Physicochemical and Microbiological Properties of Different Kayseri Pastirma Types

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Abstract

In this study, a total of 20 pastirma samples were collected from the Kayseri local market, and their physicochemical (moisture, pH) and microbiological (lactic acid bacteria, total yeast-mold, total mesophilic aerobic bacteria) properties were investigated. Moisture and pH values of samples ranged from 34.77 to 57.61% and 5.81 to 6.22, respectively. While LAB counts of samples ranged from <2 to 5.61 log CFU/g, TMAB counts were found between 3.89 and 8.60 log CFU/g. Yeast counts were highest in the P9 sample, while mold counts were highest in the P11 sample. In conclusion, these pastirma samples exhibited significant variability in the physicochemical and microbiological properties due to differences in sample type and production conditions. Furthermore, the use of different culture media led to variations in yeast and mold counts, highlighting the critical role of media selection in accurately assessing the microbiological characteristics of pastirma.

Keywords: Pastirma, Kayseri, Yeast, Mold, Lactic acid bacteria.

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1. Introduction

Pastirma is one of the most popular dry-cured meat products in Turkiye, widely appreciated for its distinctive flavor. It is a raw cured meat product made from specific cuts of beef or water buffalo carcasses. Sixteen or more types of pastirma can be produced from suitable cuts obtained from a single carcass. The different types of pastirma are named according to the location of the muscles or muscle groups used as raw materials, such as ‘şekerpare’, ‘kuşgömü’, ‘bohça’, ‘kürek’, and ‘sırt’ (Figure 1). Consequently, there are differences in texture and quality characteristics among the different types of pastirma (Gökalp et al., 1994, Ozturk, 2015).

During the production of pastirma, low water activity values are observed due to the drying and salting processes. Pastirma is classified as a semi-moist food and does not involve heating or smoking during production (Leistner, 1988). The çemen paste imparts a pleasant flavor and aroma to the product. Additionally, the çemen paste helps protect pastirma against microorganisms (Yetim et al., 2006).

Pastirma is traditionally processed under natural conditions determined by air temperature, relative humidity, climate, and weather conditions. The period known as "Pastirma Summer", which includes September, October, and November, is preferred for traditional production (Gökalp et al., 1994). The first stage of pastirma production is dry curing. In this stage, salt is used at levels of 8-10%. Several incisions are made on the meat to facilitate the penetration of the curing mixture. The meat strips are coated with the curing mixture. Nitrate is commonly used as a curing agent (Tekinşen & Doğruer, 2000). Additionally, nitrite or nitrite-nitrate mixtures can be employed as curing agents. Sucrose and glucose may also be added to the curing mixture (Aksu & Kaya, 2002). The salted meat strips are arranged in stacks about 1 meter high, piled consecutively, and left for one to two days (Gökalp et al., 1994).

Lactic acid bacteria and catalase-positive cocci (*Micrococcus*/*Staphylococcus*) are two significant groups of microorganisms used in the production of pastirma. Catalase-positive cocci exhibit nitrate reductase activity in addition to catalase activity. Along with their lipolytic and proteolytic activities, these

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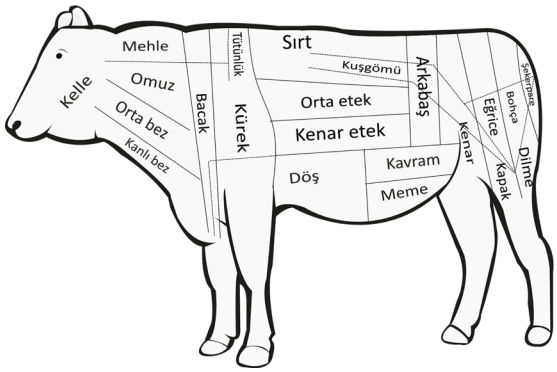

Figure 1. Pastirma parts in beef [Created by the authors based on information from TSE (1991)].

microorganisms play a vital role in color formation, stability, delaying oxidation, and aroma development (Kaya & Kaban, 2010). On the other hand, lactic acid bacteria influence the sensory and textural development of the product through acid production, despite their low proteolytic activity (Aktaş et al., 2005). During the production process, lactic acid bacteria and catalase-positive cocci show significant growth. Catalase-positive cocci can also become the dominant flora in pastirma. These acid-sensitive microorganisms exhibit substantial growth due to the favorable pH of the product (Kaban, 2009).

Studies on pastirma production generally indicates that the moisture content does not fall below 40%. Additionally, the salting stages during pastirma production alter intracellular and extracellular osmotic pressure, causing intracellular water to be removed and reducing water activity, thereby ensuring microbial stability. Many factors affect the final moisture content of pastirma. Differences in moisture values among studies and regions are due to these factors. The most significant factor affecting moisture content is the carcass region selected. Other factors influencing the final moisture content include the amount of salt used, the salting method, the structure of çemen, microbiota, drying duration, and drying method (Doğruer et al., 1995). The aim of this study is to determine the physicochemical and microbiological properties of different pastirma types produced in Kayseri.

2. Material and Methods

2.1. Materials

In this study, twenty different pastirma samples including 3 entrecote, 3 sırt, 4 but, 2 şekerpare, 2 omuz, 1 potuk (special lean pastirma), 1 kuşgömü, 1 sırt tütünlük, 1 dilme, 1 kol, and 1 kürek produced in the Kayseri (Türkiye) were used (Table 1). The pastirma samples were collected under aseptic conditions, transported to the laboratory under appropriate conditions, and stored at 4°C until analysis.

Table 1. Types of pastirma collected from the market

Sample No	*Type*
P1	Entrecote
P2	Potuk (special lean)
P3	Entrecote
P4	Sırt
P5	But
P6	Kuşgömü
P7	Şekerpare
P8	Sırt Tütünlük
P9	But
P10	Dilme
P11	Entrecote
P12	Omuz
P13	Kol
P14	Sırt
P15	But
P16	Sırt
P17	Kürek
P18	Omuz
P19	But
P20	Şekerpare

2.2. Physicochemical Analyses of Pastirma Samples

The moisture contents of the samples were determined by drying in an oven (Nüve, Türkiye). The samples were placed into pre-weighed containers and then transferred to an oven set at 105±2°C for 12 hours. Afterward, the containers were cooled and brought to constant weighing in a desiccator, and their final weights were recorded (Ozturk, 2015).

Ten grams of pastirma samples were taken, and 100 ml of distilled water was added to each. The samples were then homogenized using an Ultra-Turrax homogenizer (IKA, Germany). The homogenized samples were measured with a calibrated pH meter (WTW 720, Germany) (Ozturk, 2015).

2.3. Microbiological Analyses of Pastirma Samples

From the samples delivered to the laboratory in sterile packaging, 10 g of each sample was taken under sterile

conditions and placed in a stomacher bag. Subsequently, 90 ml of sterile maximum recovery diluent solution (MRD, Merck, Germany) was added, and the mixture was homogenized in the masticator homogenizer (IUL, Barcelona, Spain) for 1 minute. Then, serial dilutions of samples were prepared (Ozturk, 2015).

To determine the total mesophilic aerobic bacteria count, Plate Count Agar (PCA, Merck, Germany) medium was used. After incubation at 30°C for 2 days, the colonies formed on the plates were counted (Çakıcı et al., 2015).

Lactic acid bacteria counts of samples were determined using de Man, Rogosa and Sharpe Agar (MRS, Germany) and M17 agar (Merck, Germany). The prepared culture media were inoculated from the dilutions, and the plates were incubated under anaerobic conditions at 30°C for 48 hours. At the end of the incubation period, colonies with colors ranging from white to cream on MRS and M17 agar were counted as lactic acid bacteria (LAB) (Çakıcı et al., 2015).

Total mold and yeast counts of samples were determined using different media including Rose Bengal Chloramphenicol (RBC, Merck, Germany), Dichloran Rose Bengal Chloramphenicol (DRBC, Merck, Germany), Potato Dextrose Agar (PDA, Merck, Germany), Malt Extract Agar (MEA, Merck, Germany), and Czapek-Dox Agar (Merck, Germany). The plates were incubated at 25°C for 5 days. At the end of the incubation period, yeast and mold counts were separately performed (Ozturk, 2015).

3. Results

The moisture and pH values are presented in Table 2. In our study, the lowest moisture content was determined as 34.77%, while the highest was 57.61%. For P6 and P8 samples, the moisture content was below 40%. Additionally, in P1, P3, P4, P5, P10, P11, P13, and P16 samples, the moisture content ranged between 40% and 50%. In contrast, the moisture values of samples with codes P2, P7, P9, P12, P14, P15, P17, P18, P19, and P20 were determined to be above 50%. The average pH values of samples were 5,99 and the values changed between 5.81 and 6.22 in the samples. The highest pH values were determined in the P1 and P11 samples (entrecote) as pH 6.22 and 6.14, respectively.

Different culture media were used to determine the yeast counts in the pastirma samples. The yeast counts ranged from <2.00 to 6.03 log CFU/g on RBC, DRBC, MEA and PDA media. For all samples on Czapek-Dox medium the yeast counts were below the detectable limit (<2.00 log CFU/g). The highest yeast count was observed in the P9 sample (but) for all media except for Czapex-Dox medium (Table 3).

Table 2. Moisture and pH Values of Pastirma Samples

Sample	*pH Value*	*Moisture*
P1	6.22±0.02	36.53±4.04
P2	6.05±0.06	50.24±3.09
P3	5.96±0.01	41.72±0.06
P4	5.89±0.01	39.99±1.84
P5	5.93±0.01	45.49±1.10
P6	6.12±0.01	38.10±0.63
P7	5.83±0.01	50.41±2.25
P8	6.07±0.03	34.77±1.16
P9	5.81±0.01	52.96±4.17
P10	5.84±0.01	48.79±0.91
P11	6.14±0.01	37.88±2.80
P12	6.10±0.01	49.50±4.53
P13	6.04±0.01	45.20±2.04
P14	5.89±0.01	50.34±5.05
P15	5.95±0.05	57.61±1.41
P16	5.96±0.06	40.63±1.43
P17	6.05±0.01	54.89±2.17
P18	6.01±0.04	46.04±4.76
P19	6.05±0.03	51.22±0.44
P20	5.99±0.02	49.12±1.53

The mold counts of pastirma samples ranged between <2.00 and 4.06 log CFU/g, and <2.00 and 4.02 log CFU/g on RBC and MEA media, respectively, and with the highest count observed in the P13 sample (kol). The mold counts on DRBC medium were found to range between <2.00 and 4.01 log CFU/g. The highest mold count for DRBC, PDA and Czapek-Dox media was observed in the sample P11 (entrecote). Mold counts were below the detectable limit (<2.00 log CFU/g) in most the pastirma samples (Table 4).

The TMAB count was found to range between 3.89 and 8.60 log CFU/g, with the highest count observed in the P4 sample. LAB counts of samples ranged from <2 to 5.61 and <2 to 3.64 log CFU/g on MRS and M17 media, respectively. In MRS agar, the highest count was found in the P12 sample, while in M17 agar it was found in the P7 sample (Table 5).

Table 3. Yeast Counts of Pastirma Samples (log CFU/g)

Sample	*Yeast Count by Media Type*				
	RBC	*DRBC*	*PDA*	*MEA*	*Czapek-Dox*
P1	4.93±0.47	5.16±0.17	5.32±0.07	5.27±0.15	<2
P2	<2	<2	<2	<2	<2
P3	<2	<2	<2	<2	<2
P4	5.11±0.10	5.09±0.08	5.15±0.11	5.14±0.17	<2
P5	<2	<2	<2	<2	<2
P6	5.45±0.12	5.40±0.12	5.35±0.24	5.28±0.17	<2
P7	4.61±0.33	4.61±0.33	4.35±0.07	4.48±0.01	<2
P8	5.25±0.11	5.19±0.25	5.09±0.12	5.02±0.03	<2
P9	5.99±0.01	5.93±0.04	6.03±0.32	6.03±0.16	<2
P10	5.23±0.07	5.02±0.03	4.77±0.09	4.97±0.25	<2
P11	<2	<2	<2	<2	<2
P12	3.92±0.11	4.13±0.25	3.24±0.34	4.17±0.18	<2
P13	<2	<2	<2	<2	<2
P14	<2	3.15±0.21	<2	3.15±0.21	<2
P15	5.19±0.16	5.37±0.06	5.36±0.21	5.35±0.14	<2
P16	<2	<2	<2	<2	<2
P17	<2	<2	<2	<2	<2
P18	4.39±0.55	3.85±0.21	3.74±0.37	4.06±0.08	<2
P19	4.23±0.33	4.31±0.43	4.25±0.35	4.09±0.12	<2
P20	<2	<2	<2	<2	<2

Table 4. Mold Counts of Pastirma Samples (log CFU/g)

Sample	*Mold Count by Media Type*				
	RBC	*DRBC*	*PDA*	*MEA*	*Czapex Dox*
P1	3.24±0.09	3.28±0.03	<2	3.27±0.05	3.15±0.21
P2	<2	<2	<2	<2	<2
P3	<2	<2	<2	<2	<2
P4	<2	<2	<2	<2	<2
P5	<2	<2	<2	<2	<2
P6	3.24±0.34	2.95±0.07	3.15±0.21	2.98±0.03	3.10±0.28
P7	<2	<2	<2	<2	<2
P8	<2	<2	<2	<2	<2
P9	<2	<2	<2	<2	<2
P10	<2	<2	<2	<2	<2
P11	3.89±0.16	3.98±0.03	3.89±0.16	3.98±0.03	3.85±0.21
P12	3.39±0.55	3.24±0.34	3.35±0.49	3.15±0.21	3.57±0.38
P13	3.85±0.21	3.25±0.07	3.30±0.43	3.95±0.07	3.92±0.11
P14	<2	3.17±0.24	3.80±0.28	<2	<2
P15	<2	3.25±0.10	<2	<2	3.24±0.34
P16	<2	<2	<2	<2	<2
P17	<2	<2	<2	<2	<2
P18	<2	<2	<2	<2	<2
P19	<2	<2	<2	<2	<2
P20	<2	<2	<2	<2	<2

Table 5. TMAB and LAB Counts of Pastirma Samples (log CFU/g)

Sample	*TMAB*	*LAB*	
		MRS	*M17*
P1	8.37±0.30	5.37±0.24	<2
P2	5.17±0.18	3.46±0.20	<2
P3	6.63±0.09	4.37±0.37	3.27±0.38
P4	8.60±0.20	5.59±0.17	3.09±0.12
P5	5.80±0.28	2.37±0.16	<2
P6	8.17±0.24	5.55±0.14	<2
P7	7.62±0.20	5.46±0.12	3.64±0.48
P8	7.46±0.28	4.26±0.26	<2
P9	7.56±0.12	5.71±0.40	<2
P10	6.80±0.15	4.04±0.11	<2
P11	6.63±0.21	4.90±0.20	2.51±0.36
P12	7.95±0.19	5.61±0.20	2.60±0.14
P13	8.04±0.10	5.50±0.15	3.52±0.31
P14	8.15±0.24	5.59±0.35	3.16±0.23
P15	8.29±0.30	5.50±0.09	3.51±0.26
P16	4.16±0.23	<2	<2
P17	4.85±0.21	<2	<2
P18	4.95±0.07	4.21±0.30	3.13±0.18
P19	4.98±0.03	<2	<2
P20	3.89±0.16	<2	<2

4. Discussion

In this study, the pH values of pastirma samples ranged from 5.81 to 6.22. The ideal pH for pastirma should not exceed 6.0. The pH values in our samples were close to this limit. According to Article 7 of the Turkish Food Codex Meat and Meat Products Communiqué (2012), the characteristics of pastirma are as follows: excluding çemen, the moisture content must not exceed 45% by weight, the pH value must not exceed 6.0, the salt content in dry matter must not exceed 7% by weight, and the çemen content must not exceed 10% by weight.

Differences in the chemical properties of pastirma may result from the use of meat from different regions, the structure of çemen, the amount of salt, the salting method, drying, storage conditions, and events occurring during the drying period (Doğruer et al., 1995).

According to the study conducted by Tekinşen and Doğruer (2000), the moisture values were determined as 34.17%, 41.17%, 33.52%, and 36.92%, for kuşgömü, bohça, sırt, and şekerpare respectively. On the other hand, Ceylan (2009) and Ceylan and Aksu (2011) reported moisture values to be between 46.61-47.36% in the sırt, şekerpare and bohça samples. In the other studies, the moisture contents of pastirma samples were determined between 38.98 and 51.51% (Aksu and Kaya 2001; Doğruer et al.,1995; Gürbüz 1994; Hastaoğlu 2011; Özeren 1980).

In the study conducted by Ceylan & Aksu (2011), the average pH values were determined as 5.86, 5.79 and 5.82 for sırt, bohça, şekerpare, respectively. In the other studies, the average pH values of pastirma samples were pH 5.54, 5.70, 5.72 and 5.88 (Doğruer et al., 1995; Gürbüz 1994; Hastaoğlu 2011; Özdemir et al., 1999). In another study, pH values were determined to be between 5.39 and 5.80 in the 60 different samples (Elmalı et al., 2007).

Numerous microbiological studies have been conducted on pastirma samples collected from the market. Doğruer et al. (1995) reported that the average yeast and mold counts as 1.2×10^5 CFU/g. In the study conducted by Özdemir et al. (1999), the mold count was found to be $<2.0\times10^2$ CFU/g and the yeast count ranged from $<2.0\times10^2$ to 10^5 CFU/g. In the similarly study, the yeast and mold counts ranged from <2.00 to 5.76 log CFU/g (Aksu and Kaya, 2001). In another study, the average yeast and mold counts of pastirma samples were found between <2 and 7.24 log CFU/g (Çakıcı, 2012).

The microbiology of pastirma can vary significantly. This variability is caused by factors such as the microbiota of the meat and the microbiota of spices and water used in çemen production. In the study, the total aerobic bacterial count was found to range between 5.00 and 8.39 log CFU/g. Lactic acid bacteria (LAB) counts were determined to exceed 1.0×10^7 CFU/g (Aksu & Kaya, 2001). Çakıcı (2012) found that the LAB and TMAB counts ranged from 5.18 to 6.81 and 6.20 to 7.59 log CFU/g, respectively. Although there are differences compared to our study, the TMAB and LAB counts were found to be within similar ranges in log CFU/g.

5. Conclusions

As a traditional product, pastirma exhibits significant variation in its production methods, resulting in differences in physicochemical properties such as moisture and pH. Additionally, microbial counts, including those of lactic acid bacteria (LAB), total mesophilic aerobic bacteria (TMAB), and yeast and mold, varied substantially among samples. From a consumer perspective, it is crucial to preserve the diversity in production while minimizing undesirable variations that could negatively impact consumer satisfaction. Thus, standardizing diverse production methods emerges as a critical issue to ensure consistent quality while maintaining the traditional character of pastirma.

Declaration of Competing Interest

The authors declare that they have no financial or non-financial competing interests.

Author's Contributions

C. Çeviker (0000-0002-4748-954X): *Definition, Data Collection, Investigation, Methodology.*
C. Karaköse: *Definition, Data Collection, Investigation, Methodology.*
G. Kahraman: *Definition, Data Collection, Investigation, Methodology.*
N. Aydın: *Definition, Data Collection, Investigation, Methodology.*
İ. Öztürk (0000-0003-1434-4763): *Definition, Investigation Conceptualization, Writing, Editing, Methodology, Supervision.*

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