



TÜRKİYE'S WHEY CHEESES

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Abstract: In parallel with the increase in the population in the world, the amount of milk production also increases and a significant part of it is processed into cheese. Whey, which is mostly a by-product of the cheese industry, has a very high nutritional value and is used in the production of different cheeses in various countries. Different whey cheeses can be produced by processes such as thickening of whey by boiling, kneading curd cheese by mixing with different brine solutions, using yoghurt, butter, Çökelek, local herbs etc. in production, maturing in different ways. Ricotta, Mysost, Primost, Mascarpone, Requesón, Serac, Brousse, Zieger, Manouri, Myzithra, Ziger, Urda, Klila etc. are famous whey cheeses in the world. In Türkiye, cheeses such as Lor Peyniri (widely), Tire Çamur Peyniri, Horç, Tort/Dolaz, Kopanisti, Armola, Sepet Loru, Kirlihanım Peyniri, Taze Keş, Sarı Keş, Antakya Sürkü, Antakya Küflü Sürkü, Sirvatka Loru, Dumas Çökeleği, Otlu Lor and Şor Loru are cheeses made from whey.

Whey cheeses produced in Türkiye have been dealt with separately or in summary in the literature and gathered in a joint report with this study.

Keywords: Whey, Whey cheeses, Lor, Horç, Dolaz

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1. Introduction

Whey is a dairy by-product obtained after coagulation of milk, mostly cheese production, and contains all milk components dissolved in milk in varying proportions (Zall, 1992; Tunick, 2008; Yerlikaya et al., 2010). While this precious product used to be used as animal food and fertilizer or appears as waste around the world, it is now used in various products such as infant formulas, food supplements, sports bars and beverages to meet the various health goals of people of all ages (Hong, 1983; Gangurde et al., 2011; Karimidastjerd and Gulsunoglu-Konuskan, 2021).

Whey is among the drinks that Hippocrates recommended about 2500 years ago to increase the body's immune system, strength and muscle growth rate. In the late 16th century, the importance of whey protein was rediscovered when some Swiss farmers noticed that the pigs fed with whey grew faster than others. So the farmers began to drink the whey themselves. When they noticed improvement in their health, the news quickly spread throughout the country. In the last 20 years, whey protein has transformed from being a waste product of cheese making into a very valuable product in terms of its nutritional and functional properties (Gangurde et al., 2011; Çelik and Yüksel Önür, 2020).

Depending on the type of cheese, 1 kg of cheese is produced from 10 kg of milk, and 9 kg of whey is released. Considering the amount of cheese produced worldwide on a daily or annual basis, this figure reaches much more remarkable dimensions. This whey is left to

sewers in significant volumes in our country and some other countries, especially in small businesses. However, the disposal of these by-products causes significant losses in terms of energy and protein resources, as well as causing serious problems in the environment with high biological and chemical oxygen demand (Pintado and Malcata 2000; Almeida et al., 2008). For this reason, a number of countries have introduced strong legislation prohibiting the discharge of whey into streams, rivers and even municipal sewage systems (Smithers, 2015; Blažič et al., 2017).

Over the last seven decades, technological advances, increased processing capacities and new business models have shaped the dairy industry and supported the production of new value-added ingredients derived from whey. The isolation of whey components and the production of powdered whey components have been successful through the development of processing technologies, particularly membrane filtration. In combination with centrifugation and electrodialysis, it allowed the production of pure protein fractions (Yerlikaya et al., 2010; Tsermoula et al., 2021). However, since the production methods of whey proteins require large capital investments, they can only be made by a few large dairy enterprises in our country. In some other businesses, it is turned into powder or given to the milk powder factories for a very low fee or free of charge. On the other hand, in small dairy enterprises, it is used for the production of whey cheese called Lor or it is discarded without being used (Ekin, 2016).



Hatipoğlu and Çelik (2012) in their study on traditional cheeses produced in the Karacadağ basin of Diyarbakır province and the problems encountered, reported that the whey, which is referred to as waste in cheese production, was mostly (90%) not evaluated; and it was used (10%) in making butter or Lor in very few businesses and it was used by adding it to the brine at a low rate to get a brighter appearance.

In our country, dairy products are produced in small family businesses as well as industrially. Here, whey is either processed into Lor Peyniri or is encountered as waste. In this respect, this valuable product can be partially evaluated by processing it as whey cheese in these small businesses, and by increasing people's awareness on this issue and encouraging its consumption. In this study, cheeses produced from whey in our country are discussed.

2. Whey Cheeses

2.1. Lor Peyniri

Although the terms “Lor” and “Çökelek” are sometimes used interchangeably in our country due to their external similarities, the two are different products. Çökelek is a product obtained by precipitating the milk by adding lemon or some local herbs to facilitate precipitation after its acidity increases, and it contains both casein and whey proteins. It is also known as Ekşimik, Süt Koptu, Akkatik, Kesik, Torak, Urda, Süt Kırmısı or Jaji in its dried form in different regions (Kamber, 2008; Çardak, 2012).

Lor, on the other hand, is a low-fat or fat-free cheese obtained from the precipitation of whey from milk cheese production or buttermilk from yoghurt butter production, and contains less casein since the milk was previously processed into another product. It mostly consists of whey proteins and is sometimes consumed by mixing with products such as yoghurt, butter, Çökelek, local herbs, etc. to increase its flavor (Kamber, 2008; Çardak, 2012). There are some very popular cheeses among whey cheeses in the world. Ricotta in Italy, Argentina and America, Mysost, Primost, Gjestost, Grubransdalsost in Norway, Schottenziegr, Hudelziger, Mascarpone in Switzerland, Requesón in Spain, Serac, Brousse, Broccio, Greuil in France, Zieger, Schottenzieger in Germany, Manouri, Myzithra, Anthotyros in Greece, Ziger, Urda in Romania, Klila in Tunisia, Urda in Israel, Requeijão do Norte, Ricotta Fresca in Brazil, could be examples of cheeses made from whey (Irkin, 2011; Ekin, 2016; Salameh et al., 2016).

When the whey is heated, the remaining proteins (albumin and globulin) that do not coagulate with rennet and can be precipitated by heat are collected on the surface as clots. Acidity facilitates this separation. The well-known example of this in our country is Lor Peyniri (Kurt and Gülümser, 1987).

In our country, Lor Peyniri is generally produced in family businesses according to the traditional method. The whey remaining after cheese production is boiled in boiling cauldrons until coagulation is formed. After

boiling, the clot particles (serum proteins) collected on the surface of the boiler are removed and the water is filtered using fine porous cloths. Straining is done for periods ranging from 1 to 4 days. When the desired humidity is obtained, 2-8% salt is added to the product and offered for consumption (Demirci et al., 1994; Tekinşen and Tekinşen 2005). It is used in Turkish cuisine for making pastry, pasta and salads or, as in the Eastern Black Sea region, for breakfast dishes such as Buğulama and Mıhlama. (Durlu-Özkaya and Gün, 2007). The visual of Lor Peyniri is presented in Figure 1, its chemical and microbiological properties are presented in Table 1 and Table 2.

Lor Peyniri is a nutritious food and is very prone to microbial spoilage. It can turn into a microbiological threat in terms of public health and shorten the shelf life of cheese, if it is not produced and offered for sale under appropriate conditions (Tanis et al., 2021). Compared to air or vacuum packaging for Lor Peyniri, modified atmosphere packaging prevents the development of microorganisms that cause deterioration of the product and prolongs the shelf life of the product (Irkin, 2011; Temiz et al., 2009).



Figure 1. Lor Peyniri.

Table 1. Chemical properties of Lor Peyniri

	Demirci et al. (1991)	Sönmez et al. (2019)	Çardak (2012)	Ergüllü (1982)
Total solid (%)	25.99	28.70-29.15	27.87-41.87	27.57
Fat (%)	5.34	11.24-11.46	2.80-6.60	7.30
Protein (%)	13.50	-	10.21-21.05	12.88
Ash (%)	1.24	2.40-2.30	2.11-3.45	1.12
Lactose (%)	5.91	-	-	7.50
Salt (%)	-	0.46-0.76	1.12-2.23	-
Acidity (% LA)	1.31	0.46-1.84	0.33-0.82	0.31
pH	-	5.90-5.48	3.75-5.93	-
n	17	50	25	17

Table 2. Microbiological properties of Lor Peyniri (log cfu/g)

	Sert and Kivanç (1985)	Demirci et al. (1991)	Sönmez et al. (2019)	Çardak (2012)
TAMB	7.75-8.77	6.11-8.46	7.15-8.02	3.46-6.72
Coliform	0-4.60	4.00-6.60	4.44-4.57	<0.47->3.04
<i>E. coli</i>	-∞-3.54	-	3.41-2.52	<0.47->3.04
<i>S. aureus</i>	-∞-1.30	-	1.86-2.52	2.69-4.85
Fecal streptococcus	2.55-4.41	-	-	-
Yeast and mold	3.53-7.92	-	1.86-4.14	2.34-4.90
n	18	17	50	25

TAMB= total aerobic mesophilic bacteria

2.2. Tire Çamur Peyniri

Tire Çamur Peyniri is a spreadable cheese traditionally produced in Tire district of İzmir and is consumed at breakfast (Dağ and Keskin, 2020; Hastaoğlu et al., 2021; Karaalioğlu et al., 2021). While it was previously made with the whey obtained from the production of Beyaz Peynir or İzmir Tulum Peyniri made from sheep and goat milk, today it can also be produced from the whey of these cheeses produced from cow's milk or their mixture (Keskin and Dağ, 2020).

To make Tire Çamur Peyniri, Lor Peyniri is first prepared. If cow's milk is used in production, some milk can be added to the whey at the beginning (Dağ and Keskin, 2020). The whey and milk mixture is heated to 90-95 °C and kept at this temperature for about 30 minutes. Curd collected on the surface is transferred to cloth bags, left to drain, and Lor Peyniri is obtained in this way. The second whey remaining from the Lor Peyniri production is cooled to be used in the kneading process. About 2-3% of salt is added to the Lor Peyniri and left to stand for 4-5 hours. Then, the cooled second whey is added little by little and kneaded well. As a kneading solution, ripened

tin Tulum Peyniri brine (prepared with second whey) or normal brine can also be used. Cream can also be added at this stage, if desired. The amount of brine added is measured according to the desired consistency of the cheese. It becomes ready for consumption as a soft cheese suitable for spreading. Çamur Peyniri is stored in a cool place (Çelikel et al., 2020; Karaalioğlu et al., 2021). The visual of Tire Çamur Peyniri is presented in Figure 2, and its chemical and microbiological properties are presented in Table 3 and Table 4.



Figure 2. Tire Çamur Peyniri.

Table 3. Chemical properties of Tire Çamur Peyniri

	Ak and Nergiz (1998)	Erdoğan (2020)	Karaalioğlu et al. (2021)
Total solid (%)	37.94	30.35-27.33	31.20
Fat (%)	25.82	-	16.40
Protein (%)	6.75	-	10.95
Salt (%)	3.16	1.02-2.20	-
Ash (%)	0.96	-	-
Acidity (%)	-	0.10-0.08	0.22
pH	-	6.77-5.15	5.50
a _w	-	0.92-0.90	-
n	-	4	8

Table 4. Microbiological properties of Tire Çamur Peyniri (log cfu/g)

	Ak and Nergiz (1998)	Erdoğan (2020)
TAMB	9.69	4.99-4.56
Total psychrophilic aerobic bacteria	-	4.99-4.56
Yeast and mold	6.77	3.35-3.87
Lactic acid bacteria	-	3.46-5.35
Total coliform bacteria	6.87	1.75-2.27
Fecal coliform bacteria	-	1.46-1.91
n	-	4

TAMB= total aerobic mesophilic bacteria

2.3. Horç

Horç is a traditional whey product produced by the Yoruks (Yoruk is the Turkish people who have preserved the nomadic lifestyle) living in Anatolia for years (Eliuz, 2020). It was determined that it was known as Horç in Erdemli and Silifke regions, and made by the Yoruks living around Isparta, Afyon, Antalya (in the lakes region), and it was known as Tort/Dolaz there, and it was given different names as Sarı Keş in the Anamur region (Uçgun and Işık, 2018).

Horç is made from sweet whey. Its making steps are summarized by Uçgun and Işık (2018) and Eliuz (2020) as follows: Raw milk is heated to 30-35 °C and fermented for approximately 2 hours by adding ~5ml of rennet for 30 L of milk. Cooking is started after scratches are made on the formed clot with the handle of the spoon. In the meantime, it is stirred frequently and the cooking is stopped when the whey is separated. The mixture is filtered through cloth bags and the obtained whey is collected in a cauldron. At this stage, some milk can be added upon request. Subsequently, heat treatment is applied again. When it starts to boil, the curd formed is taken with ladles and boiling is continued. Boiling time varies depending on the amount of whey. If its amount is high, it takes a long time to reach a certain consistency. After the whey thickens (Figure 3), curd taken can be added back at this stage.



Figure 3. The thickened state of heat-treated whey.

By reducing the cooking temperature, heat treatment is applied for another 15-20 minutes. It is then cooled and

filtered through cloth bags. The filtrate is pressed for 1-2 days. After suppressing, it is crumbled, salted, optionally mixed with Çökelek and pressed into a skin bag (tulum) or plastic drums. It can be stored in a pothole or cold storage at 4 °C for 3-4 months. Horç, which is pressed into skin bag and rested in a sinkhole, is more delicious than the one that is pressed into a plastic drum. 2.5 kg Horç is obtained from 30 kg of milk. The image of Horç is presented in Figure 4.



Figure 4. Horç.

Horç can be consumed plain, or it can be consumed by adding raw or roasted onions in butter. Again, it is mixed with Çökelek made from the local buttermilk, and then “Sıkma” is done, especially when phyllo bread is made. Sıkma is made as follows; after the flatbread is cooked, it is buttered, wrapped by putting the Horç with onion inside, and squeezed from both sides by hand. Local tradesmen have it made collectively and eat it for breakfast. It is consumed at breakfast and afternoon meals (Uçgun and Işık, 2018).

2.4. Tort and/ or Dolaz

Tort and/or Dolaz are cheeses traditionally made by the Yoruks living in the Mediterranean region around Isparta, Antalya and Afyonkarahisar (Şimşek and Sağdıç, 2006). Tort is obtained by boiling the whey and subjecting it to heat treatment for a long time; Dolaz, on the other hand, is a product obtained by using milk, flour, butter, tort and yoghurt. (Ak and Bulut, 2020). They are produced from sheep, goat and cow milk, mostly sheep and goat milk. However, they are not produced much due to the decrease in sheep and goat husbandry recently (Okur, 2010).

Tort is made by boiling the whey for a long time and then straining it in cloth bags, putting heavy stones on it and pressing, then crumbling the product obtained and pressing it into skin bags or plastic drums. There are some points to be considered while making Tort: First of all, the cauldron in which the whey is boiled is covered with mud from the outside to prevent sticking and burning. Pressing into the skin is more preferred, as the excess water of the cheese will be better drained from its pores. While filling these materials, which are used as tort packaging material, they are pressed tightly and even sticks called "saplık" are used among the people for this. Otherwise, the porosity of the product will increase and air will remain inside. This causes the product to turn green (göğermek) that is, to mold and spoil. Şimşek and Sağdıç (2006) also stated that butter or Çökelek can be optionally added during the pressing into the skin bag.

Tort prepared in this way is taken out a little when it is to be consumed and poured into the butter melted in the pan. After roasting for a while on low heat, a small amount of water and some crumbled phyllo bread pieces are added. It will be ready for consumption after it has been fried for a while. The people call this food Tort or Deli Dolaz (Ak and Bulut, 2020).

Traditionally, in the production of Dolaz, whey, buttermilk, optionally milk, yoghurt and Lor Peyniri are used (Okur and Güzel-Seydim, 2011). If milk is used instead of whey, Dolaz made in this way is also called Süt Dolazı or Akıllı Dolaz (Milk Dolaz or Smart Dolaz). It is made by adding Tort to milk (Ak and Bulut, 2020).

Okur and Güzel-Seydim (2011) obtained cheese samples from the Isparta region in their study to determine the production method, microbial and sensory properties, and aroma components of traditional Dolaz cheese and reported the production of this cheese by observing it on site. Dolaz samples used in this study were prepared using whey (53%), buttermilk (10%), optionally milk (10%), and yoghurt (25%), Lor Peyniri (2%). The mixture prepared in this way was taken into the cauldron and subjected to heat treatment by frequently mixing with a long, cylindrical wooden mixer called "Bişşek" by the local people. Its color was yellow-light brown and heat treatment was applied until it had a consistency. After the heat treatment, it was cooled by resting for 12 hours and then transferred to cloth bags for filtration. After being matured in bags for 3-4 days, it was salted and filled into bags again and kept for 5 days. At the end of this period, it was mixed with some butter depending on preference and stuffed by pressing into the skin bag. The skin bags were kept in cool rooms (15 °C) for 15-20 days. Dolaz production was similarly expressed by Yerli et al. (2018). The visual of this cheese is presented in Figure 5.



Figure 5. Dolaz.

Like other whey cheeses, Dolaz contains all of the essential amino acids in high concentrations and stands out with its functionality. It can be stated that aldehydes and aldehyde derivatives, which are formed mainly by lactic acid fermentation and the maillard reaction during cheese production, add a characteristic aroma to Dolaz cheese (Avcı et al., 2021). According to the descriptive sensory analysis findings, the characteristic sensory properties of Dolaz were determined as a soft, yellowish-light brown color, unique smell and taste, no cooked taste despite long-term heat treatment, and a granular structure similar to Çökelek (Okur and Güzel-Seydim, 2011).

Dolaz is classified as fatty and soft cheese according to its fat values in dry matter and dry matter (Okur, 2010). The researcher also stated that in the protein fraction analyzes of traditional Dolaz samples, especially α and β caseins and β -lactoglobulin bands were observed. Alanine, Leucine- Isoleucine and Histidine were the free amino acids most detected in Dolaz samples. Some volatile components such as acetaldehyde, acetone, ethanol, acetic acid, diacetyl and 1-butanol were detected in Dolaz samples. It was also reported by this researcher that the characteristic natural color of Dolaz is dark yellow-light brown. Chemical and microbiological properties of Dolaz are presented in Table 5 and Table 6.

Table 5. Some chemical analysis results of Dolaz

	Şimşek and Sağdıç (2006)	Okur (2010)
Total solid (%)	52.04	30,31-48,63
Fat (%)	17.70	6,5-19
Acidity	1.62	1,08-3,42
pH	4.58	3,58-5,61
Salt (%)	-	2,11-6,32
Protein (%)	15.21	21,49
n	10	

Table 6. Some microbiological analysis results of Dolaz (log cfu/g)

	Şimşek and Sağdıç (2006)	Okur (2010)
TAMB	5.41	7,68-8,23
Yeast-mold	4.13	6,90-7,37
Coliform	-	2,83-3,84
Lactobacillus	-	7,87-8,08
Lactococcus	-	7,63-8,17
n	10	-

TAMB= total aerobic mesophilic bacteria

2.5. Kopanisti

Kopanisti is a cheese produced in the Greek islands in the Aegean Sea and around İzmir in our country. While it was produced in a larger area consisting of Çeşme, Karaburun, Foça and Urla districts of İzmir and exported to the Greek islands in the Aegean Sea, today it is made by a few families with traditional methods only in Karaburun, Sakız and Midilli. (Akpınar et al., 2014).

Kopanisti is a cheese of Greek origin and the word "Kopanisti" means "kneaded" in Greek (Hastaoğlu et al., 2021). In Greek islands, it is made from sheep, goat or cow's milk or from a mixture of such milks, and in our country, whey. It has a taste reminiscent of Roquefort cheese and it appeals to a certain consumer segment due to its intense aroma and bitter taste (Karabiyıklı and Karapınar, 2006). In addition, mold growth is desired in the production of Kopanisti in Greece. In our country, although surface molding is not observed in the cheese in question, molds have an important place in the microbial flora.

The production technique of Kopanisti shows slight differences according to the districts in our country. This cheese is made from the curd obtained from the whey released in the production of Sepet Peyniri from goat's milk. The main feature of its production is that the curd is transferred to earthen pots and kneaded in these pots until the desired sensory properties are obtained (Dağ and Keskin, 2020).

In the production of Kopanisti, Sepet Peyniri is obtained primarily by using goat's milk, and the remaining whey is heated to 80-85 °C in a separate boiler. In the meantime, 10-20% of fresh goat's milk is added and the heating process is continued. Then the heating is stopped and the mixture in the boiler is left to cool. Cooling of the heated whey is continued until curd is completely formed. This time is approximately 45 minutes. After a while, the clot, which starts to collect on the surface, is taken with ladles

and transferred to cheesecloth or knitted baskets. It is left to drain for a few days. The curd obtained is taken into glazed and thoroughly cleaned earthenware pots called "dahar" or "taar" and kneaded thoroughly. The kneading process is repeated several times each day for 15-30 days. However, if the air temperature is low, the time between two kneading operations may be longer, and if the air temperature is high, the time between two kneading operations may be shorter. Meanwhile, if there is any newly made curd, it is added to the bowl and kneaded together. In the last stages of the kneading process, the upper surface of the cheese acquires a shiny, slippery appearance, cracks appear in places and it begins to emit a heavy odor. At this stage, salt is added to the cheese and kneaded again. The salting process is generally carried out in three stages. In the first salting, the cheese is kneaded by adding some salt and kept for three days. The second salting is done on the third day and the third salting is done 7-10 days after that. The amount of added salt is at least 5% in dry matter. In the meantime, various substances such as black cumin can be added to the cheese. Kopanisti cheese, which can be consumed when the salting process is over, is preserved in the pots where the kneading process is done. Since the dahars are without a lid, they are covered with a cloth and some olive oil is added to the cheese to prevent contact with air and stored at temperatures below 10 °C (Dağ and Keskin, 2020; Musullugil et al., 2022). The picture of Kopanisti cheese is presented in Figure 6.

An important feature of the traditionally produced Kopanisti is the addition of one percent ripe Kopanisti cheese to the fresh curd to accelerate ripening. This mature Kopanisti is called "Mana" (Greek word for mother).

Since Kopanisti is soft enough to be spread on bread, has a creamy consistency and a roquefort flavor, it is generally used as an additive and appetizer. Especially as

an appetizer, melon, raki and Kopanisti are a traditional trio. Apart from breakfast, additives are made with melon and white grapes, especially in summer (Uhri, 2017). Kopanisti can also be consumed in table cheese and cheese pie. Locals prepare a dish called "Mykonianrusks" by spreading Kopanisti, moistened with a little water and olive oil, on bread and topping it with tomatoes (Dağ and Keskin, 2020).



Figure 6. Kopanisti.

Since it has a heavy aroma, it is famous for being eaten with the tip of a fork, not a bite. In addition, diluting it with olive oil rather than eating it directly adds an indescribable flavor to the taste of this cheese (Anonymous, 2010). Karabıyıklı and Karapınar (2007) defined lactic acid bacteria that play a role in the fermentation of Kopanisti cheese as *Lactobacillus brevis*,

Lactobacillus buchneri, *Lactobacillus casei*, *Lactobacillus collinoides*, *Lactobacillus johnsonii*, *Lactococcus lactis* subsp. *cremoris*, *Lactobacillus mali*, *Lactobacillus minor*, *Lactobacillus oris*, *Lactobacillus parabuchneri*, *Lactobacillus reuteri*, *Lactobacillus sanfrancisco*, *Lactobacillus sharpeae*, *Lactobacillus suebicus*, *Lactobacillus vaginalis* ve *Lactobacillus viridescens*.

Ergüllü et al. (1998) determined the yeast flora of Koponisti cheese as *Pischia membrane fasciens*, *Trichon cutaneum*, *Kluyveromyces lactis*, *Kluyveromyces marxianus* spp. *lactis*, *Saccaromyces cerevisiae*, *Rhodotorula ruba*, *Rhodotorula mucilaginosa*, *Candida lusitanrae* and *Debaryomyces hansei*. *Pischia membrane* formed the dominant yeast flora. They stated that *Penicillium* species are common as mold flora and *Penicillium commune* constitutes the dominant flora.

Ergüllü et al. (1998) reported short chain fatty acids in Kopanisti as Butyric acid (5,3%), Caproic acid (2,7%), Caprylic acid (3.1%), Capric acid (9.9%), Lauric acid (3.9%), Myristic acid (9.9%), Palmitic acid (23.4%), Stearic acid (13.1%); long chain unsaturated fatty acids as Oleic acid (20.3%), Linoleic acid (1.6%), Linolenic acid (1.9%). The chemical properties of Kopanisti cheese are presented in Table 7.

The total aerobic mesophilic bacteria (TAMB), lipolytic bacteria, proteolytic bacteria, yeast and mold numbers of Kopanisti cheese were determined by Ergüllü et al. (1998) as 5.51, 4.40, 4.43, 3.66 log cfu/g, respectively, and it was reported that there was no coliform bacteria. Karabıyıklı and Karapınar (2007) determined the microbiological properties of Koponisti during the 26-day storage period as follows (Table 8).

Table 7. Some chemical analysis results of Kopanisti

	Ergüllü et al. (1998)	Akgün (1988)
Total solid (%)	42.2	48.4
Fat (%)	14.3	16.1
Protein (%)	16.8	-
Salt (%)	6.3	12
Ash (%)	4.14	-
Acidity (%)	2.63	2.12

Table 8. Some microbiological properties of Kopanisti (log cfu/g) (Karabıyıklı and Karapınar, 2007)

Days	MRS Agar	M17 Agar	DRBC Agar (yeast)	DRBC Agar (mold)
0	9.72	9.65	7.26	9.65
1	9.59	9.46	6.46	9.46
7	8.94	8.46	6.36	8.46
14	8.15	8.15	6.04	8.15
21	9.04	9.04	6.82	9.04
26	8.92	8.52	< 1	8.52

2.6. Armola

Armola cheese is produced in Seferihisar, a quiet town in Izmir. This cheese, which is made in almost all villages of Seferihisar, has emerged as a traditional evaluation

method. It is a product inherited from the Greeks in our country and Armola means "whey" in Greek (Dağ and Keskin, 2020). In the past, they used to stuff Tulum Peyniri into the skin of their animals and when the Tulum

Peyniri was about to run out, they would add yoghurt, Lor Peyniri etc. left in the house and some milk on top of it so that the cheese crumbs left in the skin bag would not go to waste. It is rumored that Armola emerged in this way. Although it is made in different ways because it is a mixed cheese, it is mostly made by mixing strained yoghurt, Beyaz Peynir and low salt Lor Peyniri (Dağ and Keskin, 2020).

In the study of Yoldaş (2017), the mixture was prepared using 10 kg of pasteurized cow's milk, 3 kg of full-fat unsalted Lor Peyniri, and 5kg of full-fat yoghurt to make traditional Armola. A small amount of salt was added to the prepared mixture and pressed into skin bag, and it was matured by closing its mouth in an airtight manner. Armola cheese is matured for an average of 1 month by hanging the skin bag in a cool and airy place. Meanwhile, some filtrate drains from the skin and the cheese hardens. In order to soften the cheese and maintain its consistency, goat milk is added after a few days, and the skin is rubbed from the outside to ensure homogeneous distribution of the milk. This is why it is called "milk cheese" in some villages. In addition, to prevent deterioration of the skin, the skin is rubbed with salt from the outside and this process is repeated frequently.

It is consumed for breakfast by adding thyme, chili pepper, olive oil and mint to Armola cheese (Figure 7). It is also widely used in salads and sauces.



Figure 7. Armola prepared for presentation by adding mint, thyme and olive oil.

In her study to determine the quality characteristics and shelf life of Armola, Orşahin (2012) determined the chemical and microbiological properties of 40 cheese samples obtained from dairy farms in Seferihisar, as in Table 9 and Table 10, respectively.

Table 9. Some chemical properties of Armola (Orşahin, 2012)

Total solid (%)	Fat (%)	Salt (%)	Protein (%)	pH	Acidity (%)	a _w	n
37.26	19.52	2.51	10.87	4.70	0.95	0.91	40

Table 10. Some microbiological properties of Armola (log cfu/g) (Orşahin, 2012)

TAMB	Coliform	Lactococcus	Lactobacillus	Enterococcus	Yeast	Mold	Staphylococcus spp.	n
7.82	4.56	7.55	7.87	6.17	7.33	-	5.94	40

TAMB= total aerobic mesophilic bacteria

The high microbial load in Armola cheese showed that the hygienic conditions in production were quite low. In the sensory analysis, the dominant basic flavors were salty and sour, while creamy, baked and whey flavors were found to be aromatic flavors. According to the genotypic identification results, the dominant bacteria were reported as *Enterococcus ratti*, *Enterococcus durans*, *Enterococcus hirae*, *Streptococcus lutetiensis*, *Streptococcus equines*, *Streptococcus luteciae*, *Lactobacillus paracasei* subsp. *tolerance*, *Lactobacillus casei* subsp. *casei*, *Lactobacillus zaeae*, and *Lactobacillus paracasei* subsp. *paracasei* (Orşahin, 2012).

2.7. Sepet Loru and Kirlihanım Peyniri

2.7.1. Sepet Loru

Sepet Loru is produced in the South Marmara Region and the North Aegean Region, particularly in the Ayvalık district (Kamber, 2007). This cheese, which is said to have been transferred to our culture from the Greeks, is mostly placed in perforated plastic containers today, while in the past it was shaped in buckets made of reeds. These reed baskets are made from stems collected from riverside and humid areas (Akpınar et al., 2014).

Sepet Loru is made by boiling the remaining whey after the Sepet Peyniri is made and leaving it aside to drain into these baskets (Keskin and Dağ, 2020). The image of Sepet Loru is presented in Figure 8.



Figure 8. Sepet Loru.

2.7.2. Kirlihanım Peyniri

Kirlihanım Peyniri is made from Sepet Loru produced in Ayvalık (Çelikel et al., 2020). Creamy curd obtained from full-fat sheep or goat whey is filtered in reed baskets for

1 day. It is then removed from the basket, covered with a thin layer of salt and left to mature in a cool place. Within 15-20 days, the outer layer of the cheese begins to mold; but the inner layers remain white. For this reason, it is referred to as “dirty lady” (Keskin and Dağ 2020) (Figure 9). These molds are yellow-brown and purple in color and give the cheese its unique smell, taste and flavor (Çelikel et al., 2020; Hastaoğlu et al., 2021). It is matured by turning it upside down for 6-7 months. Cheese is consumed after the moldy parts on it are cut and discarded. Due to the lack of widespread production of this rare cheese in the Aegean Region, it is among the lesser-known cheeses of Anatolia (Keskin and Dağ 2020). Before eating Kirlihanım Peyniri, it can optionally be consumed by pouring olive oil, honey, molasses or jam on it. The chemical properties of Kirlihanım Peyniri were reported by Akgün (1988) as 64.3% dry matter, 17.9% fat, 10% protein and 4.9% salt.



Figure 9. Kirlihanım Peyniri.

2.8. Keş

Keş is a traditional Turkish product that is widely produced and consumed in many parts of Anatolia, especially in the western and southwestern regions (Tarakçı et al., 2010). In our country, there are different types of Keş produced from yoghurt, buttermilk or whey. However, this report includes products consumed as cheese.

2.8.1. Taze Keş

Taze Keş is produced from yoghurt buttermilk. For

yoghurt production, after the milk is filtered through a cheesecloth, heat treatment is applied at 90-100 °C for approximately 15-20 minutes. It is then cooled to 40-45 °C and inoculated with 2-3% yoghurt culture (homemade yoghurt). After the fermentation and cooling processes, the yoghurt produced is churned and processed into butter. After separating the butter, the remaining buttermilk is heated at 90-100 °C for about 10 minutes until a clot forms on the surface and transferred into cheesecloths. After the coarse water is removed, the pressing process is applied until the desired dry matter level is reached, and the obtained curd is salted with 2-3% dry salt and filled into cotton bags. The bags are suspended from a platform in a warm room for 2-3 days, and the bags are sometimes turned inside out for uniform dryness. In recent years, a mosaic-like structure has emerged in the final product by adding 20-30% Beyaz Peynir curd to the curd of Kes cheese to make the product more attractive. Cheeses with a total solids content of 60% to 70% can be stored in a cool place for 4-5 months (Tarakçı et al., 2003; Dervişoğlu et al., 2009; Tarakçı et al., 2010). Taze Keş sample is presented in Figure 10, the chemical composition of Keş is presented in Table 11, and the microbiological properties of Keş are presented in Table 12.



Figure10. Taze Keş.

Table 11. Chemical composition of Keş

	Kalender and Güzeler (2013)	Kalender and Güzeler (2013)	Tarakçı et al. (2003)	Dervişoğlu et al. (2009)
	Taze Keş	Sarı Keş	Keş	Keş
Total solid (%)	34.96	57.37	68.03	56.17
Fat (%)	3.00	8.70	11.35	8.79
Salt (%)	0.93	4.70	7.08	3.22
Protein (%)	27.18	29.80	42.34	-
Ash (%)	-	-	8.33	4.31
Acidity (%)	2.68	1.87	2.64	-
pH	3.54	4.65	3.88	4.75
n	10	6	20	35

Table 12. Microbiological properties of Keş (log cfu/g) (Tarakçı et al., 2003)

TAMB	Yeast -mold	Lactic acid bacteria	Proteolytic bacteria	Lipolytic bacteria	n
5.98	4.69	4.47	4.54	3.93	20

TAMB= total aerobic mesophilic bacteria

2.8.2. Sarı Keş

Sarı Keş is a dark or light brown product obtained by cooling the whey of cheeses made from sheep and goat milk, usually produced by the Yoruks in Anamur and its surroundings, after boiling for a long time and straining it from cloth bags. Sarı Keş is known as "Horç" in Silifke, and "Dolaz" or "Tort" around Isparta, Antalya and Afyon (Dinçel and Alçay 2017). Sarı Keş is an orange-brown dairy product with a distinctive taste and odour. It is consumed by the people of Anamur for breakfast either plain, mixed with onion or black cumin or mixed with Anamur village cheese, with phyllo bread. In addition, it is consumed plain or mixed with onions, together with hot flatbread, or it can be used as a filling in pastries (Kalender and Güzeler, 2013). The sample of Sarı Keş is presented in Figure 11, the chemical composition of Keş is presented in Table 11, and the microbiological properties of Keş are presented in Table 12.



Figure 11. Sarı Keş

Kuru Keş is obtained by crushing the Taze Keş produced in the Anamur region, laying it on a clean cloth and drying it in the sun until it turns yellow. A semi-hard cheese obtained by mashing and salting Taze Keş and Anamur village cheese, mixed with black cumin upon request, pressing into skin bag and then aging in a cool place for three to four months is called Deri Keşi. Gök Keş is a moldy cheese type obtained by leaving Deri Keşi or Sarı Keş to mold in a cool place after ripening (Kalender and Güzeler, 2013).

2.9. Antakya Sürkü and Antakya Küflü Sürkü

These cheeses are produced traditionally in Hatay region (Keleş et al., 2004; Hayaloğlu and Fox 2008). Antakya Sürkü and Antakya Küflü Sürkü are the products that received the Geographical Indication Registry Certificate in 2018 (Anonymous-1, 2018; Anonymous-2, 2018).

For the production of Antakya Sürkü, raw cow's milk is first filtered and then heated to boiling temperature. The heat-treated milk is cooled to 40-45 °C and fermented with yoghurt culture (1-3%) and incubated at 40-45 °C for 3-5 hours (as the local term puts it to sleep).

The yoghurt obtained is left to rest in refrigerator conditions (4-7 °C) for one or a few days, then diluted 1:1 and processed into buttermilk. Butter and buttermilk are obtained by churning buttermilk. The buttermilk is taken

to another boiler and heated up to 90-95 °C without mixing. The clot collected on the surface is transferred to cloth bags with strainers, filtered and put under pressure. The clot, which remains under pressure for 5-6 hours and the excess water has been removed, is called Çökelek. After this step, 0.1-0.3% spice mixture is added to the Çökelek. This spice mix contains thyme (8-14%), allspice (11-40%), cloves (3-8%), mahaleb (8-9%), cumin (5-14%), black pepper (5-8%), cinnamon (0-13%), ginger (0-10%), basil (0-2%), fennel (0-2%), black cumin (0-2%), chili pepper (0-2%), coriander (0-5%) and nutmeg (0-5%). (Especially the "wild thyme", locally known as "Zahter" (*Tymbra spicata* var *spicata*) and collected from the mountains, gives Antakya Sürkü its distinctive thyme scent). It is also kneaded by adding 1-3% salt, optionally a clove of garlic for 1 kg of Çökelek and optionally 1% pepper paste. The kneading process is done for the homogeneous distribution of the raw materials and takes 5-10 minutes. Palm-sized pieces are taken from the homogenized mass and shaped into a conical or pear shape by hand. The weight of each Sürk ball is 150-200 grams. Antakya Sürkü is then covered with a thin cheesecloth and left to dry in a shaded place at ambient temperature. The drying process takes one or several days depending on the ambient temperature. Drying may take 2-3 days depending on ambient conditions. The cheese obtained in this way is called fresh Sürk. It can be consumed fresh or after ripening with mold.

For molding, fresh Sürk is wrapped in paper one by one and placed in glass jars or plastic drums and left to mold. These environmental conditions are ideal for mold growth, as molds grow rapidly in moist and stagnant air. As a matter of fact, mold spores contaminated by the environment rapidly develop on Sürk preserved in this way and cover the entire surface. During 3-4 weeks at room temperature, physical, microbiological and sensory changes occur in the product due to storage conditions and mold growth, and Antakya Küflü Sürkü is formed when the product gains a completely different character. Unlike other moldy cheeses, Antakya Küflü Sürkü is consumed after the molds are removed from the surface. There is currently no industrial production of Antakya Küflü Sürkü. Pictures of Antakya Sürkü and Antakya Küflü Sürkü are given in Fig 12 and 13, and their chemical properties are given in Table 13. TAMB, yeast and mold, lactobacillus, staphylococcus numbers of fresh Antakya Sürkü were determined as 7.20, 5.91, 9.92, 3.76 log cfu/g by Keleş et al. (2004), respectively.



Figure 12. Antakya Sürkü



Figure 13. Antakya Küflü Sürkü

3. Others

Sirvatka Lor Peyniri is a type of cheese that is produced in almost all Balkan countries and is made more often in the regions where the immigrants from the Balkans reside. It is widely produced in Bursa and Balıkesir and in Mustafakemalpaşa, Manyas and Savaştepe districts in our country. This cheese is made from the whey obtained during the production of Mihaliç Peyniri. Popularly known as Kelle or Mihaliç Lor Peyniri, this cheese has a milky cream-like odor and is therefore preferred more than other curd cheeses.

For the production of Sirvatka Lor Peyniri, the whey left over from the Mihaliç Peyniri production is heated

around 90 °C and waited for 10-15 minutes. Meanwhile, the curd cheese collects on the surface of the whey. Curd accumulated on the surface is transferred to cloth bags with scoops. After the intensive whey output is finished, the cloth bags are hung on the hangers and the filtering process continues for 24 hours. It is packaged without salt and offered for sale. Since it is not salted, its shelf life is short, 5-10 days. Depending on preference, it is served fresh for breakfast or alternatively salted and mixed with green pepper and spices and pressed into jars. After aging for a while, it is consumed either directly or by using it in pies or other types of pastries (Kamber, 2008). Dumas Çökeleği is a dairy product traditionally produced in small family businesses in Darende and its villages. It is produced from yoghurt buttermilk. The buttermilk obtained during the production of butter from yoghurt is coagulated by heating. The resulting clot is filtered in cloth bags and pressed. In this way, raw precipitate is obtained. It is kneaded by mixing different proportions of milk, yoghurt, cream and a little salt (1-2%) on the raw Çökelek. Thus, Dumas Çökeleği is obtained. Dumas Çökeleği is consumed fresh or after ripening into skin bag. It can be used by the local people for breakfast, making pies and donuts, and it is also used in the production of some dishes unique to the region (Tarakçı et al., 2003).

The dry matter content of Dumas Çökeleği is 34.93%, fat 8.01%, fat in dry matter 22.08%, ash 2.39%, protein 21.66%, salt 1.64%, acidity (in terms of lactic acid) 1.67%. As a result of the microbiological analysis, TAMB was 6.97, the coliform bacteria was 2.29, the yeast and mold was 7.04, and the lactic acid bacteria was 6.17 log cfu/g (Tarakçı et al., 2003). Şor Loru is a curd cheese made in Kars and obtained by boiling the whey produced while making Kashar Cheese together with water in a boiling cauldron. Since the water in the boiling cauldron is salty, the cheese obtained here is called Şor Loru, which means “şor”, “salty” in the local dialect (Kamber, 2008). Otlu Lor is produced from the whey leftover from Otlu Peynir production in the Van province region. Herbs known as “sirmo”, “mendi” and “helis”, obtained from the region and used in the production of Otlu Peynir, are added to the curds. These herbs not only give curd cheese a different taste, smell and aroma, but also enrich it in terms of mineral content (Kılıçel et al. 2004).

Table 13: Chemical composition of Antakya Sürkü

	Keleş et al. (2004)	Güler and Konar (2002)	Durmaz et al. (2004)
	Taze Sürk	Küflü Sürk	Sürk
Dry matter (%)	48.80	44.32	49.82
Fat (%)	4.05	8.99	14.66
Protein (%)	-	19.02	26.43
Salt (%)	5.59	8.32	5.36
Acidity (%)	0.78	1.14	1.44
Ash (%)	5.80	7.96	-
pH	4.55	4.94	5.81
n	50	36	25

4. Conclusion

Many famous cheeses in various countries can be made from whey. However, in our country, cheese produced from whey remained at the local level, its industrial production was not widespread, and some of it was even forgotten. In this respect, it is necessary to raise awareness of people about whey cheeses and to process whey as whey cheese in small businesses and encourage its consumption in this way. In addition, there is a need for more academic research on whey cheeses produced in our country and studies on industrial production possibilities.

Author Contributions

The percentage of the author contributions is present below. The author reviewed and approved final version of the manuscript.

	E.M.
C	40
D	25
S	40
L	40
W	25
CR	50
SR	50

C=Concept, D= design, S= supervision, L= literature search, W= writing, CR= critical review, SR= submission and revision.

Conflict of Interest

The author declare that there is no conflict of interest.

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