

SOME QUALITY CHARACTERISTICS OF KARS GRAVYER CHEESE*

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Abstract

The goal of this study was to identify the characteristic features of Kars Gravyer cheese and to identify problems in the production process. Forty samples of Gravyer cheese procured from different points of sale in Kars were subjected to microbiological, physicochemical and organoleptic analysis. Although the analysis showed that many of the samples did not conform to the Gravyer cheese standard: 8 samples (20%) with regard to coliform bacteria count, 17 samples (42.5%) with regard to yeast-mold count, 34 samples (85%) with regard to the amount of salt and 7 samples (17.5%) with regard to the percentage of fat. However, there are not any criteria regards to yeast-mould and coliform bacteria counts in cheese according to Regulation on Turkish Food Codex Microbiological Criteria, dated 2011. For that reason, these high bacteria count constitutionally acceptable. The study identified some regular quality problems due to the lack of standards in production methods as well as inability for hygiene and sanitation on the production line. Even in developed countries all food companies has got a traditional production line having a problem to have standard quality products and generally they rely on consumer choice.

Keywords: Gravyer cheese, Gruyere, microbiological characteristic, chemical characteristic, organoleptic characteristic

KARS GRAVYER PEYNİRLERİNİN BAZI KALİTE ÖZELLİKLERİ

Özet

Bu araştırma Kars Gravyer peyniri olarak tanınan peynirin karakteristik özelliklerinin belirlenmesi ve üretim aşamasındaki sorunların tespit edilmesi amacıyla planlanmıştır. Kars'ta farklı satış noktalarından temin edilen 40 adet Gravyer peyniri örneği mikrobiyolojik, fizikokimyasal ve duyuşal yönden incelenmiştir. Analizler sonrası örneklerden 8 tanesinin (%20) koliform grubu bakteri sayısı yönünden, 17 tanesinin (%42.5) maya-küf sayısı yönünden, 34 örneğin (%85) tuz miktarı ve 7 örneğin (%17.5) yağ oranı nedeniyle Gravyer peyniri standardına uygun olmadığı belirlenmiştir. Ancak 2011 tarihli Türk Gıda Kodeksi Mikrobiyolojik Kriterler Yönetmeliği uyarınca peynirlerde maya-küf ile koliform bakteri analizi yapılmamaktadır. Dolayısı ile halen geçerli olan kodeks açısından peynirlerde mikrobiyolojik açıdan sorun yoktur. Üretim yönteminde standardizasyon eksikliğinin kalitede ciddi sorunlara sebep olduğu ve üretim hattı boyunca hijyen ve sanitasyon kurallarının noksanlığı tespit edilmiştir. Gelişmiş ülkeler de dahil olmak üzere geleneksel şekilde üretim yapılan tüm gıda işletmelerinde bu gibi standart kalite sağlama sorunları görülmekte ve tercih tüketici beğenisine bırakılmaktadır.

Anahtar kelimeler: Gravyer peyniri, Gruyere, mikrobiyolojik özellikler, kimyasal özellikler, organoleptik özellikler

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INTRODUCTION

Gravyer is a hard cheese that is produced primarily in Switzerland but also in France, Australia and Finland. It is very similar to Emmental cheese in form and production method. The cheese originates in the town of Greyerz (Gruyère) in the Swiss Alps and has a history that goes back to the 12th Century (1).

According to TS 2174, Gravyer is a hard cheese with a hard rind and its own unique shape, smell color, taste and aroma, made by processing extra class or first class raw or pasteurized cow milk according to a special technique (2).

Gravyer cheese is a hard cheese (moisture content of a maximum of 20-40%) made from raw milk using calf rennet and thermophilic starter cultures (propionic acid bacteria). This type of cheese is light yellow in color with medium sized holes spaced at even intervals, is matured for 6-12 months, has a very strong aroma and a golden yellow to brownish colored rind (3, 4). It has a unique and distinctive smell and taste. Gravyer cheese has a stronger aroma and smaller holes than Emmental cheese. The holes range in size from that of a pea to that of a hazelnut (5, 6).

Gravyer is a local variety of cheese produced in Turkey that has economic value and is one of a small number of European-style cheese that consumers like. It also has economic value for people in the region where it is produced. Production of Gravyer cheese in Kars is only exceeded by production of Kashar and Tulum cheese. It is made in the region using raw milk, most often with traditional methods on small dairy farms, aside from one or two commercial facilities. Kars Gravyer cheese is a well-known name all over Turkey, and approximately 90% (214 ton/year) of the Gravyer produced in Turkey comes from Kars province (7-9).

Very few studies have been done in Turkey on Gravyer cheese. Research on the microbiological, chemical and physical characteristics of Kars Gravyer cheese, as it is known all over the country, and work on improving the cheese is needed in order to protect this cheese and increase its quality as part of this region's cultural heritage. The purpose of this study was to identify the various levels of quality of Gravyer cheeses and to identify the problems that occur during its production.

MATERIALS and METHODS

Forty samples of Gravyer cheese were purchased from 21 different points of sale in Kars province between 2011 and 2012 and brought to the laboratory under aseptic conditions while maintaining the cold chain. All of the samples were produced in the city of Kars or its surrounding districts with traditional methods. During two years, sampling was made for two times a month from each certain marketing point. Since Gravyer cheese is produced using hoops having large diameter and weighs approximately 70 kg, it is sold as slices. For that reason, sampling was repeated for every new cheese wheel. The outer part of cheese which is dry and molded was excluded during laboratory examinations.

Microbiological Analysis

Twenty-five grams of samples were weighed and homogenised with 225 mL of sterile 1/4 ringer solution. After homogenization was complete, decimal solutions of the samples were prepared, and inoculated using spread and pour plate techniques under the following incubation conditions: Plate Count Agar (Oxoid CM 325) 30 °C / 48 hours for Total Aerobic Mesophilic Colony count; Violet Red Bile Glucose Agar (Oxoid CM 485) 37 °C / 24 hours for *Enterobacteriaceae*; Violet Red Bile Lactose Agar (Oxoid CM 107) 37 °C / 24 hours for Coliform Group Bacteria; Violet Red Bile Lactose Agar (Oxoid CM 107) 44.5 °C / 24-48 hours for *Escherichia coli*; Potato Dextrose Agar (Difco B 13) 22 °C / 5-10 days for Yeast-Mold; Propionibacter Isolation Agar (HiMedia, M956) 37 °C / 5-7 days (Anaerobic) for Propionic Acid Bacteria; and Baird Parker Agar (Oxoid, CM 275) 37 °C / 24-48 hours for staphylococcus-micrococcus; MRS Agar and Modified Chalmers Agar (10) 30 °C / 24-48 h for Lactic Acid Bacteria (11, 12).

Physicochemical Analysis

The Mohr method was used to identify the amount of salt in the samples, the Gerber method was used to identify the fat content (13, 14), and gravimetric analysis was used to identify the ash and moisture content (13, 15). To determine the pH value of the samples, 10 g of grated cheese and 10 ml of distilled water were mixed together and homogenized in a homogenizer. The pH of the mixture was measured with a digital pH meter (16). Protein content was measured with the Kjeldahl method (17)

Organoleptic Analysis

Sensory analysis of the samples was performed by five panelists. They evaluated the external appearance, internal appearance, texture, flavour/taste of the samples. The ratings given by the panelists were recorded as points and averaged. Sensory analysis of the samples was performed according to TS 2174 (2).

Statistic Analysis

Statistical correlations between counts of microorganisms and physicochemical parameters investigated were assessed by the Pearson's correlation coefficient. Statistical correlations between organoleptic parameters and physicochemical parameters investigated were assessed by the Pearson Chi-Square method. In this analyze, arithmetic means of each test criteria were used for grouping. Statistical analysis was performed using the SPSS 20.0 (for windows) software (18).

RESULTS and DISCUSSION

These 40 samples of Gravyer cheese produced with traditional methods were subjected to microbiological, physicochemical and sensory analysis. Fecal coliform was not found in the samples. The *Enterobacteriaceae* count was measured at $<1-4.90$ log CFU/g, the coliform count was $<1-4.90$ log CFU/g, the total bacteria

count was $5.90-8.90$ log CFU/g, the lactic acid bacteria count was $3.90-8.30$ log CFU/g, the propionic acid bacteria count was $2.60-4.30$ log CFU/g, yeast and mold was $<1-4.60$ log CFU/g and the staphylococcus-micrococcus count was $<1-4.60$ log CFU/g.

The fat content of the samples varied from 23 to 42%, ash content varied from 3.95 to 6.61%, pH levels varied from 5.73 to 6.82, the amount of dry matter varied from 63.2 to 79.63%, protein content varied from 23.7 to 33.3% and salt content varied from 1.03 to 5.57%.

The effect of dry matter, pH and salt concentration of cheese samples against microorganisms was evaluated statistically. Although the pH levels of cheese samples had negative correlation with microorganism counts, the difference was not statistically significant ($P>0.05$). Souza et al. (19) conducted microbiological and physicochemical tests to evaluate the Serrano cheeses during production and maturation period. They observed that pH levels had negative correlation with microorganism counts in particular proteolytic bacteria and they declared that this might attributed to increase of acid tolerant bacteria count during maturation. Although we found a positive correlation between dry matter and propionic acid bacteria and yeast-mold, this was not statistically significant ($P>0.05$). Similarly, salt

Table 1. Results of microbiological analysis of Gravyer cheeses sold in Kars (log CFU/g).

Gravyer cheese (n:40)						
Microorganism (log CFU/g)	Min	Max	X	SX	Standard limit values (2)	Number of samples which exceed standard limits
Total mesophilic aerobic colony count	5.90	8.90	7.75	0.80	-	-
Staphylococcus-micrococcus	4	6.48	5.48	0.66	-	-
<i>E. coli</i>	-	-	-	-	-	-
Koliform	<1	4.90	1.47	1.01	<2	8
Enterobacteriaceae	<1	4.90	1.39	0.98	-	-
Lactic Acid Bacteria	3.90	8.30	6.67	1.29	-	-
Propionic Acid Bacteria	2.60	4.30	3.68	0.48	-	-
Yeast-mould	<1	4.60	2.10	1.39	<2	17

Table 2. Results of chemical analysis of Gravyer cheeses sold in Kars.

Gravyer cheese (n: 40)						
Criteria	Min	Max	X	SX	Standard limit values (2)	Number of samples which exceed standard limits
Fat (%)	23	42	33.65	4.12	30-48	7
Ash (%)	3.95	6.61	4.98	0.67	-	-
pH	5.73	6.82	6.02	0.29	-	-
Dry matter (%)	63.2	79.63	69.88	3.74	62	-
Salt (%)	1.03	5.57	2.35	1.143	3-10	34
Protein (%)	23.7	33.3	28.89	2.295	-	-

concentration and total mesophilic microorganism, propionic acid bacteria and lactic acid bacteria count had the positive correlation but statistically it was not significant ($P>0.05$).

Sensory analysis revealed that the samples received low ratings and did not meet the sensory quality standard. All of the samples looked significantly different inside and exhibited significant variety with regard to the size and distribution of the holes.

The relation between sensorial features and dry matter, pH and salt concentration was statistically evaluated. It was observed that dry matter and salt did not have any effect on sensorial characteristics, however there was a strong relation between dry matter and physical appearance ($P<0.05$).

The analysis showed that many of the samples did not conform to the Gravyer cheese standard: 8 samples (20%) with regard to coliform bacteria count, 17 samples (42.5%) with regard to yeast-mold count, 34 samples (85%) with regard to the amount of salt and 7 samples (17.5%) with regard to the percentage of fat. However, there are not any criteria regards to yeast-mould and coliform bacteria counts in cheese according to Regulation on Turkish Food Codex Microbiological Criteria, dated 2011 (20). For that reason, these high bacteria count constitutionally acceptable.

Analysis showed that the 40 samples of Gravyer cheese were different with regard to microbiological, chemical and sensory characteristics. The difference was not statistically significant ($P>0.05$). There are many causes for these disparities. Gravyer cheese is usually made from raw milk, which means that the microbial load and chemical characteristics of the milk used for production is obviously very important. Since controlled fermentation is not used during production and maturing, each product develops different consistency and different characteristics. Gravyer cheese takes many months to mature. The degree

of maturation inevitably changes the microbiological and chemical composition of the cheeses that were analyzed (6, 21, 22).

The total bacteria count and lactic acid bacteria count of the samples was found to be high. Throughout the long period of maturation required for Gravyer cheese, lactic acid bacteria and propionic acid bacteria dominate the environment and increase in number. The yeasts that develop on the surface in the first three weeks of maturation increase in number throughout the maturation period and neutralize the acidity that develops on the surface. The mold and some bacteria that develop on the surface of Gravyer cheese can make a positive contribution to the cheese's aroma. At the same time, lipolysis and proteolysis also have an impact on the cheese (23, 24). The fact that the coliform bacteria and yeast/mold counts were high in most of the samples may be due to surface contamination during the long maturation period. The fact that the staphylococcus and micrococcus counts were high indicates that there are hygiene problems during the production and maturation stages of Gravyer cheese. In addition to contamination, certain micrococci and staphylococci have been identified on the surface of Gravyer cheese whose effects on the maturation of the cheese have not yet been determined (25).

Interaction between microorganisms while the cheese is maturing causes changes in the cheese's chemical makeup. Almost no studies have been carried out on this valuable and strongly aromatic cheese that is produced in northeastern Turkey. One study that investigated the chemical characteristics of Gravyer found them to contain 68.20% dry matter, 33.45% fat content, 35.01% non-fatty dry matter, 28.95% protein, 4.94% ash and 3.70% salt (8). Those results are consistent with our findings. The low salt concentration, which we also found in many of

Table 3. Results of organoleptic analysis of Gravyer cheeses sold in Kars.

Gravyer cheese (n: 40)				
Criteria	Min	Max	X	SX
External appearance	2	4	3.35	0.66
Internal appearance	2	4	2.82	0.67
Texture	1	4	2.67	0.94
Flavour/taste	1	4	3.12	0.72

* The analysis used a scale of 1 as the lowest rating and 5 as the highest rating.

our samples, is notable. In interviews with cheese producers, it was determined that the amount of salt was kept low in order to ensure that the cheese matures and for it to develop holes. Zerfiridis et al. (26) found a relatively high level of pH and fat content in Gravyer cheeses aged for 6 months, but that their salt content was quite low compared to other Swiss cheeses. Grappin et al. (27) reported that the salt concentration in Gravyer cheese has a significant effect on proteolysis and propionic acid fermentation. The authors studied the effect of the salt concentration on the microbial flora, the formation of CO₂ and consequently the formation of holes in cheese. The study showed that higher concentrations of salt resulted in fewer and smaller holes (28).

The cheeses that were analyzed were also found to have relatively low levels of moisture. Gravyer cheese is a hard cheese, and the long maturation period causes a hard rind to form. In these kinds of cheeses, the moisture content has a significant effect on certain characteristics such as texture, aroma and flavor (6, 21).

CONCLUSION

Kars province is located in a region where many animals are raised, so there is quite a large potential for milk production. Some of the milk that is produced is used to make cheese on dairy farms and in small family operations. Because of the region's climate, large amounts of high quality milk can only be obtained in the 2 - 3 months of summer. During the rest of the year, the amount and yield of milk drops. In interviews carried out with Gravyer cheese producers in Kars, it was determined that the biggest problem is not being able to procure a continuous supply of high quality milk for large capacity production facilities*.

In addition to the problem of procuring a continuous supply of raw materials, there is also a problem with the availability of good quality milk. In order to obtain good quality milk with a low microorganism load, animal owners need to be better informed about animal husbandry, and milking machines need to be used on healthy animals under hygienic conditions. Educating

animal owners about these issues is absolutely necessary to increase both the yield and the quality. Most of the Gravyer cheese made in Kars province is produced with traditional methods using raw milk on small dairy farms. It is not possible to maintain a certain standard of quality with these cheeses, which are not produced under controlled conditions. This results in an inevitable loss of quality in Gravyer cheese, which has a negative effect on the consumer. Consequently, it is not possible for cheeses of varying quality to maintain their market share. A certain standard of quality must be achieved in order to increase consumer demand, be competitive and expand the product's market share.

Naturally, the use of a starter culture is necessary to produce healthy, good quality cheese. The use of starter cultures in production will not only assure standardized quality, but it will also maintain the desired taste and aroma when the cheese is produced under controlled conditions. In this way, cheese producers who are now using raw milk will start to use pasteurized milk when they see that it is also possible to produce cheese with good taste and aroma from pasteurized milk (29).

Healthy food can be produced by following hygiene rules at every stage of production. Unfortunately, there are almost no production facilities in our province that hold a quality standard certificate or implement the HACCP program. This is a glaring deficiency that must be eliminated. Production needs to be moved from dairy farms and small family establishments to professional production facilities. This is the only way to ensure the production of packaged products that carry a quality standard label, and only these kinds of products can maintain a share in the market.

Another problem producers mentioned is the lack of qualified workers to produce Gravyer cheese. There were 15 - 20 locations where this cheese was produced when it came to Turkey in the 1930s, but now there are only three in Kars and not more than 10 in all of Turkey. The traditional production method is based on a master/apprentice model and can only be maintained when a well-trained expert is available. Whether a facility's capacity is small or large, it is essential

* Acay İ. 2010. Personal communication. Owner of dairy plant, Kars.

Aydın Y. 2009. Personal communication. Owner of dairy plant, Kars.

to have a qualified worker on every production line**. To resolve this problem, it is necessary to educate production line workers about hygiene, sanitation and cheese making. Organizing seminars to train dairy workers about hygiene and sanitation will have a significant effect on ensuring that healthier and better quality dairy products are produced in our province.

In conclusion, we determined that if we are to increase the quality of Kars Gravyer cheese in Turkey and increase product recognition, animal owners and milk producers need to be educated, production needs to be moved from dairy farms and small family establishments to professional facilities where modern production methods can be used, and qualified workers must be employed in the production process. Furthermore, it is absolutely necessary that Gravyer cheese producers adopt the principles of "High quality raw materials equals high quality product" and "Commitment to hygiene and sanitation at every stage of production," which are essential rules in the food sector.

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