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Research Article

Evaluation of Physicochemical and Microbiological Properties of a Traditional Local Cheese: Tire Camur Cheese

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Abstract: This study examined the physicochemical and microbiological properties of Tire Camur cheese, a traditional dairy product widely consumed in the Tire district of Izmir, Turkey. Ten samples of Tire Camur cheese, purchased from the local market, were analyzed, and the findings were evaluated to assess food quality, offering recomendations for improvement. Physicochemical parameters including pH, acidity, dry matter, fat, and protein content were determined. Microbiological quality was asessed by counting *Lactobacillus spp.*, *Lactococcus spp.*, yeast-mold, *S. aureus*, and *E. coli*. The mean values for pH, titratable acidity (%), dry matter (%), fat (%), and protein (%) were found to be 5.56±0.01, 0.15±0.01 LA, 29.65±0.16, 10.41±0.16, and 11.68±0.16, respectively. The results indicated that the physicochemical properties of Tire Çamur cheese lack standardization due to inconsistencies in its production process. Microbiological analysis revealed that stricter attention to hygiene and sanitation practices is necessary. Notably, significant variations in *S. aureus* and *E. coli* counts were observed among samples from the same producer, underscoring the critical need for improved hygiene during post-production packaging, storage, and sales.

Keywords: tire camur cheese, microbiological quality, food safety, local product.

Araştırma Makalesi

Geleneksel Bir Yerel Peynirin Fizikokimyasal ve Mikrobiyolojik Özelliklerinin Değerlendirilmesi: Tire Çamur Peyniri

Özet: Bu çalışmada, İzmir'in Tire ilçesinde yaygın olarak tüketilen geleneksel bir süt ürünü olan Tire Çamur peynirinin fizikokimyasal ve mikrobiyolojik özellikleri araştırılmıştır. Yerel pazardan satın alınan 10 adet Tire Çamur peyniri örneği analiz edilmiş ve bulgular gıda kalitesi açısından iyileştirme önerileri sunmak için değerlendirilmiştir. pH, asitlik, kuru madde, yağ ve protein içeriği gibi fizikokimyasal parametreler belirlenmiştir. Mikrobiyolojik kalite *Lactobacillus* spp., *Lactococcus* spp., maya-küf, *Staphylococcus aureus (S.aureus)* ve *Escherichia coli (E.coli)* sayılarak değerlendirilmiştir. Ortalama pH, titre edilebilir asitlik (LA%), kuru madde (%), yağ (%) ve protein (%) değerleri sırasıyla 5.56 ± 0.01, 0.15 ± 0.01%, 29.65 ± 0.16%, 10.41 ± 0.16% ve 11.68 ± 0.16% olarak bulunmuştur. Sonuçlar Tire Çamur peynirinin fizikokimyasal özelliklerinin üretim sürecindeki tutarsızlıklar nedeniyle standardizasyondan yoksun olduğunu göstermektedir. Mikrobiyolojik analizler ise, hijyen ve sanitasyon uygulamalarına daha fazla dikkat edilmesi gerektiğini ortaya koymaktadır.

Aynı üreticiden alınan numuneler arasında *S. aureus* ve *E. coli* sayımlarında önemli farklılıklar gözlenmiş olması, üretim sonrası paketleme, depolama ve satış sırasında hijyen uygulamalarının iyileştirilmesine yönelik kritik ihtiyacın altını çizmektedir.

Anahtar Kelimeler: tire çamur peyniri, mikrobiyolojik kalite, gıda güvenliği, yöresel ürün.

1. Introduction

Cheese, with its high nutritional value, exhibits great diversity in worldwide due to variations in milk types, starter cultures, processing techniques, and maturation methods. Türkiye, owing to its geographical location, reflects its rich gastronomy culture in cheese production, offering a wide variety of cheese types unique to the region. Moreover, the integration of traditional practices passed down through generations enhances the diversity of these local products. To preserve cultural heritage and ensure the quality and authenticity of these unique production methods, many countries, including Türkiye, have embraced geographical indication (GI) systems.

In Türkiye, 41 traditional cheese types have been granted Geographical Indication (GI) status out of a total of 61 applications submitted to date, with 20 others currently under review [1]. This system plays a crucial role in the preservation and promotion of local gastronomic heritage [2]. Tire Camur cheese is a traditional cheese produced and consumed primarily in the Tire, Ödemiş, and Bayındır regions of Izmir. Its production begins with curd cheese obtained from whey, primarily of cow's milk, though sheep and goat milk are sometimes used. The final product's quality depends on how the curd is processed by local producers and households.

Tire Camur cheese is generally described as a soft, spreadable cheese with unique consumption patterns. It is prepared by combining whey—a by-product of cheese production—with buttermilk, milk, and additional whey to achieve a smooth and homogeneous texture. This mixture is thoroughly kneaded using dough-kneading boilers in commercial production or with wooden spoons or mixers in household settings [3].

Tire Camur cheese, a local delicacy, can be consumed in various ways: it is mixed with olive oil for breakfast, spread on bread, or used as a filling in pastries. A traditional serving method involves pairing it with black mulberry jam, creating a popular regional dessert where the jam is drizzled over the cheese [4,5].

The quality of the final product may vary considerably depending on the specific production methods employed. Several studies in the literature have highlighted potential public health concerns associated with locally produced cheeses [6-10]. Issues such as the lack of standardization, poor hygiene of tools and equipment, insufficient personnel hygiene, and inadequate storage and sales conditions may negatively impact the microbiological quality of traditionally produced cheeses.

Numerous studies have emphasized the distinctive features and production challenges of Tire Camur cheese. Karaalioğlu (2021) identified 29 volatile compounds in the cheese and reported that sensory attributes such as cooked, whey, creamy, fermented, and milky flavors were strongly perceived. The

study also underlined the need for standardization to facilitate industrial-scale production of this traditional product [11]. Similarly, Keskin and Dağ (2020) attributed the limited regional awareness of traditional cheeses, including Tire Camur, to the challenges associated with traditional production methods. Nevertheless, cheeses derived from whey, such as Tire Camur, remain among the most prominent local varieties [12]. Furthermore, Erdoğmuş (2020) noted that the short shelf life of market-sourced Tire Camur cheese is primarily due to poor hygiene practices during production. The study also suggested that the inclusion of probiotics in the production process could significantly enhance both the safety and shelf life of the final product [13].

This study aims to evaluate the microbiological characteristics of Tire Camur cheese produced by traditional methods, with a particular focus on food safety parameters. In light of previous findings highlighting the short shelf life and hygiene-related concerns associated with this traditional product, the research seeks to generate data that can contribute to quality enhancement and support standardization efforts essential for safe industrial production.

2. Materials and Methods

2.1. Materials

The material of this study consisted of Tire Camur cheese samples offered for sale in local businesses located in the Tire district of İzmir Province, Türkiye. A total of 10 cheese samples were collected from 10 different retail points within the district, representing products from 8 distinct producers. The samples were purchased in their original sales packaging between April 11 and October 17, 2023, under conditions that reflected those available to consumers. Following collection, all samples were stored at +4 °C until further laboratory analysis.

2.2. Methods

The pH value of Tire Camur cheese samples was determined with a pHmeter (Inolab WTW digital Series pH720). Tire Camur cheese samples were analyzed for total solids, protein, and titratable acidity using The Association of Official Analytical Chemists methods [14]. Fat content was analyzed using the Gerber method [15].

In order to determine the microbiological properties of Tire Camur cheese samples, the analyses to be performed were determined by taking into consideration the Food Safety and Production Hygiene criteria specified in the Turkish Food Codex Communiqué on Microbiological Criteria [16]. S. aureus and E. coli counts as well as Lactobacillus, Lactococcus and yeast-mould counts were performed in order to ensure hygiene control in cheese samples. For this purpose, Baird-Parker Agar, TBX (Tryptone Bile X-glucuronide) Agar (Oxoid, UK), MRS (de Man, Rogosa, Sharpe) (Merck, Germany), M17 Agar (Merck, Germany) and YGC (Yeast Glucose Chloramphenicol Agar) (Merck, Germany) media were used respectively. For microbiological analyses, 10 g of cheese samples were weighed into sterile stomacher bags, followed by the addition of 90 mL of 0.1% peptone water (Merck, Germany). Then, sample was homogenised in peptone water with stomacher blender.

Baird-Parker Agar containing Egg Yolk Tellurite was inoculated with appropriate dilutions by smear method. The petri dishes were incubated at 37±1°C for 48 hours. At the end of incubation, round, convex, narrow, black-grey shiny colonies with a clear zone around them were defined as S. aureus [17].

E. coli counting was performed by surface spread method on the selective medium TBX Agar (Oxoid, UK) and incubated at 37°C for 4 hours under aerobic conditions and then incubated at 44°C for 20 hours. After incubation, green coloured colonies were counted and evaluated as E. coli [17].

Yeast and mould counts were performed using YGC Agar smear method and plates were incubated at 25°C. After 5 days of incubation, colonies were counted [18].

MRS Agar and M17 Agar were used to determine the number of Lactobacilli and Lactococci, respectively. For MRS Agar, anaerobic jars (Oxoid, UK) and anaerocult A (Merck, Germany) were used to provide anaerobic environment after sowing. Petri dishes were incubated at 37°C for 48 hours.

All analyses were conducted in duplicate, and results are expressed as mean ± standard deviation.

3. Results and Discussion

Within the scope of this research, a total of 10 Tire Camur cheese samples collected from retail outlets in the Tire district were analyzed. The samples, obtained from local sales points reflecting typical consumer profiles, represented products from 8 different producers. The pH values of the samples ranged from 4.81 to 6.21, while titratable acidity, expressed as % lactic acid (LA), ranged between 0.10% and 0.18%. In a study by Karagözlü et al. (2016), which also examined the physicochemical properties of traditional cheeses, the pH and titratable acidity values of Tire Camur cheese were reported as 5.30 and 0.48% LA, respectively. The dry matter content in the current study was found to range between 25.03% and 35.80% [19].. Although this represents a relatively broad distribution, the values are consistent with those reported in previous studies [20,13].

Table 1. *Physicochemical analysis results of Tire Camur cheese*

Sample	pH	Titratable acidity (% LA)	Dry Matter (%)	Fat (%)	Protein (%)
1	5.15 ± 0.01	0.16 ± 0.01	28.09 ± 0.01	12.25 ± 0.35	10.43 ± 0.33
2	6.11 ± 0.01	0.18 ± 0.00	32.10 ± 0.08	9.13 ± 0.18	14.52 ± 0.40
3	6.04 ± 0.00	0.13 ± 0.01	35.48 ± 0.46	14.00 ± 0.00	14.76 ± 0.51
4	5.56 ± 0.01	0.14 ± 0.03	25.42 ± 0.54	7.25 ± 0.35	11.79 ± 0.27
5	4.81 ± 0.01	0.16 ± 0.01	27.90 ± 0.34	8.00 ± 0.00	12.27 ± 0.30
6	5.44 ± 0.00	0.16 ± 0.02	27.19 ± 0.25	8.50 ± 0.00	11.19 ± 0.35
7	5.48 ± 0.00	0.11 ± 0.01	29.20 ± 0.22	12.25 ± 0.35	9.80 ± 0.51
8	6.11 ± 0.01	0.14 ± 0.00	31.08 ± 0.14	13.13 ± 0.18	10.41 ± 0.47
9	5.34 ± 0.03	0.16 ± 0.01	31.20 ± 0.33	10.50 ± 0.00	10.38 ± 0.62
10	5.53 ± 0.01	0.17 ± 0.01	28.91 ± 0.30	9.13 ± 0.18	11.24 ± 0.06
Minimum	4.81	0.11	25.42	7.25	9.80
Maksimum	6.11	0.18	35.48	14.00	14.76

Tire Camur cheese, as a traditional product, can be produced using various artisanal methods. Prior to consumption, the final product is typically diluted with the addition of water, buttermilk, or whey to achieve its characteristic spreadable consistency. The use of different production approaches leads to considerable variation in the dry matter content of the final product. This variability is primarily attributed to the differing amounts of buttermilk, water, or whey added after curd formation.

As shown in Table 1, the fat content of Tire Camur cheese ranged from 7.25% to 14.00%, while protein content varied between 9.80% and 14.76%. These values reflect a wide distribution, similar to that observed in dry matter content. Notably, the highest fat value is nearly double the lowest, indicating a substantial inconsistency. Such differences are directly related to the composition of the curd used during production and underscore the lack of standardization in the manufacturing process of Tire Camur cheese. The continued reliance on traditional techniques and the absence of a standardized formulation contribute to the observed variability in key quality parameters.

A study by Karaalioğlu et al. (2021) investigated the physicochemical and sensory properties of Tire Camur cheese. They reported that the total dry matter content of the samples ranged from 22.76% to 40.81%, attributing this broad range to variations in fat content [11].. These findings are consistent with the results obtained in the present study.

Whey, which serves as the primary raw material in curd production, plays a critical role in microbial dynamics due to its low acidity and high water activity. These characteristics make it a favorable medium for microbial growth. Inadequate production conditions and poor personnel hygiene may further facilitate the proliferation of pathogenic microorganisms. Therefore, maintaining strict hygiene practices during all stages of production, packaging, and distribution is essential to ensure consumer safety. The microbiological data obtained from the analysis of Tire Camur cheese samples are presented in Table 2.

Table 2. *Microbiological results of Tire Camur cheese (cfu/g)*

Sample/Microorganism	***Lactobacillus* spp.**	***Lactococcus* spp.**	**Yeast-Mould**	***S. aureus***	***E. coli***
1	$4.6x10^5$	$5.7x10^4$	$2.5x10^3$	$3.6x10^3$	$<10^2$
2	$4.7x10^4$	$4.8x10^5$	$3.6x10^3$	$2.2x10^3$	$<10^2$
3	$3.8x10^4$	$4.3x10^4$	$3.5x10^3$	$<10^2$	$3.8x10^3$
4	$4.6x10^3$	$4.9x10^3$	$1.9x10^5$	$<10^2$	$2.6x10^5$
5	5.7x10	$4.5x10^3$	$2.6x10^4$	$3.6x10^3$	$4.4x10^2$
6	$3.6x10^6$	$4.3x10^5$	$1.5x10^4$	$2.5x10^3$	$<10^2$
7	$5.9x10^3$	$4.4x10^4$	$4.9x10^4$	$4.7x10^5$	$4.6x10^3$
8	$4.6x10^3$	$4.6x10^4$	$1.6x10^3$	$4.9x10^4$	$3.6x10^4$
9	$5.5x10^4$	$3.6x10^5$	$4.3x10^3$	$<10^2$	$<10^2$
10	$3.7x10^4$	$4.6x10^3$	$2.4x10^5$	$<10^2$	$1.9x10^2$
Minimum	$4.6x10^3$	$4.5x10^3$	$1.6x10^3$	$<10^2$	$<10^2$
Maximum	$3.6x10^6$	$4.8x10^5$	$2.4x10^5$	$4.7x10^5$	$2.6x10^5$

Lactic acid bacteria (LAB) are essential microorganisms widely employed as starter or adjunct cultures, particularly in fermented milk products, due to their significant role in the development of cheese-specific flavors [9].In the analyzed Tire Camur cheese samples, Lactobacillus counts ranged from 4.6×10^3 to

3.6×10^6 cfu/g, while Lactococcus counts varied between 4.5×10^3 and 4.8×10^5 cfu/g. Yeast and mold counts ranged from 1.6×10^3 to 2.4×10^5 cfu/g.

Yeasts and molds can proliferate over a wide range of temperatures and pH levels, and their presence in dairy products may result in undesirable changes such as bitterness, off-odors, gas formation, and spoilage. The high water activity of Tire Camur cheese provides a favorable environment for their growth, thereby increasing the risk of microbial deterioration.

A study by Sönmez et al., (2019) examined yeast and mold levels in both vacuum-packaged and openly sold curd cheeses in Elazığ province. The average yeast and mold count was reported as 4.14 ± 0.31 log cfu/g in vacuum-packaged samples and 1.86 ± 0.23 log cfu/g in unpackaged samples. The study emphasized that although vacuum packaging offers protection against external contamination, maintaining proper hygienic conditions prior to packaging remains critical [21].

A study investigating the effects of probiotic addition in Tire Camur cheese produced using traditional methods included microbiological analyses of cheese samples collected from the Tire market. The LAB counts in these samples ranged from 3.46 to 5.35 log cfu/g, while yeast and mold counts were reported to be between 3.35 and 3.87 log cfu/g [13]. In comparison, the yeast count in our study was slightly higher but showed consistency with the LAB counts.

The most significant impact of yeast and molds causing spoilage in curd-based and similar dairy products is observed in the sensory properties of the product. Controlling yeast and mold counts is crucial to maintaining the quality of the final product and ensuring sensory acceptability for consumers, making it a key parameter for curd-type cheese varieties [22, 23].

Erdogmus (2020) reported that S. aureus and E. coli were not detected in Tire Camur cheese samples. However, in our study, S. aureus and E. coli were found in samples collected from 10 different sales points in the Tire market. Microbiological count results showed that the number of E. coli varied between $<10^2$ and 2.6×10^5 cfu/g, and the number of S. aureus varied between $<10^2$ and 4.7×10^5 cfu/g [13].

E. coli is classified as a hygiene indicator microorganism under the Turkish Food Codex Production Hygiene Criteria for cheeses produced from heat-treated milk or whey. According to the Turkish Food Codex Communiqué on Microbiological Criteria, if E. coli is detected in more than two out of five analyzed samples, corrective actions—such as improving production hygiene and revising raw material selection—must be implemented [16].

S. aureus counts presented in Table 2 indicate that appropriate hygiene practices are not sufficiently observed during the production of Tire Camur cheese. In a study conducted on various cheeses sold in the Aydın province, the S. aureus count in curd cheese was reported as 5.09 log cfu/g, which is considered significantly high.S. aureus is a critical microorganism primarily transmitted through direct human contact. Although it is a common component of the nasal, throat, and skin flora, it is pathogenic to humans. During food production, preparation, and serving, frequent hand contact facilitates its transfer to food products. Once it reaches a critical concentration, it can exert toxic effects [24,25].

When the Staphylococcus aureus and Escherichia coli levels in the analyzed Tire Camur cheese samples were evaluated, both pathogens were found to be absent in samples obtained from only one sales point.

Notably, despite originating from the same production facility, variations in microbial counts during the sales stage highlight the critical role of hygiene practices related to personnel and equipment during storage, packaging, and distribution.

The detection of these pathogens at the point of consumer access suggests deficiencies in sanitation protocols throughout the production and post-production stages of Tire Camur cheese. These findings indicate that inadequate heat treatment, along with poor hygiene practices during packaging, storage, and sales, may pose considerable risks to consumer health.

4. Conclusion

The implementation of sanitation protocols in food production is of critical importance for safeguarding consumer health. Inadequate hygienic conditions within the production environment, coupled with the failure of personnel to comply with essential hygiene practices, can significantly compromise the quality of the final product and lead to a reduction in its shelf life. The findings of this study on Tire Camur cheese highlight the significance of maintaining both food and personnel hygiene in the production of local products. In this regard, prioritizing hygiene practices during production and storage, as well as emphasizing personnel hygiene, should be key strategies to mitigate risks to consumer health.

Microbiological differences observed in samples collected from three different sales points of the same company were primarily linked to variations in personnel hygiene and packaging practices at the point of sale. Maintaining strict control over packaging and sales processes from a food safety perspective is essential to ensure the delivery of safe products to consumers.

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Conflict of Interest

The author declare that there is no conflict of interest in this study. The manuscript has been written with contributions from all authors.

Research and Publication Ethics Statement

There is no need to obtain permission from the ethics committee for this study. The author declares that this study complies with research and publication ethics.

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