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Divle Tulum Cheese

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ABSTRACT Turkey has an important potential in terms of domestic cheese varieties. In recent years, the increase in the interest of consumers in traditional tastes and delicacies both in the world and in Turkey may have an important influence on the evaluation of this potential. It is necessary to standardize the production methods in order to produce local cheeses of uniform product characteristics. Standard production is a prerequisite for the cheese varieties to compete in domestic and foreign markets. Although there are many studies on local cheese varieties in our country, there are still few cheese varieties with defined production and product standards. Divle Tulum cheese also known as Divle Obruk cheese, is important cheese varieties produced in our country. The name is derived from the Divle (also known as Ücharman) village within the boundaries of Ayrancı city within the borders of Karaman province where it is produced and from the Divle Mountain in this village. This type of cheese produced and consumed for hundreds of years in this region is a kind of Tulum cheese produced from sheep milk and consumed after ripening. The micro flora in the natural sinkhole (Divle Sinkhole) where ripening is made gives the cheese an excellent taste by covering the surface of sheep goat skin (tulum) during ripening and penetrate into the cheese. This cheese type which has begun to be emphasized more in recent years is acknowledged by the experts as one of the important cheese delicacies of the world. In this review; it is aimed to summarize the results obtained from a limited number of studies on this cheese by giving information about the production method of Divle Tulum cheese.

Keywords: *Cheese, Divle Tulum Cheese*

ÖZ

Divle Tulum Peyniri

Türkiye yerli peynir çeşitleri açısından önemli bir potansiyele sahiptir. Son yıllarda hem Dünyada hem de Türkiye'de tüketicilerin geleneksel tat ve lezzetlere olan ilgisinin artması, bu potansiyelin değerlendirilmesi açısından önemli bir etkide bulunabilir. Ancak yerel olarak üretilen bu peynir çeşitlerimizin üretim metotları ve ürün özellikleri bakımından süratle standardizasyonlarının yapılması gerekmektedir. Peynir çeşitlerinin iç ve dış pazarlarda rekabet edebilmesi için standart üretim şarttır. Ülkemizde yerel peynir çeşitleri üzerinde birçok çalışma yapılmış olmasına rağmen henüz çok az peynir çeşidimizin üretim ve ürün standardı bulunmaktadır. Divle tulum peyniri de ülkemizde üretilen önemli peynir çeşitlerimizden birisidir. Divle obruk peyniri olarak da bilinmektedir. İsmini üretildiği Karaman İline bağlı Ayrancı İlçesi sınırları içerisinde bulunan Divle (Üçharman) köyünden ve bu köyde bulunan Divle Obruğundan almaktadır. Bu bölgede yüzlerce yıldır üretilen ve sevilerek tüketilen bu peynir çeşidi, koyun sütünden üretilen ve olgunlaştırıldıktan sonra tüketilen bir tulum peyniri türüdür. Olgunlaştırmanın yapıldığı doğal mağarada (Divle Obruğu) bulunan mikroflora, olgunlaşma esnasında deri tulumların yüzeyini kaplayıp peynirin içerisine nüfuz ederek peynire kendine has müthiş bir lezzet kazandırmaktadır. Son yıllarda üzerinde daha fazla durulmaya başlanan bu peynir çeşidi, uzmanlar tarafından da dünyanın önemli peynir lezzetlerinden kabul edilmektedir. Bu derlemede; Divle tulum peynirinin üretim şekli hakkında bilgi verilerek, bu peynir üzerinde yapılan sınırlı sayıda çalışmalardan elde edilen sonuçların özetlenmesi amaçlanmıştır.

Anahtar Kelimeler: *Divle tulum peyniri, Peynir*

INTRODUCTION

Milk is the first sustenance consumed by humans and others mammals after their birth. Rich in nutrients and complex in structure, it is one of the most important aliments for human nourishment. Since milk spoils in a short time under natural conditions due to its relatively high water content, it is difficult to transport and preserve it; therefore milk is processed into more durable products like cheese or yoghurt. Processing milk into cheese is one of the most common ways of utilizing the milk. Cheese, which has hundreds of varieties, is a popular food that has

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been known since ancient times. They are classified according to criteria like consistence, ripening level, lipid content, type of raw material, and method of salinization (Yöney 1970; Çağlar et al. 1996; Kindstedt 2012; Varnam and Sutherland 2012). The aim of this review is to provide information about the Divle tulum cheese which is distinguished amongst the most common produced traditional tulum cheese varieties due to its popular flavor and taste.

TULUM CHEESE

One of the most popular and fondly consumed traditional cheese types in Turkey is the tulum cheese. Tulum cheese is produced all around the country except the Thrace region, especially in the small family enterprises in villages and towns where the milk cannot be processed in modern facilities. Since consumer demand in the larger cities began to increase, the production of tulum cheese in modern facilities have increased as well. Every region of the country is producing the tulum cheese by using own traditional methods. In Turkey, there are two methods to tulum cheese manufactured, including dry and briny methods.

Dry tulum cheese is produced mostly in the Central, Eastern, Southern and Southeastern Anatolia regions, while briny tulum cheese is mainly produced in settlements of the Aegean region close to the shorelines. Taking into account the unregistered production conducted in smaller establishments and considering the production volumes of the past years, it can be estimated that approximately 45-50 thousand tons of tulum cheese is produced in our country every year (Yöney 1970; Gönç 1974; Kılıç et al., 2002; Karaca et al. 2007; Hayaloğlu 2008; Sert and Akın 2008).

Named after the region of its production like Erzincan, İzmir, Divle, Kargı, Afyon, Isparta, Giresun, and Çimi- the production methods of the tulum cheese display a considerable variation. Of those, Erzincan and Divle tulum cheeses are quite similar to each other. The main difference between them is that during the production of Divle tulum cheese, the curd (the brine free and soft cheese) is washed (Keleş and Atasever 1996; Hayaloğlu et al. 2007; Hayaloğlu 2008).

DIVLE TULUM CHEESE

Divle tulum cheese is produced in the Üçharman Village of the Ayrancı County of the Karaman City and its surroundings, and fondly consumed in the nearby regions (Kamber 2005; Morul and İşleyici 2012).

Production of the Divle Tulum Cheese

Almost all of this traditional cheese type is produced in family type enterprises, while a small amount is also produced in small dairies. The stages of the production period may display small variations between producers (Gönç 1974; Kamber 2005).

The cheese is mostly made out of ewe milk. After the ewes are milked, the milk is filtered through clothes in order to cleanse it from coarse pollutants. No chemical or microbiological standardization is exists for the milk that will be used in the process. When the ewe milk is scarce, goat milk is sometimes added to the ewe milk before the production process. If the milk is recently milked and is still warm, no additional heating process is applied. If the milk is cold, however, it is heated slightly. The milk is fermented at approximately 25 to 32 ^{o}C. The temperature of the milk is controlled with fingertips to check if it is suitable for fermentation. Approximately half a teacup of rennet (50 ml) is calculated per 100 liters of milk, which is then watered down with cold water and introduced to the prepared milk (Gönç 1974; Tekinşen et al. 1997; Kamber 2005; Morul and İşleyici 2012).

The milk coagulates in 1.5 to 2 hours. The consistence of the coagulum is controlled by dipping the index finger into the coagulum and moving around. If the finger is able to crumble the coagulation and a greenish water is released, the coagulation is determined to be in the right consistency for further processing. Some families do not crumble the coagulation at all and move directly to the dewatering stage. The coagulation is then crumbled with a rolling pin, a wooden stick or by hand, and is slightly heated for easier separation of its water. Crumbling the coagulation and heating it in its own water leads to separation of more cheese whey, which in turn shortens the time required for both the filtering and the press stages. The curd is poured into bags made of canvas fabric, and are hanged to a high and cool place. After the curd has released its water thoroughly, the bag is placed over a wooden surface, and pressed by placing it under a weight. The weight is gradually increased and the press stage takes around 12 to 18 hours, but if the coagulation was not heated, the bag is kept under pressure for 24 hours (Gönç 1974; Kamber 2005).

The raw cheese is cut like bread slices after it is removed from the press and the slices are placed inside bread bins or suitable cups, upon which cold water is added on top. The water is removed every time it gets a saturated color and fresh water is added back again, and this process is continued for 2 to 3 days in order to eliminate the sour aroma of the cheese and to remove the yellowish water that has remained inside the raw cheese. The whey remaining from the production is then boiled to obtain the whey cheese. The sliced raw cheese is then thoroughly crumbled by hand and treated with rock salt to make it briny. The amount of salt to be introduced is determined by tasting the cheese periodically. If too much salt is used the cheese does not ripen, and such cheese are called “keshleshmish” (roughly translated as cluckered) by the local people (Gönç 1974; Tekinşen et al. 1997; Kamber 2005; Morul and İşleyici 2012).

The crumbled and salted cheese is placed into bags called “Tulum” made out of sheep, goat or lamb skin, and pressed wooden sticks called “koskuch”, leaving no air pockets during the process. The tulums are then sealed off by placing salt in their vents, and sewed off completely. In order to filter the cheese better and to make it dry faster, the tulum is penetrated in 15-20 spots with a packing needle (Gönç 1974; Kamber 2005).

Prepared in this way, the tulum cheese is placed over sand or gravel in a cool place of the house and is left to rest for a week, the sand or gravel are changed when humidified during this time. When the tulum begins to get slightly drier, the outer layer is cleaned and marked, after which the tulum is taken to the main ripening location: a cave called Divle sinkhole (also known as Divle Obrugu, or “the Obruk”). After a month in the cave, blue, white and slightly red fungi grow over them in this particular order. The fungi dry in September and October, and the outer layer of the tulum gets the color of the fungi. This is considered to be an sign for a complete ripening for the cheese. Tulums are usually placed in the sinkhole in April - May, and removed at the end of October. So that, average ripening

period is 5 to 6 months (Gönç 1974; Tekinşen et al. 1997; Kamber 2005).

The yield of the Divle tulum cheese varies according to the composition and type of the milk used and many other variables. As mentioned before, goat milk -and sometimes even cow milk- can be added to the ewe milk before the production. The yield is said to be between 10% and 12%. This ratio increases if only ewe milk was used (Gönç 1974).

Fig 1. Divle tulum cheese in skin bag (tulum)

Fig 2. Divle tulum cheese removed from skin bag (Tulum)

Preparation of the Tulum

The tulums to place the Divle tulum cheese inside are prepared out of sheep, goat, yean or lamb skin. The goat skin is preferred since it is thick and sturdy. After the animal is slaughtered, the skin is removed in the shape of a bag, and is cleaned of its meat and fat. The skin is then cured (salted) right away and is left to dry in a cool place for 3-4 days so that it may absorb its salt thoroughly. The skin is left there until the day it will be used. When the time to use the tulum comes, the dried skin is first softened in water for 1-2 days, and the hairs and fuzz are removed by shaving them off with a razor or scissors. The inner side of the skin bag is thoroughly scrubbed with salt and flour. The skin is then folded and wrapped in fabric and left to rest for 1-2 more days, after which the skin is unfolded again and the salt and flour remains are removed with the help of a knife. The skins thusly tanned are used directly if they are small in size, or are cut down to necessary size if they are larger, after which they are sewn into the tulum shape. This approach causes the tulums to lack a standardized size. Smaller tulums are favored because they are easier to use (Gönç 1974; Kamber 2005; Morul ve İşleyici 2012).

Divle Sinkhole (Divle Obruğu)

Also called "the Obruk", this cave is located towards 1.5 - 2 km southeast of the Üçharman (Divle) village, and is under a hill. The hill has a cliff of 37 meters, with the sinkhole's entrance at its bottom. The cheese are lowered into and retrieved from the sinkhole by an elevator mechanism that is built on top of the hill. The length of the sinkhole is around 150 meters, and is oriented in east-west direction. The width and height of the inner areas are not consistent, and occasionally widens up, making the width vary between 2 and 8 meters. In order to increase the storage capacity and to make it easier to line the tulums up, shelves have been built inside the cave out of cedarwood. Total storage capacity is around 100 tons, but only 40% of the capacity is being utilized at a given time. The sinkhole has a long history and is a very characteristic sinkage. It is found out an a specific aroma occurs to cheese in the sinkhole (under the influence of the microflora inside the sinkhole) Divle sinkhole is a natural cold storage area, and its relative humidity and temperature levels make it an ideal location to ripen the cheese. The relative humidity between April, where the tulums are placed inside, and 29th of October, where they are retrieved, is between 85% and 95%. The temperature in the same period varies between +2 and +5 ^{o}C (Gönç 1974; Kamber 2005; Hayaloğlu et al. 2007; Kan et al. 2010).

COMPOSITION OF DIVLE TULUM CHEESE AND ITS PROPERTIES

The color of the Divle tulum cheese varies from porcelain white to creamy white color. The portion that is in contact with the skin of tulum is pale in color if it is thin, or is dingy grey if it is thick. A well-ripened cheese has a particular aroma and taste that is sought after. Defects like sour, leaven, fruit-like, bitter and piquant aroma and taste may be seen in cases of faulty production, and formation of fungal scents and tastes may be seen in overly fungous cheese (Gönç 1974).

There are only a handful studies conducted on the production of Divle tulum cheese and its chemical and microbiological properties. It has only caught the attention of researchers in recent years, where the studies on it began to take place.

In his one study where he inspected the Divle tulum cheese in detail, Gönç (1974) was determined production method and manufacturing stages of this cheese variety and he was reported in 28 cheese samples the average humidity, dry matter, lipid, dry matter lipid, protein, water-soluble nitrogen (100 g/g), raw ash, salt, dry matter salt and acidity values as 42.86%, 57.14%, 25.15%, 45.02%, 25.98%, 0.826, 5.059%, 3.36%, 5.89% and 76.70 (SH) respectively. Researcher also have reported that the values obtained from cheese samples in this study from each other vary widely.

Keleş and Atasever (1996), has inspected 20 samples of Divle tulum cheese and reported an average humidity of 42.986%, lipid ratio of 21.3%, salt ratio of 3.006%, ash ratio of 3.784%, titratable acidity of 0.497% L.A, pH value of 5.416, coliform group bacteria count of $1.64x10^{6}$/g, fecal streptococcus count of $5.58x10^{7}$/g, and yeast/fungus count of $3.50x10^{6}$/g. These researchers have also reported that the values show a wide variations.

İşleyici et al. (2011) have evaluated the aflatoxin M1 (AFM1) presence and levels in the 55 Divle tulum cheese samples they have inspected, and reported that 18.18% of the samples contained an average level of 10.835±6.70 ng/kg AFM1, varying between 5.15 ng/kg and 26.44 ng/kg. They have also reported that 23 of the samples (41.82%) contained less than 5 ng/kg AFM1, while 22 (40%) contained none. They have concluded that all of the samples had less AFM1 content than the maximum amount specified in the Turkish Food Codex (500 ng/kg), and thus Divle tulum cheese posed no risk for the public health in terms of AFM1. İşleyici et al. (2011) have investigated levels of the aflatoxin M_1 (AFM_1) in 55 Divle tulum cheese samples and they have reported that 10 cheese samples (18.18%) contained average level of 10.835±6.70 ng/kg AFM_1, varying between 5.15 ng/kg and 26.44 ng/kg. They also have reported that 23 of the samples (41.82%) contained less than 5 ng/kg AFM_1, while 22 (40%) contained none. In the results of this study, researchers have determined that all of the samples had less AFM_1 content than the maximum limits specified in the Turkish Food Codex (500 ng/kg), and thus Divle tulum cheese posed no risk for the public health in terms of AFM_1 content.

Morul and İşleyici (2012) inspected 50 Divle tulum cheese samples, and determined the average pH, water activity, dry matter, humidity, lipid, ash, salt and protein values as 5.42±0.61, 0.956±0.026, 1.074±0.425% L.A., 56.27±7.59%, 43.71±7.59%, 23.46±4.48%, 4.96±0.66%, 3.99±0.75% and 25.90±3.40%, respectively. The results of microbiological analyses revealed that the average anaerobic mesophilic count was 6.78±1.42 $\log_{10}$ kob/g, while 9 samples had *E. coli* count of 3.61±0.87 $\log_{10}$ kob/g, 20 samples had coliform count of 3.04±1.52 $\log_{10}$ kob/g, 40 samples had *S. aureus* count of 5.04±1.45 $\log_{10}$ kob/g, 25 samples had coagulase (+) *S. aureus* count of 4.82±1.32 $\log_{10}$ kob/g, 48 samples had enterococcus count of 6.69±1.28 $\log_{10}$ kob/g, 40 samples had *Enterobactericeae* count of 2.90±0.16 $\log_{10}$ kob/g, 50 samples had *Lactobacillus-Leuconostoc-Pediococcus* group microorganism count of 6.93±1.17 $\log_{10}$ kob/g, 38 samples had *Pseudomonas* spp. Count of 3.60±1.05 $\log_{10}$ kob/g, 50 samples had yeast/fungus count of 6.36±1.43 $\log_{10}$ kob/g, 13 samples had sulfide reducing anaerobic spore forming microorganism count of 1.31±0.44 $\log_{10}$ kob/g, and 25 samples had psychrophilic count of 4.29±1.55 $\log_{10}$ kob/g. The researches have reported that displays considerable among the samples was observed and that they posed significant risks for public health in terms of pathogenic microorganisms they contained.

Ozturkoglu Budak et al. (2016a) have conducted a study on the development and identification of the microflora of the Divle tulum cheese, and they have detected the presence of 23 types of bacteria in both the outer and inner portions of the cheese on 60th and 120th days of its ripening. The dominant species were identified as the *Bacilli* and *Gammaproteobacteria* species in the early stages of the ripening, and as *Actinobacteria* species for the later stages. 19 types of the filament fungi and 5 types of yeasts were detected in the samples, and the highest isolation levels were found for *Penicillium polonicum, Penicillium biforme, Penicillium roqueforti, Penicillium chrysogenum* and *Debaryomyces hansenii.* It was reported that the microflora of the groups were similar to each other in terms of species and that they displayed high variation in various portions of the cheese during the ripening, the authors suggested that the technological characterization of the identified strains indicated that they could be used for developing new starter cultures.

Hayaloğlu and Karabulut (2013) have reported the free fatty acid contents of 8 samples of Divle tulum cheese, C_4: 13.9, C_6: 10.7, C_8: 14.9, C_{10}: 19.5, C_{12}: 12.5, C_{14}: 32.8, C_{16}: 75.8, $C_{18:0}$: 22.5 $C_{18:1}$: 87.2 ve $C_{18:2}$: 7.9. These researchers have reported that Divle tulum cheese samples had the lowest humidity level (39.9%) and the highest lipid content (25.92%) amongst all the cheese types they have inspected, identifying the Divle tulum cheese as a high-lipolysis group cheese.

Ozturkoglu Budak et al. (2016b) have inspected the formation of volatile compounds in the Divle tulum cheese during the production and ripening stages and revealed the presence of 110 compounds including acids, alcohols, ketones, esters and terpenes. The researchers have reported that the presence and concentrations of these compounds differ production and ripening stages, and the cheeses made by different producers display slight variations in these properties. The findings of the study also indicate that carboxylic acids are the largest group to be identified in the cheese, and that the relative ratio of acids and ketones increase until the 90th day of the ripening, while alcohol levels increase significantly in the first 30 days. Ethers, on the other hand, keep increasing in volume till the end of ripening, and researchers report that 2-butanol, 2-butanone, 2-heptanone, ethyl butanoate, α-pinene and toluene are the compounds that probably contribute the most to the characteristic aroma of the cheese.

Isleyici et al. (2017) investigated the amounts of heavy metal and mineral substances in 20 matured Divle tulum cheeses. They found that the mean levels of lead (Pb), cadmium (Cd), arsenic (As), mercury (Hg), copper (Cu), iron (Fe), zinc (Zn), calcium (Ca) , phosphorus (P), magnesium (Mg), aluminium (Al), potassium (K), tin (Sn) and nickel (Ni) were found 0.026±0.019 (n:11), 0.020±0.013 (n:7), 0.068±0.039 (n:16), 0.009±0.007 (n:8), 0.201±0.129 (n:2), 10.892±3,835 (n:14), 21.699±8.697 (n:16), 6333.96±748.829 (n:20), 4802.260±552,841 (n:20), 203.762±68,485 (n:20), 0.513±0.358 (n:3), 1153.230±176.638 (n:20), 0.061±0.010 (n:10) and 0.167±0.149 (n:7) mg/kg respectively. The results suggest that the mineral level of the Divle tulum cheese is important for human nutrition and that the heavy metal levels in the samples studied do not exceed the limits set by national and international standards.

Ozturkoglu-Budak et al. (2018) examined the role of mikroflora on proteolysis and lipolysis profiles during the production and maturation of Divle tulum cheese. They observed a large amount of peptide accumulation during maturation and they attributed this to a large amount of lactic acid bacteria. Similarly, they obtained high levels of lipolysis which can be explained by the native lipase in milk and microbial lipases in the samples.

Almost all of the researchers have stated that the chemical, microbiological and sensory properties of the Divle tulum cheese samples displayed significant variations, and that particularly the microbiological qualities of the cheeses were quite low. Therefore they have emphasized that this sort of cheese should absolutely be produced with a standardized method, using pasteurized milk and starter cultures in the production (Gönç 1974; Keleş and Atasever 1996; Morul and İşleyici 2012).

CONSUMPTION AND MARKETING OF THE DIVLE TULUM CHEESE

Divle tulum cheese is an indispensible delicacy for the local population. Most of the cheese produced in the area is consumed by the families themselves, while the excess is sold in the regional bazaars or in larger cities. Due to the decrease of the number of sheep stock in the region over last few years, the production of Divle tulum cheese has decreased as well, causing further increase in the price of the already expensive cheese. Yet still, no proper system has been established for the marketing of this particular cheese (Yaşar and Yurdakul 2010; Morul and İşleyici 2012).

Divle tulum cheese has become indispensible in the preparation of traditional foods of the area like the sıkma (small pastry with cheese & parsley), gozleme (Turkish pancake) and the gillan timbales, and the local population yearns for it during their travels, even going as far as to prepare a couple tulums to bring along in order both to consume themselves and offer to their acquaintances during such trips. Divle tulum cheese also is an important protein source for the regional population who has low income level, as well as providing them a source of additional income. In the last few years, significant projects like "My Cheese Divle Project" have been conducted by associations and municipalities with the EU granted funds, and attempts at obtaining a geographical indication for the cheese have been started by Karaman Chamber of Commerce and Industry. As a result of these efforts, a geographical indication was obtained from Turkish Patent Authority for Divle tulum cheese on December 2017 (Anonymous 2017).

Another important problem with the production and marketing of the Divle tulum cheese is the unfair competition posed by the cow-milk tulum cheeses produced in the surrounding cities and towns under the name of "Karaman Divle tulum cheese" or "Divle type tulum cheese", all of which are ripened in cold storage facilities. The most significant income sources for the villagers in the region are their sheep stocks, and sheep milk and the products that are made out of it. Lacking any other marketing alternative, however, most producers have to sell their products to the dairies, which results in a negative impact on the production of the cheese (Karaca et al. 2007; Yaşar and Yurdakul 2010).

CONCLUSION

The greatest problem in the production of the Divle tulum cheese is the lack of standards for the production stages and the cheese itself. While there are many advantages of Divle tulum cheese production -like main activity of the area being sheep breeding, the specific renown of the cheese itself and the high demand for it, the distinctive taste and aroma of the cheese, and the utilization of the sinkhole in the region- there are still many shortcomings and problems, such as the droughts causing production problems for the forage plants which negatively affect impact the sheep breeding and sheep milk yields, lack of standards for the production of the cheese and its quality, hygiene related problems, difficulties encountered in the utilization of the Divle sinkhole, inadequate foraging areas, and the lack of efficiency of the manufacturer associations, all of which have a negative impact on the Divle tulum cheese production (Karaca et al. 2007; Yaşar and Yurdakul 2010; Morul and İşleyici 2012).

As such, it is very important to obtain standardization for the production of this cheese variety and to provide publicity for it. It is necessary to improve the conditions of the grassland areas of the region and to develop better sheep breeding methods, along with establishment of the required conditions for proper marketing of the cheese, and to form manufacturer associations and organizations to achieve these goals. If these goals can be achieved, the production of the cheese could be made hygienically and with standardized quality, which would undoubtedly contribute to economies of both the local population and the nation itself, perhaps even transforming this particular region to a significant distributionand production center of Divle cheese whole country, maybe even whole world.

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