbly texture) but also the shelf life. For example, Queso Criollo from Central America has a very high salt content (6–7% salt) and longer shelf life than Quesillo from South America (1–4% salt). Fresh cheese made from skim milk in Costa Rica (*Queso Huloso*, which means rubbery) has the translucent appearance and hard, rubbery texture commonly found in low-fat cheeses. Acid set Queso

Blanco exhibits a grainy texture and sour aroma, contrasting with fresh cheeses made with no acid added. Except for acid set cheeses, fresh cheeses generally have low acid development (i.e., high pH values) that limits melting when heated, making them suitable for baking, grilling, or frying applications (Fig. 16.2); examples include Queso Panela (Mexico), Queso para Freir (frying cheese from Dominican Republic), and Coalho (Brazil). When consumed, fresh cheeses are characterized by their fresh milk flavor and tend to release water when pressed, and if the cheese is truly recently made, a squeaky noise can be perceived during mastication. However, these cheeses are prone to develop defects that are mainly affected by the quality of raw materials as well as processing and storage conditions.

Some common defects that may occur in fresh cheeses include the following:

- Excessive watering-off (syneresis) due to temperature abuse during storage and transportation
- Uncontrolled acid development (lactic and/or acetic acid) due to fermentation of lactose and citrate from undesired bacteria
- Undesirable gas formation commonly observed as puffed or bloated packaging and/or the formation of slits or round eyes of varying size in the cheese structure

Table 16.3 Different styles of Latin American fresh cheeses and their different regional names

Style of fresh cheese	Common names and countries of manufacture
Fresh cheese made with various types of coagulants (mainly rennet) from whole, partially skimmed or skimmed milk and varying salt content.	Queso fresco (generic name in various countries of Latin America). Panela or canasta (Mexico), Paraguay (Paraguay), Blanco (Nicaragua) or Quesillo (Bolivia, Chile, Ecuador). Del Pais or De la Tierra (Puerto Rico). Llanero, Maracay or Perija (Venezuela). Estera (Colombia) Descremado or Huloso (Costa Rica) Altiplano (Bolivia). Coahlo (Brazil). Crema or Criollo (various countries from central and South America). Campesino (Paraguay) Chacra (Chile). De Puna (Puerto Rico). Ranchero (Mexico)
Fresh cheese generally made with acid and heat coagulation	Blanco (Puerto Rico). De Prensa (Mexico, Venezuela). De Freir (Dominican Republic). Sierra (Mexico) Turrialba (Costa Rica)

Made with internal information from the Center for Dairy Research (University of Wisconsin-Madison) and Path (2008)

due to fermentation of sugars and/or organic acids caused by contaminant bacteria
- Development of bitterness due to:
  - Increased proteolysis caused by excessive use of coagulant (rennet) during manufacture
  - Occurrence of contaminant microorganisms with high proteolytic activity
  - Temperature abuse during storage/transport
  - Low salt content
- Surface mold growth due to low acid development, low salt, and high moisture content (i.e., high water activity)
- Blue discoloration due to contamination with *Pseudomonas fluorescens* during storage at low temperature
- Development of cardboard-like off-flavors due to light-induced lipid oxidation of milk prior to cheese manufacture or during transport/storage of the finished product

Several of the defects associated with microbial activity can be found exacerbated in raw milk cheeses made with poor hygienic practices.

Melting cheeses are very popular in Latin America and are highly valued for their functional properties. Their characteristics are reminiscent of Pasta Filata cheeses or Gouda-style cheeses, with pH values between 5.1 and 5.4, and moisture contents of 45–60%. Examples of Pasta Filata cheeses include Oaxaca and Chihuahua (Mexico), Quesillo (Honduras), Queso de Mano (Venezuela), and Palmito (Costa Rica), whereas examples of Gouda-style cheeses include Prato (Brazil), Gauda (Chile), Patagras (Cuba, Argentina), and Yamandu (Uruguay).

Fig. 16.2 Appearance of fried Queso Fresco with limited melting. (Photo from the authors' private collection)

Semihard cheeses are also popular in various regions of Latin America. These groups of cheese present a great diversity of specific and unique sensory characteristics depending on manufacture and ripening/storage conditions. For instance, Queso Colonia (Uruguay) resembles a Swiss cheese with typical eyes and nutty notes; Queso Tafi (Argentina) has a rind that is fully covered by mold; and Queso Chanco (Chile), Mantecoso (Peru), Minas Padrao (Brazil), Maduro (Costa Rica), and Benianco (Bolivia) usually have mechanical openings and a rind of varying thickness.

Aged cheeses are less common but still culturally important types of Latin American cheeses. Dry, salty, hard, and often grated, they have strong flavors and aromas that can be reminiscent of aged Parmesan or Romano cheese but can also include flavors that are often considered defects, such as excessive rancidity, yeasty, floral, barny, and fruity notes (Jimenez-Maroto et al., 2016). Examples of these cheeses include Cotija and Cincho (Mexico), Duro (Costa Rica), Criollo (Central America), Goya (Argentina, Uruguay), Majado and Petacones (El Salvador), Pera (Colombia), de Prensa (Puerto Rico), Reggianito (Argentina), and Reino (Brazil).

Lastly, it is important we mention analogous or imitation cheeses in Latin America. Generally, these are cheeses that have nondairy components, such as the partial or total substitution of the milkfat for vegetable fat, or the use of starches in their manufacture. These nondairy ingredients can change the flavor, texture, and functional properties of the products in subtle or noticeable ways. And, although they have their place in their domestic marketplaces, this chapter will not cover their sensory properties, focusing instead only on natural cheeses.

16.3.2 Safety Concerns with Latin American-Style Cheeses

Raw milk may contain pathogenic bacteria such as *Salmonella*, *E. coli*, and *Listeria*, which have been linked to many foodborne illness outbreaks (FDA, 2018). Therefore, the Code of Federal Regulations dictates that cheese made from raw milk must be held at no less than 1.7 °C (35 °F) for at least 60 days (CFR, 2022). This is impractical in the case of Queso Fresco and Queso Blanco due to their high moisture content and subsequently short shelf life. Thus, these cheeses must be made from pasteurized milk. Latin American cheeses such as Queso Fresco, Panela, and Queso Blanco may be sold in the United States only if they are made from pasteurized milk (FDA, 2018).

Yet the traditional use of raw milk in the production of Latin American cheeses gives them distinctive flavors, textures, and cooking properties. Unfortunately, and paradoxically, US-produced Latin American cheeses made from pasteurized milk may not exhibit the full range of properties of cheeses made from raw milk. This creates the dilemma of simultaneously trying to achieve both safety and consumer acceptance quality in Latin American cheeses. One approach to this challenging issue has been the incorporation of exogenous starter cultures. Since naturally occurring lactic acid bacteria from raw milk are inactivated by pasteurization, starter

cultures are now more frequently added as adjunct microflora in the manufacture of soft Latin American cheeses that are traditionally made with raw milk (Van Hekken & Farkye, 2003). However, even if made from pasteurized milk, the commonly high moisture content and pH level of Latin American cheese may prove problematic in terms of food safety if any post-pasteurization contamination occurs (Path, 1991).

While yields increase with higher moisture cheeses, this comes with a loss in shelf life and greater chance of survival of pathogenic post-pasteurization contaminants, especially with the high pH levels (~6.2) common to Latin American cheeses (Path, 1991; Clark et al., 2004). Because soft Latin American-style cheeses (fresh) are not aged, they rarely develop acidic conditions whereby unwanted bacterial growth may be inhibited. Furthermore, if the cheeses are brined, an additional advantage is afforded to *Listeria* spp., halo-tolerant microorganisms, over other bacteria if they happen to be present (Linnan et al., 1988). This emphasizes the importance of high-sanitation protocols and standards in the manufacture of Latin American cheeses (Path, 1991). In 2002, the FDA and FSIS advised at-risk individuals, particularly pregnant women, not to consume soft cheeses (including Latin American-style cheeses and soft cheeses made from pasteurized milk) due to increased incidences and risk of contamination with *L. monocytogenes* (FDA, 2002). This warning was modified in 2003 to state that soft cheeses, including Queso Blanco, Queso Fresco, and Panela, made from pasteurized milk and properly stored were safe for consumption by at-risk consumers (FDA, 2003).

16.4 Latin American Cheeses: Mexico

16.4.1 Queso Panela

Queso Panela is a Mexican fresh cheese named after the name given to the basket mold used in its manufacture (panela). It is related to Queso Blanco, but is self-pressed, has an open body, and is not acid-set. It is typically made with whole or part skim cow's milk using mesophilic starters. The curd is cut and worked for a short time, around 10 min, before draining the whey. There is no milling or grinding of the curd, which can be direct salted or brined, and undergoes a self-press step where the basket molds are stacked a few molds high and rotated every 4–6 h (Villegas de Gante, 2004). Its typical composition range is: 53.2–58.3% moisture, 18.8–12.1% fat, 18.4–20.5% protein, 1.3–1.8% salt, and pH values of 5.6–6.4 (Ramírez-López & Vélez-Ruiz, 2012). The appearance of this cheese requires the presence of the grooves left by the basket mold to be considered authentic (Jimenez-Maroto et al., 2016), although the pattern can vary (Fig. 16.3). The body is open due to being self-pressed, knit enough to be easy to cut and curdy but not crumbly: can be separated into large curd particles if kneaded between the fingers unlike Queso Fresco, where the curd is ground, the mouthfeel of Queso Panela should not be mealy or grainy. Because it is a fresh cheese, its taste should be slightly salty and mildly acid, but

never bitter, as that would imply the whey is fermenting due to temperature abuse and/or high microbial load due to lack of good manufacturing practices. The flavor should be that of fresh milk: milkfat with perhaps a minor note of diacetyl depending on the cultures used, grassy notes are acceptable too since the milk is often from grazing animals. A small amount of free whey is permissible, but large amounts can indicate temperature abuse during storage or transportation, especially if the whey is opaque. Its very mild flavors make defects readily evident, and most of the time they are caused by the fermentation of the whey: bitter taste, whey taint, unclean, fruity/fermented, barny, and even yeasty.

16.4.2 Queso Fresco

Queso Fresco, which translates to "fresh cheese", is more commonly named Queso Ranchero, Queso de Aro, or Queso Molido in Mexico. Debatably even more popular than Queso Panela due to the simplicity of its manufacturing process. It is a fresh, soft, unpressed cheese typically found in the shape of a short cylinder in pieces of 0.2–1 kg (0.4–2.2 lb) (Fig. 16.4). Its typical compositional range is: 47–60% moisture, 20–29% fat, 15–21% protein, 0.7–3% salt, and pH of 4.8–6.2 (Tunick & Van Hekken, 2010). This huge range of compositional values includes artisanal cheeses made using raw milk and cheeses made with pasteurized milk and industrialized equipment and hints at the large variation in texture, flavor, and functionality that encompasses what can be considered a Queso Fresco.

Queso Fresco is traditionally made of whole or part-skim cow's or goat's milk, raw if artisanal make, or pasteurized and with mesophilic starters if made at industrial scale. The curd is cut soft, cooked at 30–35 °C (85 °F–95 °F), drained, salted, and ground up. This grinding step used to be done by hand with a *metate* (a ground stone tool used for processing foods, traditional in Mesoamerican cultures), but in modern times, it is more often ground using a mill (Villegas de Gante, 2004). The ground cheese is then packed into short cylindrical hoops, unmolded, and is ready to be sold. The body is fairly closed, with the small curd particles packing closely together but most often not fully knitting, making it very crumbly. This functional property is critical to its authenticity, as it is often used as an ingredient crumbled over soups, salads, beans, etc. Although high in moisture, they rarely present much free whey. Because the curd was ground, it has a mealy or grainy mouthfeel. The taste should be salty, with a slight acid note. Like other fresh cheeses, its flavors are primarily those of fresh milk: milkfat, grassy, or feed, and sometimes a hint of diacetyl depending on the cultures used. Its mild flavors make defects easy to detect, which are often caused by temperature abuse allowing bacteria to ferment the whey left in the cheese. Common defects include any amount of bitter, whey taint, unclean, fruity/fermented, and barny.

Fig. 16.3 Queso Panela must have the imprint of the basked used in its manufacture to be considered authentic, although the pattern can vary. (Photos from the authors' private collection)

16.4.3 Queso Oaxaca

Queso Oaxaca gets its name from the state of Oaxaca in southern Mexico, where it originates. However, in the state of Oaxaca, it is called *Quesillo*, and in other places *Queso de Hebra* (string cheese). The origin story of this cheese, as told by the inhabitants of the "cradle of Quesillo," the Reyes Etla municipality in the state of Oaxaca, is that in 1885, Leobarda Castellanos García, a 14-year-old girl in charge of preparing her family's cheese, got distracted and allowed the milk to set for too long after adding the rennet. She tried to cover her mistake by adding hot water to the firm curd in an attempt to soften it a bit, which resulted in a molten curd that stretched without breaking when it was pulled. The resulting cheese was found to be very pleasant and unique by the family and neighbors. This cheese was named *Quesillo*, and it became popular enough for neighboring cheesemakers in the Central Valleys region of Oaxaca to begin producing it too. Eventually, the cheese was marketed in the neighboring state of Puebla, where it was called "Queso de Oaxaca" (cheese from Oaxaca) and eventually renamed to *Queso Oaxaca* (Osegueda, 2022).

Nowadays, its manufacture is based on Mozzarella cheese, with some adaptations to perform better in subtropical and tropical climates (González-Córdova et al., 2016). As such, there is no single manufacturing method: it can be made using raw cow's, sheep's, goat's, or water buffalo's milk allowing the pH to drop from the milk's native flora, or using pasteurized cow's milk either acid-set using organic acids or with mesophilic or thermophilic starter cultures and rennet. The final curd pH is a critical step and must be between 5.1 and 5.4, or it will not melt and stretch properly (Villegas de Gante, 2004). The resulting cheese can be a Queso Oaxaca compositionally similar to whole milk Mozzarella, part-skim Mozzarella, low-moisture Mozzarella, or low-moisture part-skim Mozzarella, depending on the composition of the milk and the manufacturing protocols. Typical composition ranges are 49.3–52.4% moisture, 20.6–24.2% fat, 20.4–22.4% protein, 1.4–2.3% salt, and pH values of 5.0–5.3 (Ramírez-López & Vélez-Ruiz, 2012). Like in

Fig. 16.4 Queso Ranchero, de Aro, Molido, or Fresco showing the typical short cylinder shape and crumbly, grainy texture. (Photo from the authors' private collection)

Mozzarella manufacture, this cheese goes through a cook-stretch step in which the curds are placed in water at >70 °C (>160 °F), after which the molten curds are stretched into a strand that is then rubbed with salt and rolled into a yarn-ball shape (Fig. 16.5) that should maintain its definition throughout its shelf life and is critical for its authenticity. The body and texture should be very similar to string cheese Mozzarella, reminiscent of chicken breast when the strand is pulled apart (Fig. 16.6). The taste should be slightly salty and mildly acidic, and the flavor should present buttery and milky notes. Queso Oaxaca is highly sought after for its melting properties and extensively used in melting applications throughout Mexican cuisine.

16.4.4 Queso Asadero

Queso Asadero is pasta filata cheese developed in the Villa Ahumada municipality of the state of Chihuahua, in northern Mexico. It is not a Queso Oaxaca in a loaf form. Traditional manufacture of Queso Asadero mixes fresh raw cow's milk with day-old, acidified raw milk that is then warmed to 30–33 °C (86–91 °F) and set with animal, microbial, or vegetable rennet extracted from the fruit of *Solanum elaeagnifolium*, a local, wild-growing plant commonly known as "trompillo" (Martínez-Ruiz & López-Díaz, 2008). The curd is then cut wide, cooked, and drained but retaining some of the whey. The curd is allowed to drop in pH to 5.1–5.3 in a process similar to cheddarization, while the retained whey is heated to 70 °C (160 °F) and added back to melt and knead the curd. Salt is added in the whey washing step. The molten mass is then molded, often in loaves, but sometimes in the shape of flat patties, balls, or stretched and rolled into a yarn ball like Queso Oaxaca. The industrialized version uses pasteurized milk, starter cultures, and animal or microbial rennet, keeping the rest of the process the same (Villegas de Gante, 2004). Its sensory characteristics are very similar to Queso Oaxaca: good melting properties, slightly less acid taste, and flavors similar to Mozzarella cheese.

16.4.5 Mexican Manchego

Mexican Manchego shares the name with Queso Manchego from Spain. But that is where the similarities end: Mexican Manchego is made with cow's milk instead of sheep's milk and is aged only a few weeks instead of months, resulting in very different texture and flavor profiles.

The story of Mexican Manchego's development and commercialization begins sometime in the second half of the twentieth century: a Mexican cheese manufacturer wanted to develop a new cheese for the Mexican market and called their culture house for help. The technician sent followed a make procedure that was a variation on Monterey Jack cheese, but using different cultures. The resulting cheese impressed the manufacturer so much that they decided to name it after their

Fig. 16.5 Two examples of Queso Oaxaca or Quesillo, showing variations of the yarn-ball shape that gives them their authenticity. (Left: Photo from the authors' private collection. Right: Photo courtesy of Dr. Stephanie Clark)

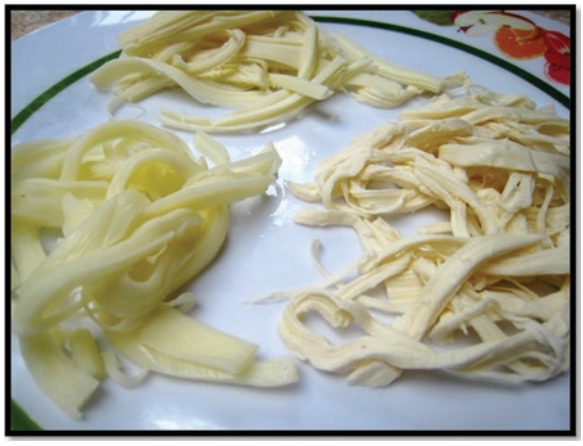

Fig. 16.6 Chicken breast-like texture of Queso Oaxaca or Quesillo after strands are pulled apart. (Photo from the authors' private collection)

personal favorite cheese: Queso Manchego. Its mild but pleasant flavor and melt characteristics made it a success in the Mexican marketplace, quickly becoming ubiquitous with consumers, who did not know the traditional Spanish version of Queso Manchego.

Mexican Manchego is made with part-skim cow's milk, mesophilic cultures, undergoes a curd wash step, the curd is then ground, salted, molded, and pressed into cylinders that then are ripened for 10–15 days at 10 °C (50 °F). The cylinders are from 3 to 5 kg (6.6–11 lb), and their composition is typically 41–45% moisture, 27–30% fat, 22–25% protein, and 2–2.5% salt (Villegas de Gante, 2004). Mexican Manchego has a light yellow color, a closed semisoft body, slightly salty and very mildly acidic taste, and milky and buttery flavor notes. Although sometimes eaten as a snack, it is most often used as an ingredient in melting applications.

16.4.6 Queso Chihuahua

Queso Chihuahua is a traditional cheese native to the state of Chihuahua in Mexico, where it is known as Queso Menonita after the Mennonite community that lives in the state and first developed and commercialized the cheese. These Mennonites, however, call it Queso Chester, after the English Chester cheese they were initially trying to produce while using Cheddar manufacturing techniques (González-Córdova et al., 2016).

In the United States, the name "Queso Chihuahua" has been trademarked by one cheese manufacturer, so it is often found in the marketplace under the moniker of *Queso Quesadilla*. It is made of part skim cow's milk inoculated with mesophilic cultures. After cutting, the curd is cooked 30 min at ~32–38 °C (90–100 °F), drained and must undergo a cheddaring step. The cheddared curds are then milled, salted, molded, pressed, and ripened for 15–30 days (Villegas de Gante, 2004). The cheese is sold in wheels of varying sizes (Fig. 16.7) depending on the end user and is highly valued for its flavor and versatility, being used for snacking, pizzas, fondue, and especially quesadillas. Its typical composition varies and can contain 32.5–44.9% moisture, 26.2–36.1% fat, 17.6–27.6% protein, 0.73–1.55% salt, and a pH between 5.5 and 6.5 (Villegas de Gante, 2004; López-Díaz & Martínez-Ruiz, 2018). Its flavor is similar to a mild Cheddar cheese and can develop excessive acid and bitterness as it ages. Slight butter, brothy, and very slight sulfur notes are also sometimes present in this type of cheese.

16.4.7 Queso Cotija

The name comes from the town of Cotija, in the state of Michoacan in Mexico, although production of this cheese, with slight variations, occurs in the region located along the mountain range known as Sierra Jalmich, between the states of Michoacan and Jalisco. In 2005, a collective mark was registered for the manufacture of this cheese in the Jalmich region, and over the last 20 years, the artisanal manufacture of this cheese has been regulated and standardized to differentiate the original Queso Cotija from imitations made in other states. Queso Cotija is the only cheese in Mexico that has its artisanal production regulated by an official Mexican Norm (González-Córdova et al., 2016).

Queso Cotija is produced exclusively from mixed native-Zebu livestock (Holstein-Zebu, Brown Swiss-Zebu). The raw milk is standardized, allowed to naturally acidify, rennet set, cut, drained, kneaded, and salted. The curds are placed in cylindrical molds that are tightened with belts for 18–24 h, then pressed to further remove water. The cylinders are aged for at least 3 months under conditions that vary depending on the cheesemaker from refrigerated and moisture-controlled caves to ripening chambers barely below room temperature (Villegas de Gante, 2004; González-Córdova et al., 2016). The exterior surface of Queso Cotija is

sometimes rubbed with chili pepper paste to add some flavor and make it stand out in the marketplace (Fig. 16.8). The resulting cheese comes in cylinders that weight from 1 to 30 kg (2.2–66 lb) and have a hard and dry texture, closed, crumbly body (Fig. 16.9), with a unique blend of flavors developed by the native flora in the raw milk that varies based on the environmental conditions during its ripening and that can be harsh and unexpected to those unfamiliar with the cheese. The flavors in Cotija cheese can include cowy/barny, cooked milk, fruity, floral, yeast, musty, sulfur, butyric, waxy, soapy, oxidized, bite, and burn (Jimenez-Maroto et al., 2016).

Queso Cotija-style cheese made outside of the Sierra Jalmich region can be found under the names of Queso Sierra and Queso Cincho.

16.5 Latin American Cheeses: Brazil

16.5.1 Minas Cheeses

Minas (mines) cheeses are named after the state of Minas Gerais in Brazil, which were originally made by Portuguese immigrants on the seventeenth century who settled in that region to extract gold. Minas cheeses can be classified based on the final moisture content: Frescal (>55%) and Padrao (<46%; Oliveira & Brito, 2006).

Minas Frescal is a soft cheese that is produced at various manufacture scales (from small dairy farmers to high-scale industry), and its physicochemical properties are detailed in Table 16.4.

Fig. 16.7 Small format cylinders of Queso Chihuahua. (Photo from the authors' private collection)

Due to its high moisture content, Minas Frescal cheeses are typically consumed within 10 days after they are made. The manufacture protocol is similar to those used for other fresh cheeses, including the use of mesophilic starter cultures or direct milk acidification with lactic acid. These cheeses can also use different salting methods that can also contribute to rather variable composition. Direct salting of milk leads to an even distribution of salt in the final product, although a large proportion of the salt is lost in the whey. The application of a salt brine to the surface of the cheeses during the molding/turning stage produces cheeses with an uneven distribution of salt, which may lead to unbalanced flavors in the final product (lack of saltiness and bitterness). The immersion of cheeses into brine is currently the most common salting method used to unsure an even salt distribution in the final product.

Minas Frescal cheeses are produced in cylindrical shapes with varying sizes (0.5–3.0 kg or 1.0–6.0 lb) and have a white-pale color with mechanical openings in their structure. It is slightly salted and may have varying levels of acidity, which mainly depends on the use of direct acidification at low levels (pH 6.1–6.3; low acid, sweet cheeses) or the use of starter cultures. The latter tends to over-acidify cheeses, which may contribute with watering off and a grainy, undesirable texture. However, cheesemakers can address these issues during manufacture and thus avoid several of the defects in the final product. It is important to highlight Minas Frescal is closely related to a fresh cheese variety; hence, they can present various attributes/defects previously discussed.

In contrast, Minas Padrao cheese originated from modifications of the cheesemaking protocol from Minas Frescal that leads to a product with extended shelf life

Fig. 16.8 Two varieties of Queso Cotija: enchilado (surface rubbed with chili pepper paste) on the left, and plain on the right. (Photo courtesy of Dr. Arnoldo López-Hernández)

Fig. 16.9 Typical appearance of Queso Cotija, with a dry, hard body. The red specks come from close contact with the surface of an adjacent Queso Cotija that had red chile powder. (Photo from the authors' private collection)

and increased flavor development, due to a lower moisture content (<46%) and extended ripening time, respectively. These changes include pre-pressing the curd during whey drainage, pressing unsalted cheeses after molding and storing cheeses in a dry room (10–12 °C and 70% relative humidity for 24–48 h), followed by a ripening period (10–12 °C, or 50–54 °F, and 85% relative humidity for 10 days) to induce rind formation, as well as 10 days of extra storage (10–12 °C) in sealed packaging for flavor development and to avoid further moisture loss. The physico-chemical properties of Minas Padrao cheeses are detailed in Table 16.4. These cheeses are produced in cylinders of 0.8–1.0 kg (1.6–2.0 lb). On the exterior, they have a yellow protective rind with varying thickness, while the interior has a pale-yellow color with mechanical openings of irregular shape, caused by the way the cheeses are pre-pressed and pressed during/after manufacture (Fig. 16.10). They have a smooth body, slight acid development and tend to have a milky note due to their reduced ripening time, with some slight development of buttery notes, which is also dependent of the fat content.

16.5.2 Prato Cheese

In late 1880s, a Brazilian dairy manufacturer imported from Europe the technology and knowledge to adapt the production of rennet-coagulated cheeses with scalded (or cooked) curd step, similarly as traditional Dutch-style cheeses. Characteristic manufacture steps for Prato cheese include the addition of annatto to increase yellowness, the use of mesophilic starter culture blends for acid and flavor

Table 16.4 Physicochemical parameters of selected South American cheeses produced in Brazil, Argentina, and Chile

Cheese	Moisture (%)	FDM (%)	pH
Brazil[a]			
Minas Frescal	55.0–59.9	38.0–50.0	5.0–5.2 (microbial) 6.1–6.3 (acid-set)
Minas Pedrao	36.0–45.9	42.0–57.0	5.0–5.2
Prato	36.0–45.9	45.0–59.9	5.7–6.0
Argentina[b]			
Cremoso	46.0–54.9 (high moisture) >55.0 (very high moisture)	>50.0	5.1–5.4
Reggianito	<35.9	>32.0	5.3–5.5
Chile[c]			
Gauda	46.0–48 0.0	45.0–59.9	5.1–5.3
Chanco (farmhouse – Young)	46.0–50.0	>52.0	5.2–5.4
Chanco (farmhouse – Matured)	44.0–48.0	>50.0	5.2–5.4
Chanco (industry made)	44.0–48.0	>45.0	5.2–5.4

[a]Brazil, Ministério da Agricultura (1997, 2004, 2020) and Oliveira and Brito (2006)
[b]ANMAT (2018) and Wolf et al. (2021)
[c]Chile-INN (1999a, b) and Oliveira and Brito (2006)

development, a whey dilution step (i.e., partial whey drainage, around 25%, followed addition of warm water to the original whey level) to reduce excessive acid development, a curd-cooking step to 39–41 °C (102–106 °F) to reduce the final moisture content, pre-pressing of the curd in the whey, the addition of sodium nitrate (<50 mg/kg) to reduce the incidence of gas defects, brine salting, a 24 h drying period in a cold room, followed by vacuum sealing, and ripening at 12–14 °C (54–57 °F) for at least 25 days, but traditionally for 60 days. The physicochemical properties of Prato cheese are detailed in Table 16.4. Due to the curd cooking step, the moisture content is reduced (<46%) and exhibits relatively high pH values (5.7–6.0), due to the application of whey dilution. This makes the use of sodium nitrate critical, which is allowed by Brazilian legislation, to reduce the incidence of undesirable gas formation. However, the manufacture of cheeses with lower pH values (<5.6) and storage conditions that prevent the occurrence of gas defects are being preferred in recent years to avoid the use of this compound. Prato cheese is usually made in varying sizes, typically from <1 to 3 kg (<2 to 6 lb), and shapes: cylindrical (Prato Coboco), a loaf shape (Prato Lanche) for slicing applications, as well as a round shape (Prato Bola or Ball). Prato cheese has a characteristic yellowish appearance due to the addition of annatto, with a soft-firm texture (suitable for slicing) with milky and buttery notes, but milder overall flavor when compared with traditional Dutch-style cheeses, due to the relatively reduced ripening time. This variety does not form eyes and is considered as a defect when formed. Development of excessive acidity can occur when cheesemakers target low pH values to avoid the use of nitrates, which can lead to a brittle texture that makes them unsuitable for slicing.

Fig. 16.10 Body of Minas Padrao cheese exhibiting a thin rind and mechanical openings. (Photo from the authors' private collection)

16.6 Latin American Cheeses: Argentina

16.6.1 Cremoso

Cremoso is one of the main varieties produced in Argentina, leading up to 40% of total cheese volume produced. This cheese was originally developed by Italian immigrants, who made a product with similar characteristics to the traditional Italian varieties of Crecenza, Taleggio, and Bel Paese. Its manufacture process uses mesophilic starter cultures for acidification and rennet for coagulation of pasteurized milk, followed by cutting the curd, whey drainage, curd washing, molding, brine salting, and a ripening time of 20–45 days at 12–14 °C (54–57 °F) and 85–90% relative humidity. The physicochemical properties of Cremoso cheese are detailed in Table 16.4. According to Argentinian legislation, Cremoso cheese can be made with high (<55%) or very high moisture content (>55%). It is usually made in 2.5–5.0 kg (5–10 lb) square-like shapes, with a yellow-pale appearance, a soft, long body, with no eyes or mechanical openings, pasty texture, very low acidity, and definite milky notes. Cremoso cheese is generally served with sweet deserts, such as dulce de membrillo (a typical South American jelly made of quince) or dulce de batata (sweet potato jelly), and is also used as a substitute of Mozzarella cheese for pizza applications due to its melting properties.

16.6.2 Reggianito

Similar to Cremoso, this variety was originally made by Italian immigrants who were trying to produce their own version of the traditional Parmigiano Reggiano cheese. It is the only hard grana-style cheese produced in Latin America that is made by cheesemakers from small and large manufacturing scales. The

physicochemical properties of Reggianito cheese are detailed in Table 16.4. When compared with European varieties, Reggianito has a reduced ripening time (6–12 months instead of ≥2 years), as well as higher moisture and fat contents. This variety is made in wheels of 5 or 10 kg (10–20 lb) and contains a pale-yellow rind of varying thickness (Fig. 16.11). The rind can also be painted, mostly black. It is common to place labels above the rind, which can be glued or not. On the inside, Reggianito cheese has an ivory-yellow appearance with a compact, grainy, and hard-brittle texture. Depending the manufacture conditions (composition and pressing), mechanical openings can be observed. The flavor intensity could be milder than traditional varieties due to its reduced ripening time but is perceived as definite salted, with slight piquant notes and characteristic notes found in these varieties, due to metabolism of main components of milk during cheese manufacture and ripening. A common defect for this variety is undesirable gas formation caused by metabolism of lactic acid by clostridia spores that can also produce butyric acid, which is associated with development of undesirable aromas, known as "baby vomit."

16.7 Latin American Cheeses: Chile

16.7.1 Gauda

This variety is a local version of the traditional Dutch-style cheese Gouda and is considered one of the most common cheese varieties produced in Chile, with nearly 45% of the total volume produced. It was introduced by European manufacturers to the Chilean dairy industry in the 1950s and nowadays is mostly made in large-scale cheese plants. The manufacture protocols are similar than those used in Prato cheese, although the target moisture content is higher in Gauda (Table 16.4) and can be made in full-fat or reduced-fat versions. The use application of sodium nitrate is allowed (≤50 mg/kg). It is ripened for 15–30 days at 10–15 °C (50–60 °F). The physicochemical properties of Gauda cheese are detailed in Table 16.4. Cheese blocks of rectangular shape vary in size from 2 to 15 kg (2–30 lb). It has no rind, a yellow color, a semi-firm and elastic texture that makes it suitable for slicing and may present small eyes in the body due to citrate fermentation. Similar to Prato, it is a milder version of Dutch-style cheeses with milky and buttery notes.

16.7.2 Chanco

Chanco is a cheese variety named after the town of Chanco, located approximately 300 km (186 mi) south of Santiago, the capital of Chile. Originally made by Spanish immigrants in the eighteenth century, Chanco is the second most common cheese produced in Chile, making up ~25% of the total volume. It is made by small and

Fig. 16.11 Typical appearance of Reggianito cheese. (Photo courtesy of Dr. Elisa Ale and Dr. Guillermo Peralta (Instituto de Lactologia Industrial, Santa Fe, Argentina))

artisan cheese manufacturers that typically use raw milk as well as by large cheese companies that use pasteurized milk. This cheese is made with the use of mesophilic starter cultures and rennet. As with Gauda and other Latin American varieties, a whey dilution step is applied to reduce the level of acid development in the final product, which can differ based on the scale of production. After partial (25–35%) whey drainage, small/artisan cheesemakers add hot water (~70 °C; 158 °F) back into the curd/whey mixture in the same proportion to that of the whey that was drained to reach typical cooking temperatures (38–40 °C; 100–104 °F), whereas large manufacturers add water at the same temperature to the curd/whey mixture, following a gradual increase of temperature to reach cooking conditions. Chanco cheese can be salted by various approaches:

1. Prior to molding, the curd is partially salted with 1 L (1 quart) of 30% (w/v) brine solution per 100 L (25 gallons) of cheese milk, followed by brine salting of the cheese blocks/wheels after pressing.
2. Salting the curd with a 2 L (2 quarts) of 18% (w/v) brine solution per 100 L (25 gallons) of cheese milk.
3. Dry salting prior to molding.

One of the advantages of the last approach is that reduced levels of salted whey are produced. The ripening time can range between 7 days and 6 weeks at 10–14 °C (50–57 °F) and 85% of relative humidity (Fig. 16.12). During this time, cheeses are turned daily to allow the formation of a homogeneous thin rind. In addition, the rind is washed with a brine solution to avoid the formation of fungi. Alternatively,

cheeses can be coated with wax or other commercially available products (Fig. 16.13).

The physicochemical properties of Chanco cheese are detailed in Table 16.4. These parameters can differ based on the scale of production as well as the final use of the cheese. For instance, Chanco cheese with increased moisture content is referred as Mantecoso cheese and is desirable by some consumers that associate its pastiness with increased fat content (creamier). Similarly with Gauda, the application of sodium nitrate is allowed (≤ 50 mg/kg), although it is not generally used by cheesemakers. Chanco cheese is also known as Campo Bueno, El Rincon, Huentelauquen, Llifen, Los Alerces, Los Alpes, Los Fundos, Quilpue, and Ranco. Nevertheless, there is no standard of identity for any of these names. Chanco cheeses can be found in several sizes and shapes: rectangular cheese blocks of 5 or 10 kg (10–20 lb.; Fig. 16.12), as well as wheels of 0.5 to 2 kg (1–4 lb.; Fig. 16.13). The color is pale yellow, and the rind should be free of molds. On the inside, Chanco cheese should only present mechanical openings of irregular shape (Fig. 16.14), due to a relatively gentle pressing. Chanco cheese has a semi-hard consistency and a creamy body and has typical milky and buttery notes. Some defects found in this variety are development of excessive bitterness which can be caused by high residual chymosin activity that contributes with increased proteolysis, due to low salt content, high levels of coagulant added during cheese manufacture, as well as temperature abuse during ripening, storage, and transport; accumulation of calcium lactate crystals on the surface of retail blocks (Fig. 16.14) and slices, due to development of excessive acidity (inadequate control of acid by whey dilution) and temperature abuse. However, this defect can also occur in various Latin American varieties if those two conditions take place. Undesirable gas formation leads to the formation of rounded eyes and is caused by the metabolism of sugars and/or organic acids by

Fig. 16.12 Ripening of Chanco cheeses. (Source: Guzman & Ilabaca, 2007)

Fig. 16.13 Typical appearance of an artisan Chanco cheese with waxed rind. (Photo courtesy of Hardy Aviles (Osorno, Chile))

Fig. 16.14 Accumulation of calcium lactate crystals in the surface of a retail Chanco cheese block. This defect is common in various cheese varieties that exhibit excessive acid development and accumulation of serum in the surface. (Photo from the authors' private collection)

nonstarter lactic acid bacteria and contaminants, such as coliforms or spores. Interestingly, Chanco cheese has been made with different proportions of cow's and goat's milk, in which increasing levels of goat's milk lead to cheeses with a whiter appearance, brittle texture, and goaty notes (Vyhmeister et al., 2019).

16.8 Final Remarks

Increased popularity of Latin American-style cheeses in the US market is caused by a large proportion of consumers with Hispanic heritage, along with the high popularity of Latin American cuisine among US consumers, which has increased >5 times the production of Latin American cheeses in US cheese plants over the last 25 years. However, most of the cheese varieties found in the United States are from Mexican origin. Despite the great diversity of cheeses found throughout Latin America (i.e., fresh-style cheeses, melting cheeses, semi-hard cheeses, and age-hard cheeses), there are various examples of cheeses made with similar manufacturing approaches and composition, although the final sensorial experience perceived by consumers of Latin American cheeses can greatly differ, due to the cheeses' historical, cultural, and regional background.

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