Sabuncuoglu Serefeddin Health Sciences (SSHS)

ISSN: 2667-6338, 202-/Vol.5:2/19-28

COMPARISON OF MICROBIOLOGICAL PROPERTIES OF TURKISH TRADITIONAL RAW MEATBALLS IN WINTER AND SUMMER

[*1]Merve YURTTAŞ

[1]Amasya University, Faculty of Health Science, Nutrition and Dietetics Department, Amasya, Türkiye

Research Article

Received: 08.04.2023, Accepted: 01.08.2023

*Corresponding author: merve.yurttas@amasya.edu.tr

Abstract

Raw meatball (çiğ köfte) is a popular food consumed fondly in Türkiye. The lack of being cooked and the constant hand contact during production and sale increase the risk of product contamination. This can cause food poisoning and pose a danger to public health. This study aims to determine the microbiological quality of raw meatballs sold in Çorum, Türkiye. For this purpose, a total of 40 samples were studied in winter (n = 20) and summer (n = 20) months. Samples were analyzed for pH, total aerobic mesophilic bacteria, yeast-mold, *E. coli*, coliform, *Enterobacteriaceae*, *Enterococcus*, and *Staphylococcus/Micrococcus*. The pH value of raw meatball samples was 4.64-5.35 in the winter, and in summer, it was determined as 4.65–5.09. The total aerobic mesophilic bacteria, yeast-mold, coliform, *Enterobacteriaceae*, *Enterococcus*, *Staphylococcus/Micrococcus* count results of samples in summer and winter periods were determined respectively as <1.00–5.59 and <1.00-6.12; <1.00–4.69 and <1.00–4.45; <1.00–5.61 and <1.00–3.2; <1.00–4.80 and <1.00–2.00; <1.00–4.57 and <1.00–3.95; <1.00–3.77 and <1.00–2.7 log cfu g^{-1}. *E. coli* bacteria could not be detected in any samples. As a result of the analysis, it was determined that the microbiological quality of the raw meatball samples was low. In addition, it is thought that the quality of raw material, additives used, and ambient temperature had an effect on the analysis results.

Key Words: Raw meatball, Microbiology, Temperature

Özet

Çiğ köfte ülkemizde severek tüketilen popüler bir yiyecektir. Çiğ köfteye ısıl işlem uygulanmaması, üretim ve satış sırasında sürekli el temasının olması ürünün kontaminasyon riskini artırmaktadır. Bu durum gıda zehirlenmelerine neden olabilmekte ve halk sağlığı açısından tehlike arz etmektedir. Bu çalışmada Çorum'da satılan çiğ köftelerin mikrobiyolojik kalitesinin belirlenmesi amaçlanmıştır. Bunun için kış (20) ve yaz (20) aylarında olmak üzere toplam 40 örnek ile çalışılmıştır. Örnekler pH, toplam aerobik mezofilik bakteri, maya-küf, *E. coli*, koliform, *Enterobacteriaceae*, *Enterococcus*, *Staphylococcus/Micrococcus* analizlerine tabi tutulmuştur. Çiğ köfte örneklerinin pH değeri kış döneminde 4.64-5.34; yaz döneminde ise 4,65-5,09 olarak tespit edilmiştir. Örneklerin kış ve yaz dönemlerinde toplam aerobik mezofilik bakteri, maya-küf, koliform, *Enterobacteriaceae*, *Enterococcus*, *Staphylococcus/Micrococcus* sayım sonuçları sırasıyla <1.00-5.59 ve <1.00-6.12; <1.00-4.69 ve <1.00-4.45; <1.00-5.61 ve <1.00-3.2; <1.00-4.80 ve <1.00-2.00; <1.00-4.57 ve <1.00-3.95; <1.00-3.77 ve <1.00-2.7 log kob g^{-1} olarak belirlenmiştir. Hiçbir örnekte *E. coli* bakterisi tespit edilememiştir. Analiz sonucunda yaz döneminde satılan çiğ köfte örneklerinin mikrobiyal kalitesinin düşük olduğu belirlenmiştir. Ayrıca hammadde kalitesi, kullanılan katkı maddeleri ve ortam sıcaklığının analiz sonuçları üzerinde etkili olduğu düşünülmektedir.

Anahtar Kelimeler: Çiğ köfte, Mikrobiyoloji, Sıcaklık

1. Introduction

Türkiye has a rich culinary culture due to its deep-rooted history and diverse ethnic cultures (Küçükkömürler et al., 2018). Raw meatballs are an important part of this culinary culture. Raw meatballs are prepared in various ways according to geographical region. They are a traditional food created by kneading ground beef and fine cracked wheat, adding tomato paste, onion, garlic, parsley, salt, chili pepper, and various spices (Ghazzi et al., 2018; Çiftçi & Kara, 2022). This traditional dish is consumed with pleasure in Türkiye and various Middle Eastern countries. However, it is risky for health as it is a meat product that is consumed raw or without being cooked. As it is a raw meat product, it contains pathogenic microorganisms that can cause food poisoning (Durmaz et al., 2007; Dogan et al., 2014). This situation threatens food security and

public health. The microbiological quality of raw meatballs depends on the hygienic quality of the ingredients (Çalıcıoğlu & Dikici, 2008). However, poor personnel hygiene and any unhygienic equipment during production and packaging cause contamination of raw meatballs (Sancak & İşleyici, 2006). Using raw meat in the raw meatball is only available in traditional home productions. Today, Turkish regulations forbid the sale of raw meatball with raw meat in the markets (Uzunlu, 2019). Even if raw meatballs are produced under hygienic conditions, keeping them at room temperature in the areas where they are for sale increases the microbiological load of the product (Küplülü et al., 2003). There are various studies to determine the microbiological quality of raw meatballs (Uzunlu & Yıldırım, 2003; Vural & Yeşilmen, 2003; Uzunlu et al., 2004; Sancak & İşleyici, 2006; Ardic & Durmaz, 2008; Hampikyan et al., 2008; Aslan et al. et al., 2012; Çetinkaya et al., 2012; Delikanlı et al., 2014; Yurdakul et al., 2017; Kurt et al., 2019; Uzunlu, 2019; Balpetek Kulcu et al., 2020). However, there is no study comparing the microbiological quality of raw meatballs in the summer and winter months. This study examines the raw meatballs offered for sale in Çorum in terms of microbiological properties in the summer and winter – considering that they pose a potential risk as the temperature changes due to seasonal differences.

2. Material and Methods

In this study, a total of 40 samples were collected from stores that only sell raw meatballs during the winter and summer seasons (January-February and June-July 2022). After the samples were collected under aseptic conditions, they were transported to the laboratory using a cooling bag. At least 200 g were collected from each sample.

2.1. pH analysis

After homogenizing 10 g of the raw meatball sample with 100 mL of distilled water, the pH value of the samples was measured using a pH meter (ADWA, Romania) (Bingol et al., 2011; Kurt et al., 2019).

2.2. Microbiological analysis

10 g of raw meatball sample was added with 90 mL of sterile buffered peptone water at a rate of 0.1 % and then homogenized with a stomacher for microbiological analysis. Afterward, serial dilutions were prepared up to 10^{-7}. From the prepared dilutions, the prepared dilutions were inoculated on the medium specified in Table 1 for total aerobic mesophilic bacteria (TAMB),

yeast-mold, *E. coli*, coliform, *Enterobacteriaceae*, *Enterococcus*, *Staphylococcus/Micrococcus (Stap/Micro)* counts. All colonies grown on Plate Count were evaluated as mesophilic bacteria; those on Potato Dextrose Agar as yeast-mold; the greenish fluorescent colonies grown on Eosin Methylen Blue Agar as *E. coli*; the dark red colonies with 1–2 mm diameter grown on Violet Red Bile Agar as coliform; the red colored colonies with a diameter of 0.5–1 mm growing on glucose agar even in violet red as *Enterobacteriaceae;* the colonies 1–2 mm large and pink-red to brown growing on Slanetz and Bartley Medium as *Enterococcus*; and the yellow-opaque colonies surrounded by a yellow zone growing on Mannitol Salt Agar as *Staphylococcus/Micrococcus*. Pouring and spreading plate cultivation methods were used for the analysis by repeating twice (Anonymous, 2005; Şimşek et al., 2006).

Table 1. Analyzed microorganisms and microbiological cultivation conditions

Microorganism	**Medium**	**Incubation conditions**	**Method**
TAMB	Plate Count Agar (Merck)	37°C 48 hours	Anonymous (2005); Şimşek et al., (2006)
Yeast-mold	Potato Dextrose Agar (Merck)	25°C 5 days	Anonymous (2005); Şimşek et al., (2006)
E. coli	Eosin Methylene Blue Agar (Neogen)	37°C 24–48 hours	Anonymous (2005); Şimşek et al., (2006)
Coliform	Violet Red Bile Agar (Merck)	37°C 24 hours	Anonymous (2005); Şimşek et al., (2006)
Enterobacteriaceae	Violet Red Bile Glucose Agar (Neogen)	37°C 24 hours	Anonymous, (2005); Şimşek et al., (2006)
Enterococcus	Slanetz-Bartley Medium (Neogen)	37°C 24–48 hours	Anonymous (2005); Şimşek et al., (2006)
Staphylococcus/Micrococcus	Mannitol Salt Agar (Himedia)	37°C 24–48 hours	Anonymous (2005); Şimşek et al., (2006)

2.3. Statistical analysis

Statistical analysis of the samples was performed using the *t*-test (independent variable) with the SPSS 25 package program at a 95% confidence level.

3. Results and Discussion

Table 2 presents the max., min., and mean values of pH, total aerobic mesophilic bacteria, coliform, *E. coli*, *Enterobacteria*, *Enterococcus*, *Staphylococcus-Micrococcus*, and the yeast-mold count results of 40 raw meatball samples collected in the winter and summer months. The pH values of the raw meatball samples varied between 4.64–5.34 in the winter and 4.65–5.09 in the summer. The pH values of the raw meatballs without meat sold in Adıyaman were found to vary between 3.99–4.84. (Kurt et al., 2019). Sancak and İşleyici (2006) determined the pH value of raw meatballs as 3.62–5.49 in their study on raw meatballs sold in Van. Balpetek-Külcü et al. (2020) found the pH value of raw meatballs as 3.5-5.15. A study on raw meatballs consumed in Siirt reported the pH value of raw meatballs as 4.32–6.99 (Kardeş, 2017). Although the pH values obtained in the present study are slightly higher than those in the abovementioned studies, at the lower limit, they are consistent with those in the literature. Also, there was no significant difference between the winter and summer pH values of the raw meatballs ($\rho > 0.05$).

Table 2. pH and microbiologically count results of raw meatball samples (log cfu g^{-1})

	Min.	***Max.***	***t***	***Mean±SD***
pH	4.64	5.34	1.64	4.94±*0.15*
TAMB	0.00	6.12	2.22	2.85±*1.79*
E. coli	0.00	0.00	0.00	0.00
Coliform	0.00	5.61	1.56	0.64±*1.41*
Enterobacteriaceae	0.00	4.80	2.16	0.53±*1.34*
Enterococcus	0.00	4.57	0.65	0.31±*1.11*
Stap./Micro.	0.00	3.77	2.69	1.46±*1.32*
Yeast-mold	0.00	4.69	-1.15	2.12±*1.97*

The total number of aerobic mesophilic bacteria and yeast mold gives information about the production-storage conditions and hygienic quality of foods. In this study, the bacterial count of raw meatball samples in the winter and summer was <1.00–5.59 and <1.00–6.12 log cfu g^{-1}, and their yeast-mold count was found as <1.00–4.69 and <1.00–4.45 log cfu g^{-1}, respectively. The total number of aerobic mesophilic bacteria was found as 5.40–8.82; 3.60–7.35; 4.30–8.86; 2.72–6.77; 5.98–7.84 log kob g^{-1} by Sancak and İşleyici (2006); Aslan et al., (2012); Kardeş (2017); Kurt et al., (2019); Balpetek Kulcu et al. (2020), respectively. These figures were also reported as $6x10^4$-$5.1x10^7$; $2.4x10^5$-$1.7x10^7$; $1x10^4$-$3.2x10^8$ kob g^{-1} by Vural and Yeşilmen (2003); Hampikyan et al., (2008); Delikanlı et al. (2014), respectively. In addition, the number of yeast-mold was found as 2.60–6.76; 3.30–7.19; 5.00–8.17; <2.00–6.10 log kob g^{-1}, and $3.0x10^2$-$1.0x10^7$ kob g^{-1} by Küplülü et al., (2003); Aslan et al., (2012); Kardeş (2017); Kurt et al., (2019) and Vural & Yeşilmen (2003), respectively. The TAMB and yeast-mold counts of this study are consistent with those in the literature. While the total number of aerobic mesophilic bacteria differed from each other in the summer and winter periods ($\rho < 0.05$), the yeast-mold counts were found to be similar ($\rho > 0.05$).

Coliform bacteria in foods are considered indicator microorganisms and show that fecal or other microorganisms may contaminate the food after insufficient heat treatment (Ünlütürk & Turantaş, 1998). This study found the number of coliform group bacteria as <1.00–5.61 and <1.00–3.2 log cfu g^{-1} in the winter and summer periods, respectively. Küplülü et al. (2003); Aslan et al. (2012); Kurt et al. (2019), and Vural and Yeşilmen (2003) found the coliform group bacteria counts as 2.78–5.71; <2.30–4.20; <2.00–5.98 log kob g^{-1}, and $3.0x10^1$-$1.1x10^6$ kob g^{-1}, respectively. In addition to the coliform group bacteria count, *Enterobacter* and *Enterococcus* counts may be an indicator of insufficient heat treatment or fecal contamination in foods (Kurt et al., 2019). In the present study was determined the number of *Enterobacteriaceae* as <1.00–4.80 and <1.00–2.00 log cfu g^{-1} in the winter and summer periods, respectively. These figures were found by Küplülü et al. (2003); Aslan et al. (2012); and Kardeş (2017) as 3.30–6.20; <2.30–4.77; 5.44-8.14 log kob g^{-1}, respectively. In the present study, the number of *Enterococcus* was determined as <1.00–4.57 and <1.00–3.95 log kob g^{-1} in winter and summer periods, respectively. Küplülü et al. (2003); Aslan et al. (2012); and Kardeş (2017) found the number of *Enterococcus* as 2.60–6.11; <2.30–7.07; 6.30–6.77 log kob/g, respectively. The number of *Staphylococcus/Micrococcus* is considered an indication of insufficient heat treatment or personnel hygiene in foods (Küpeli Gençer & Kaya, 2004; Bostan et al., 2011). The present study

found the number of *Staphylococcus/Micrococcus* to be <1.00–3.77 and <1.00–2.7 log kob g^{-1} in winter and summer periods, respectively. Küplülü et al. (2003), Aslan et al. (2012), and Vural and Yeşilmen (2003) reported the number of *Staphylococcus/Micrococcus* as 3.60-6.95; <2.30–6.66 log kob g^{-1} and 0-4.0x10^4 kob g^{-1}, respectively. The coliform bacteria, *Enterobacteriaceae, Enterococcus, and Staphylococcus/Micrococcus* count results in this study are consistent with those in the literature. *Enterobacteriaceae* and *Enterococcus* bacteria were detected in only one (1) sample for the summer period. While the coliform and *Enterococcus* bacterial counts were similar in summer and winter periods ($\rho > 0.05$), *Enterobacteriaceae* and *Staphylococcus/Micro*coccus count results were different from each other ($\rho < 0.05$).

In this study was determined that the counts of microorganisms other than total aerobic mesophilic bacteria were lower in the summer than in the winter. Contrary to expectations, the analysis results were higher in the summer than in the winter. During sample collection, it was observed that the selling places of raw meatballs were warmer in the winter than in the summer due to the use of heaters, coolers, and air conditioning. Additionally, it is thought that the moisture and dry matter content, type, and microbiological quality of the spices and sauces used in making raw meatballs and the number of additives may be related to the changes in the number of microorganisms in the raw meatballs (Şireli et al., 2008; Bostan et al., 2011; Keskin et al., 2018). The obtained results may have differed due to all of these factors.

4. Conclusion

This study aimed to compare the microbiological properties of raw meatballs sold in Çorum depending on seasonal temperature differences. As a result, the hygienic quality of raw meatballs was low. Since raw meatballs are consumed without being cooked, special attention should be paid to food safety criteria such as production conditions, raw material quality, personnel hygiene, equipment cleanliness, and selling place temperature. Raw meatballs should be consumed shortly after they are purchased. Currently, it is insufficient to determine the microorganisms, which give an idea about the production-storage and hygiene conditions of foods, only by a counting method. In addition to counting the microorganisms examined in this study, there is a need to determine the important microorganism species, such as *Salmonella* sp., *Listeria monocytogenes,* for food safety and public health at the molecular level.

Conflicts of interest: None

Funding Statement: This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

References

Anonymous, (2005). *Merck gıda mikrobiyolojisi uygulamaları* (1st ed.). Ankara: Başak Matbaacılık.

Ardic, M., & Durmaz, H. (2008). Determination of changes occured in the microflora of cig kofte (raw meat balls) at different storage temperatures. *International Journal of Food Science and Technology*, 43(5), 805-809. doi: 10.1111/j.1365-2621.01519.x

Aslan, S., Kara, R., Akkaya, L., & Yaman, H. (2012). Afyonkarahisar'da satılan çiğ köftelerin mikrobiyolojik kalitesi. *Akademik Gıda*, 10(4), 24-27.

Balpetek Kulcu, D., Soguksulu, S., Cakan, Y., & Ergen, C. (2020). Determination of the microflora of meatless cig kofte in the Black Sea region of Turkey. *Middle Black Sea Journal of Health Science*, 6(2), 177-182. doi: 10.19127/mbsjohs.707934

Bingol, E.B., Cetin, O., & Muratoglu, K. (2011). Effect of lemon juice on the survival of *Salmonella* Enteritidis and *Escherichia coli* in cig kofte (raw meatball). *British Food Journal*, 113(9), 1183-1194. doi: 10.1108/00070701111174604

Bostan, K., Yılmaz, F., Muratoğlu, K., & Aydın, A. (2011). Pişmiş döner kebaplarda mikrobiyolojik kalite ve mikrobiyel gelişim üzerine bir araştırma. Kafkas Üniversitesi Veteriner Fakültesi Dergisi, 17(5), 781-786. doi: 10.9775/kvfd.2011.4438

Çalıcıoğlu M., & Dikici, A. (2008). Esansiyel yağların çiğ köftede Salmonella'nın inaktivasyonu üzerine etkileri. *Fırat Üniversitesi Sağlık Bilimleri Dergisi*, 22(5), 283-288.

Çetinkaya, F., Mus, T.E., Cibik, R., Levent, B., & Gulesen, R. (2012). Assessment of microbiological quality cig kofte (raw consumed spiced meatball): prevalence and antimicrobial susceptibility of *Salmonella*. *Food Control*, 26, 15-18. doi: 10.1016/j.foodcont.2012.01.001

Çiftçi, E.R., & Kara, R. (2022). Investigation of Aflatoxin B1, total Aflatoxin, and Ochratoxin a presence in cig kofte: raw meatballs without meat. *Journal of Food Science and Technology*, 59(12), 4706-4712. doi: 10.1007/s13197-022-05552-8

Delikanlı, B., Sönmez, B., & Özdemir, Y. (2014). Bursa merkezinde tüketime sunulan etsiz çiğ köftelerin mikrobiyolojik kalitesi. *Harran Üniversitesi Veteriner Fakültesi Dergisi*, 3(1), 13-17.

Dogan, M., Cankurt, H., Toker, O.S., Yetim, H., & Sagdic, O. (2014). Effect of yoghurt or yoghurt serum on microbial quality of cig kofte. *Journal of Food Science and Technology*, 51(7), 1406-1410. doi: 10.1007/s13197-012-0649-4

Durmaz, H., Sagun, E., Sancak, H., & Sagdic, O. (2007). The fate of two *Listeria monocytogenes* serotypes in "cig kofte" at different storage temperatures. *Meat Science*, 76(1), 123-127. doi: 10.1016/j.meatsci.2006.10.020

Ghazzi, M., Port-Fett, A.C.S., Ayaz, N.D., Ozansoy, G., Çufaoğlu, G., Goncuoglu, M., Dluzneski, A., Holinka, S., Shoyer, B.A., Shane, L.E., Stahler, L.J., Campano, S.G., & Luchansky, J.B. (2018). Microbiological characterization of çiğ köfte sold at retail in Ankara, Turkey and evaluation of selected antimicrobials as ingredients to control foodborne pathogens in çiğ köfte during refrigerated storage. *Food Control*, 84, 138-147. doi: 10.1016/j.foodcont.2017.04.033

Hampikyan, H., Ulusoy, B., Bingöl, E.B., Çolak, H., & Akhan, M. (2008). İstanbul'da tüketime sunulan bazı ızgara tipi gıdalar ile salata ve mezelerin mikrobiyolojik kalitelerinin belirlenmesi. *Türk Mikrobiyoloji Cemiyeti Dergisi*, 38(2), 87-94.

Kardeş, M. (2017). Siirt ilinde tüketime sunulan çiğ köftelerin mikrobiyolojik kalitesi. Yüksek Lisans Tezi. Siirt Üniversitesi, Fen Bilimleri Enstitüsü, p.65, Siirt, Türkiye.

Keskin, S.N., Şin, E., Akarca, G., & Tomar, O. (2018). Çeşitli bitki ekstraktlarının çiğ köfte üzerindeki antimikrobiyal etkisi. *Kocatepe Veterinary Journal*, 11(3), 266-278. doi: 10.30607/kvj.422778

Kurt, Ş., Ceylan, H.G., & Fener, M. (2019). Adıyaman'da satışa sunulan çiğ köftelerin mikrobiyolojik kalitesi. *ADYÜTAYAM,* 7(2), 57-68.

Küçükkömürler, S., Şirvan, N.B., & Sezgin, A.C. (2018). Dünya'da ve Türkiye'de gastronomi turizmi. *Uluslararası Turizm, İşletme, Ekonomi Dergisi,* 2(2), 78-85.

Küpeli Gençer, V., & Kaya, M. (2004). Yaprak dönerin mikrobiyolojik kalitesi ve kimyasal bileşimi. *Turkish Journal of Veterinary & Animal Science*, 28, 1097-1103.

Küplülü, Ö., Sarımehmetoğlu, B., & Oral, N. (2003). The microbiological quality of çiğ köfte sold in Ankara. *Turkish Journal of Veterinary & Animal Science*, 27(2), 325-329.

Sancak, Y.C., & İşleyici, Ö. (2006). Çiğ köftelerin mikrobiyolojik kalitesi üzerine bir araştırma. *Yüzüncü Yıl Üniversitesi Veteriner Fakültesi Dergisi,* 17(1-2), 81-86.

Şimşek, Ö., Çon, A.H., & Tulumoğlu, Ş. (2006). Isolating lactic starter cultures with antimicrobial activity for sourdough process. *Food Control*, 17, 263-270. doi: 10.1016/j.foodcont.2004.10.011

Şireli, U.T., Göncüoğlu, M., & Pehlivanlar, S. (2008). Growth of *Listeria monocytogenes* in çiğ köfte (raw meat ball). *Ankara Üniversitesi Veteriner Fakültesi Dergisi*, 55(2), 83-87.

Uzunlu, S., & Yıldırım, İ. (2003). Çiğ köftenin mikrobiyolojik kalitesi ve farklı muhafaza sıcaklık ve sürelerindeki mikrobiyal değişimin incelenmesi. *Gıda,* 28(5), 553-558.

Uzunlu, S., Yıldırım, İ., & Serdengeçti, N. (2004). Antalya il merkezinde tüketime sunulan çiğ köftelerin mikrobiyolojik kalitesinin incelenmesi. *Türk Mikrobiyoloji Cemiyeti Dergisi*, 34, 257-261.

Uzunlu, S. (2019). Assessment of some physicochemical and microbiological quality parameters of raw meatballs prepared with high pressurized meat. *The Journal of Food*, 44(2), 340-347. doi: 10.15237/gida.GD18119

Ünlütürk, A., Turantaş, F. (1998). Gıda Mikrobiyolojisi (1. baskı). İzmir: Mengi Tan Basımevi.

Vural, A., & Yeşilmen, S. (2003). Diyarbakır'da satışa sunulan çiğ köftelerin mikrobiyolojik kalitesi üzerine bir araştırma. *Türk Mikrobiyoloji Cemiyeti Dergisi*, 33, 350-355.

Yurdakul, Ö.K., Kırdar, S.S., & Keyvan, E. (2017). Etsiz çiğ köftelerde patojen *Candida* spp. varlığının tespiti. *Etlik Veteriner Mikrobiyoloji Dergisi*, 28(1), 46-50.