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Research Article/Araştırma Makalesi

The effect of turmeric on microbial quality in meatballs

Köftelerde zerdeçalın mikrobiyal kalite üzerine etkisi

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ABSTRACT

Investigation of the effects of turmeric on the pH and microbiological quality of the meatballs was aimed in this study. 2% and 4% turmeric was added to the meatballs, and these samples stored at refrigerator temperature. pH values, total aerobic bacteria, total coliform bacteria, lactic acid bacteria and *Staphylococcus aureus* counts of the samples were followed at daily intervals for five days. As a result of the analysis, it was shown that Total Aerobic Bacteria counts of the turmeric containing groups were lower compared to the control group. pH value of the 4% turmeric group was found lower than the control group. It was found that the Total Coliform Bacteria counts of the 4% turmeric group were lower when compared to the control group. As a result, the addition of 4% turmeric to the meatballs is effective on the microbiological quality of the meatballs.

Key Words: Food safety, Meatball, Microbiological quality, Turmeric

ÖZ

Bu çalışmada, zerdeçalın köftelerin pH'sı ve mikrobiyolojik kalitesi üzerindeki etkileri incelenmesi amaçlanmıştır. Köftelere %2 ve %4 oranında zerdeçal ilave edilmiştir ve örnekler buzdolabı sıcaklığında muhafaza edilmiştir. Örnekler pH, toplam aerob mezofil bakteri, toplam koliform bakteri, laktik asit bakteri ve *Staphylococcus aureus* sayıları açısından beş gün süresince analiz edilmiştir. Analizler sonucunda zerdeçal kullanılan grupların Toplam Aerob Mezofil Bakteri sayısının kontrol grubuna kıyasla daha düşük düzeyde olduğu görülmüştür. %4 Zerdeçal içeren grubun pH değeri kontrol grubundan daha düşük olduğu bulunmuştur. Köftelerden %4 zerdeçal içeren grubun Toplam Koliform Bakteri sayısının kontrol grubuna kıyasla daha düşük değere sahip olduğu belirlenmiştir. Sonuç olarak, köftelere %4 konsantrasyonda zerdeçal ilave edilmesinin köftelerin mikrobiyolojik kalitesinde etkili olduğu görülmüştür.

Anahtar Kelimeler: Gıda güvenliği, Köfte, Mikrobiyolojik kalite, Zerdeçal

Introduction

Foodstuffs could be contaminated by microorganisms such as bacteria and fungi. These microorganisms may cause undesirable changes in the taste, smell, color, sensory and structural properties of food (Lucera et al., 2012; Ünver and Çelik, 2017; Yaralı, 2019). Various preservation methods such as fermentation, drying, heat treatment, organic acid application, UV ionizing radiation, non-thermal applications such as high hydrostatic pressure are used in the food industry to prevent the development of spoilage and pathogenic microorganisms in foods (Davidson and Taylor, 2007; Farkas, 2007; Ünver and Çelik, 2017; Belibağlı and Ersan, 2018). In recent years, there has been a significant increase in the preservation of food with natural additives due to consumer concern about synthetic chemicals used in foods (Lucera et al., 2012).

Consumers prefer the preservation of foods with natural additives instead of storage with synthetic chemicals. Natural preservatives that have little or no side effects are being investigated in the food industry. The spices and herbs used for this purpose in the foods not only add taste to the food but also protect the food from various factors affecting its quality (Tsigarida et al., 2000; Gill et al., 2002; Tajkarmi et al., 2010; Abdollahzadeh et al., 2014).

The use of natural antibacterial compounds, such as spices and herbs for food preservation, has become increasingly common in the food industry (Estevez et al., 2007; Pezeshk et al., 2011). Despite the widespread use of various food preservation techniques such as heat treatment, cold storage and addition of antimicrobial compounds, these techniques could cause loss of nutrients in foods and alter organoleptic properties. Instead of the traditional food preservation techniques, the food industry is increasingly interested in new techniques for consumer expectations such as taste, nutritional quality, natural and easily processed foodstuffs. For this reason, researches on medicinal plants are becoming more important in terms of the food industry and human health (Gul and Bakht, 2015).

In order to inhibit the growth of undesirable microorganisms in foods, antimicrobials can be added directly to the product formulation or applied as a surface coating or by adding to the packaging material (Lucera et al., 2012).

Bacterial resistance for existing antibiotics and increasing popularity of traditional medicine have led researchers to investigate plant-derived antimicrobial compounds (Hosny et al., 2011). Curcumin, which forms the major parts of turmeric food colorants, is isolated from rhizomes of *Curcuma longa*. The powders of these rhizomes are very important in the Asian diet and have been used for many years in traditional medicine for the treatment of diseases and infections (Shah et al., 1999). *Curcuma longa* is a medicinal plant and belongs to the family *Zingiberaceae*. Turmeric powder is produced from *Curcuma longa* rhizome and is generally used as a spice, food additive and food coloring (Shah et al., 1999; Han and Yang, 2005; Niamsa and Sittiwet, 2009; Bhawana et al., 2011; Mun et al., 2013; Moghadamtousi et al., 2014; Liu et al., 2016). Curcumin is an oil-soluble pigment and its solubility in water is very limited. The solubility of curcumin in water is 0.6 µg mL^{-1}, which can be increased by heating to 7.4 µg mL^{-1}. Curcumin is also soluble in ethanol and acetone (Hosny et al., 2011). Curcumin has a wide spectrum of biological activities including anti-inflammatory, antioxidant, anti-cancer, antidiabetic, anti-allergic, antiviral, antiprotozoal and antifungal activities (Niamsa and Sittiwet, 2009; Oyagbemi et al., 2009; Bhawana et al., 2011; Hosny et al., 2011; Mun et al., 2013; Moghadamtousi et al., 2014; Gul and Bakht, 2015). Curcumin is generally used in Asia as a food coloring agent and spice, as well as in a wide range of conditions, from acute infections to chronic diseases. It is reported that curcumin has excellent protective effects against *Vibrio vulnificus* infections and reduces the various virulence factors of *Pseudomonas aeruginosa* (Mun et al., 2013). Because of these biological activities, curcumin is considered a functional food source in the food industry. Nowadays, curcumin is used as a colorant in food and beverages, dairy products and pastry products (Liu et al., 2016). It is also stated that curcumin is used as an antimicrobial agent in textile products and when used in combination with aloe vera, it suppresses microbial growth in cotton, wool and rabbit feathers (Moghadamtousi et al., 2014).

Turmeric contains antioxidants known as curcuminoids and is reported to inhibit tumor growth. Turmeric, which is also a powerful antioxidant, promotes colon health, shows neuroprotective activity and assists in maintaining a healthy cardiovascular system (Hosny et al., 2011). Although the mechanism of antimicrobial action of curcumin is not known, it is thought that the presence of methoxyl and hydroxyl groups may be responsible for the antimicrobial effect (Han and Yang, 2005). Turmeric has three

components; curcumin (diferuloylmethane) is the main part (95%) of the turmeric and is responsible for the antibacterial, antifungal, anti-inflammatory and antioxidant effects, demethoxycurcumin, and bisdemethoxycurcumin (Naz et al., 2010).

In this study, the effect of turmeric on the microbiological quality and pH values of meatballs was investigated.

Material and Method

Material

In the study, Plate Count Agar (PCA, Merck 1.05463), Reinforced Clostridial Agar (RCA, Merck 1.05410), Violet Red Bile Agar (VRBA, Merck 1.01406), Maximum Recovery Diluent (MRD, Merck 1.12535), Baird-Parker Agar (BP, Merck 1.05406), Egg yolk tellurite emulsion (Merck 1.03785), De Man Rogosa Sharpe Agar (MRS, Merck 1.10660), stomacher (Bagmixer-400, France), pH meter (Hanna HI 221, Romania), distilled water and turmeric were used.

Method

The minced meat used in the preparation of the meatballs was obtained from a local market in Ankara and brought to the laboratory in cold storage. For the control group, 30 grams of minced meat was taken and placed into polypropylene packages after manual shaping. The packages were then covered with stretch film and stored in a refrigerator at + 4 °C until analyzed. For the turmeric groups, 2% and 4% turmeric was added to the remaining ground beef homogeneously and mixed. Groups of 2% and 4% turmeric were prepared by weighing 30 grams of these ground beef. Prepared groups were kept in polypropylene plastic packages with stretch film and were storage at + 4 °C until 8 $\log_{10}$ CFU g^{-1}; odor development limit (Fung, 2009).

pH analysis

The pH meter (Hanna HI 221, Romania) was adjusted with pH4 and pH7 buffer solutions. Ten gram of samples was weighed and diluted with 90 mL distilled water and then pH was measured (Anonymous, 1990).

Microbiological analysis

Weighed 10 grams of meatballs in a sterile bag, diluted with 90 mL of Maximum Recovery Diluent (MRD) and homogenized in the stomacher for 1 minute. In the analysis, dilution was performed as serial dilutions with MRD by calculating the ratio of 1 9^{-1} (Halkman, 2005). The dilutions were used to determine the total aerobic mesophilic bacteria, total coliform bacteria, lactic acid bacteria and *Staphylococcus aureus* counts.

Total aerobic mesophilic bacteria (TAMB)

Plate Count Agar (PCA) was used for total bacteria analysis by standard spreading plate or pour plate method. The prepared dilutions were inoculated at 0.1 mL to the PCA plates using standard spreading plate method and the plates were incubated at 28 ± 2˚C for 48 hours. At the end of the incubation period, colonies formed in Petri plates were counted and expressed as $\log_{10}$ CFU g^{-1} (Anonim, 2000).

Total coliform bacteria

A 0.1 mL of the prepared dilutions was inoculated to the Violet Red Bile (VRB) Agar with standard spreading plate method and incubated at 32 °C for 24 hours. Colonies with 1-2 mm diameter dark red precipitation at the end of incubation were considered as coliform group bacteria and expressed as $\log_{10}$ CFU g^{-1} (Anonim, 2000).

Lactic acid bacteria

A 0.1 mL of the serial dilutions were inoculated to MRS Agar with standard spreading plate method and plates were incubated at 28 °C for 48 hours. At the end of the incubation, white-cream colored lenticular shaped colonies were counted and the number of Lactic Acid Bacteria was expressed as $\log_{10}$ CFU g^{-1} (Halkman, 2005).

Staphylococcus aureus

ISO method was used to detect *Staphylococcus aureus* in samples (Anonymous, 2003). According to this method, 0.1 mL of the

dilutions inoculated in the Baird-Parker Agar with egg yolk tellurite enrichment and plates were incubated at 37 °C for 24-48 hours. At the end of incubation, typical and atypical colonies of 1-1.5 mm in size, gray-black in color and bright were evaluated as *Staphylococcus aureus* suspicious colonies and expressed as $\log_{10}$ CFU g^{-1}.

Statistical analysis

Statistical evaluation of the results was done by using SPSS statistical program. The factors affecting the change in quality criteria were determined as a sample group and storage time. Duncan's test was used as a result of a one-way analysis of variance in repeated measurements (Daniel, 1991).

Results and Discussion

pH value is an important criterion affecting the shelf life, color, water holding capacity and cooking efficiency of meat and meat products (Turhan et al., 2017). The initial pH value of the minced meat was 5.88. Milon et al. (2016) studied the effect of turmeric powder in meatballs and they found the initial pH value of the meatballs between 5.75 and 6.18, similar to our study. Changes in the pH of the sample groups are given in Figure 1. It was determined that the pH value of sample groups increased during storage ($P<0.05$). The pH of the control group was found to be higher ($P<0.05$) than that of 4% turmeric containing group from the 2nd day of storage. The increase in pH during storage may result from the accumulation of metabolites and deamination of proteins due to bacterial activity in meat (Biswas et al., 2004). It is thought that the pH value of the control group is higher than the 4% turmeric containing group, which may be related to the high bacterial load of the control group.

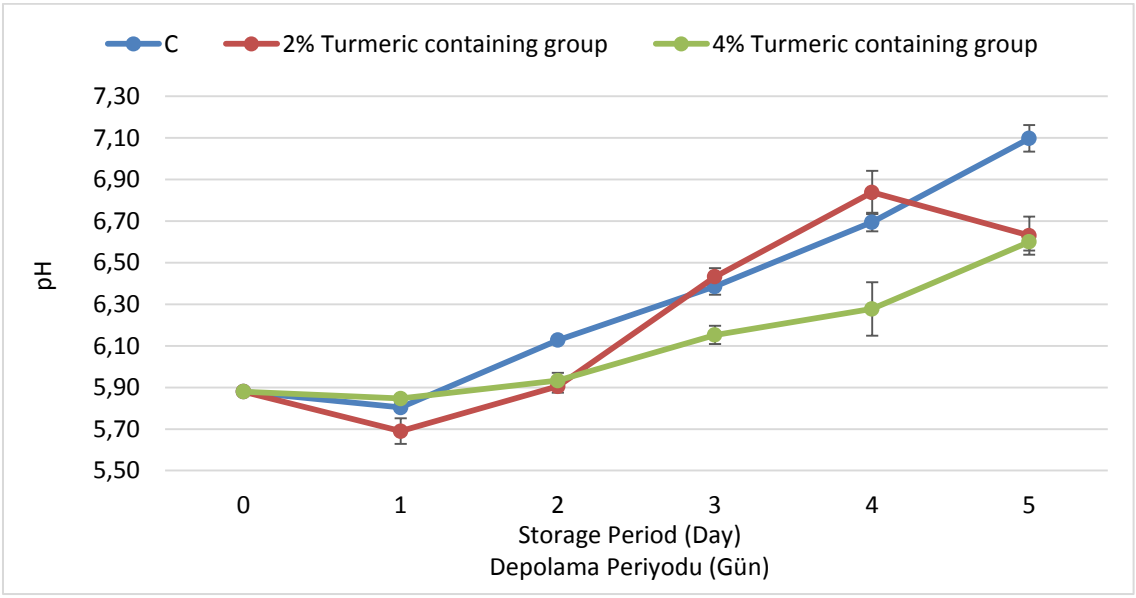

Figure 1. Changes occurred in pH values of meatballs during the storage. C: Control group, 2% and 4% turmeric containing groups. Error bars: mean ± standard error.

Şekil 1. Muhafaza süresince köftelerin pH değerlerinde meydana gelen değişimler. C: Kontrol grubu, %2 Zerdeçal ve %4 Zerdeçal içeren gruplar. Hata barları: ortalama ± standart hata.

The initial TAMB bacterial counts of the samples were 6.8 log CFU g^{-1} (Figure 2). Milon et al. (2016) reported in their study that the initial total bacteria count of raw materials was 5.12 log CFU g^{-1} and similar with the study the number of bacteria increased during storage. The increase in the TAMB counts of the groups during the storage period was statistically significant ($P<0.05$). When the difference between the TAMB counts of the sample groups was evaluated, the difference between the 4% turmeric containing group and the 2% turmeric containing group and control groups was statistically significant ($P<0.05$), and TAMB count of the 4% turmeric containing group

was found to be lower than the others. The TAMB counts of all groups remained close to each other until the 3rd day of the storage and were found to be lower in the turmeric-containing groups on the 4th and 5th days of storage compared to the control group.

The initial coliform count of the samples was 3.46 log CFU g^{-1}. Coliform bacterial count changes of the groups are given in Figure 3. There was an increase in the number of coliform bacteria counts during the storage period ($P < 0.05$). When the difference between the groups in terms of the coliform bacteria counts was examined, the total coliform counts of the meatballs containing 4% turmeric was found to be lower than the control and 2% turmeric containing group on the 4th and 5th days of the storage ($P < 0.05$).

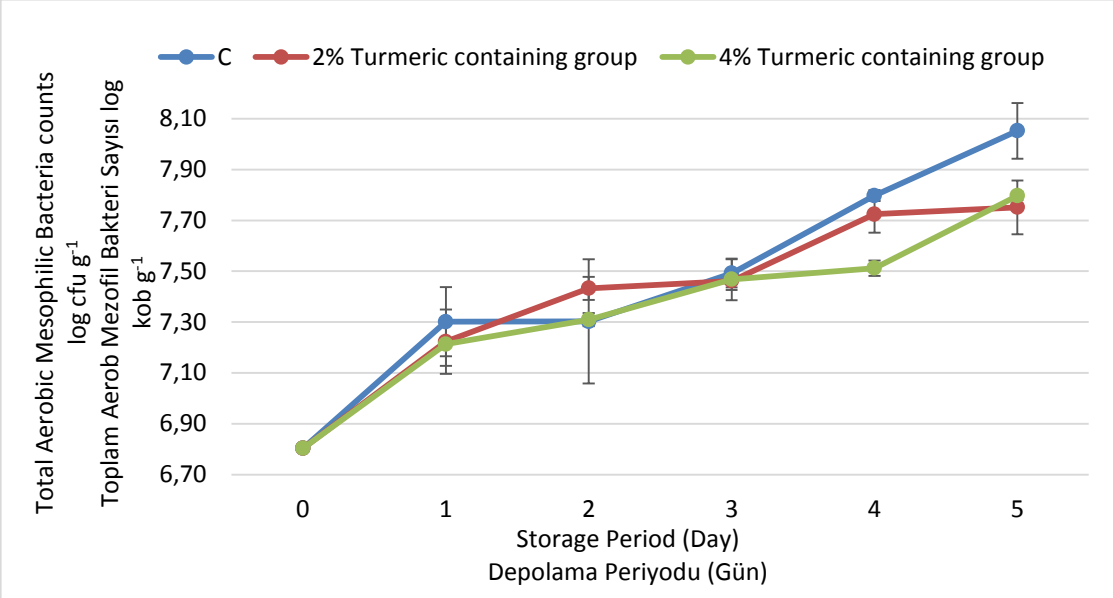

Figure 2. Changes occurred in total aerobic mesophilic bacteria count of meatballs during the storage. C: Control group, 2% and 4% turmeric containing groups. Error bars: mean ± standard error.

Şekil 2. Muhafaza süresince köftelerin toplam aerob mezofil bakteri sayısında meydana gelen değişimler. C: Kontrol grubu, %2 Zerdeçal ve %4 Zerdeçal içeren gruplar. Hata barları: ortalama ± standart hata.

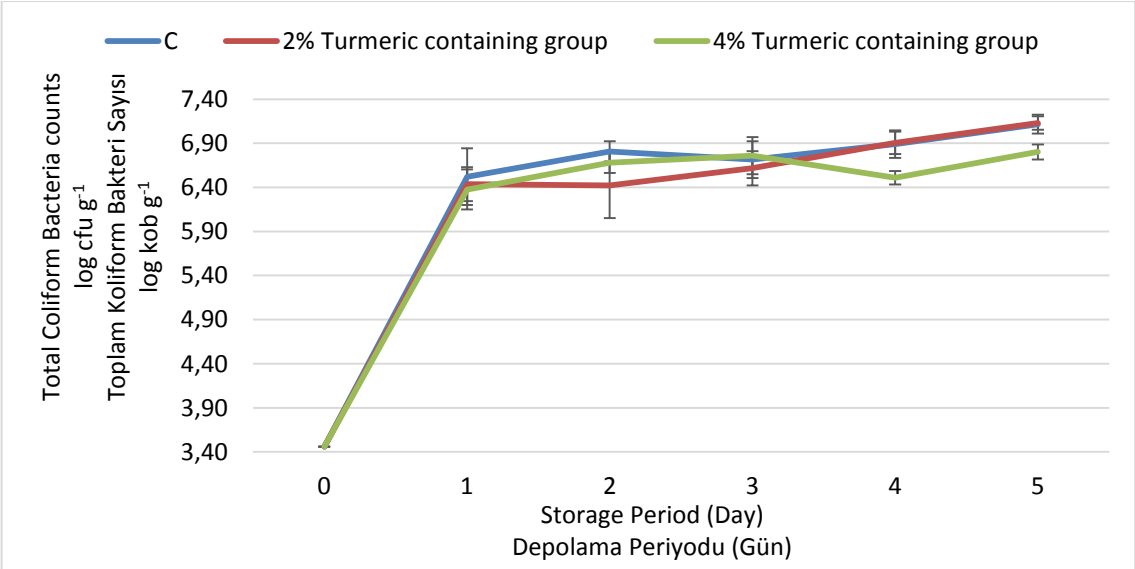

Figure 3. Changes occurred in total coliform bacteria count of meatballs during the storage. C: Control group, 2% and 4% turmeric containing groups. Error bars: mean ± standard error.

Şekil 3. Muhafaza süresince köftelerin toplam koliform bakteri sayısında meydana gelen değişimler. C: Kontrol grubu, %2 Zerdeçal ve %4 Zerdeçal içeren gruplar. Hata barları: ortalama ± standart hata.

The initial LAB counts of the samples were found as 5.32 log CFU g^{-1}. While the LAB counts of the turmeric-containing groups increased (P <0.05) during the storage period, the LAB counts of the control group were fluctuated (Figure 4). The difference between the LAB counts of the groups except for the first day of storage was statistically significant (P <0.05) and the LAB counts of the turmeric containing groups were higher than the control group. pH values of the turmeric containing groups, especially the 4% turmeric containing group, were higher than the control group because of the lactic acid production of the LAB.

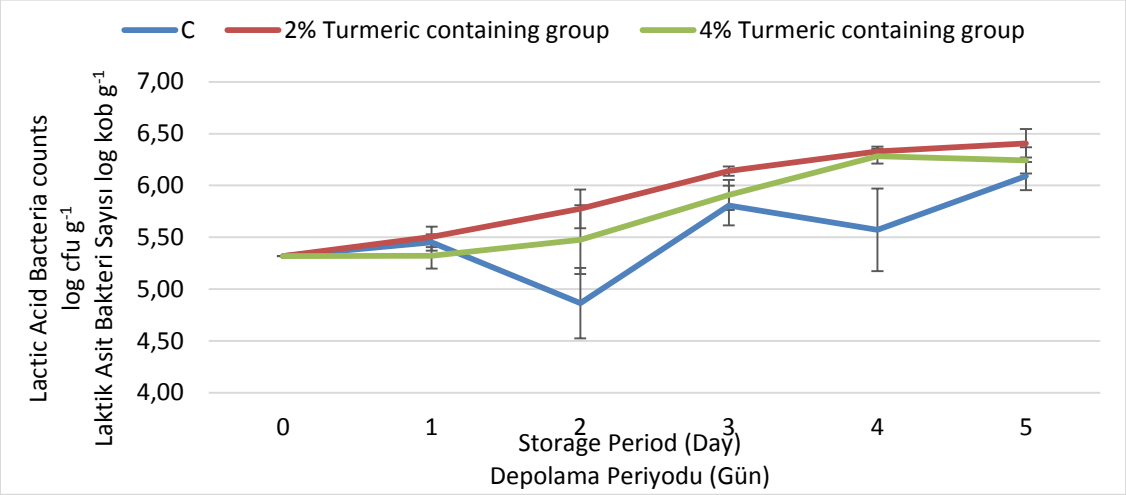

Figure 4. Changes occurred in lactic acid bacteria count of meatballs during the storage. C: Control group, 2% and 4% turmeric containing groups. Error bars: mean ± standard error.

Şekil 4. Muhafaza süresince köftelerin laktik asit bakteri sayısında meydana gelen değişimler. C: Kontrol grubu, %2 Zerdeçal ve %4 Zerdeçal içeren gruplar. Hata barları: ortalama ± standart hata.

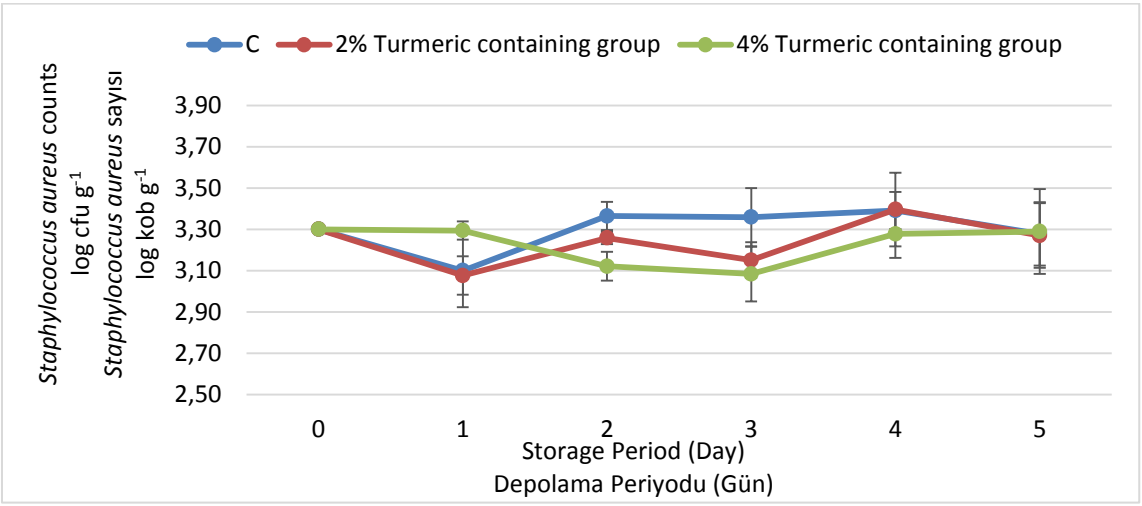

Figure 5. Changes occurred in *Staphylococcus aureus* count of meatballs during the storage. C: Control group, 2% and 4% turmeric containing groups. Error bars: mean ± standard error.

Şekil 5. Muhafaza süresince köftelerin *Staphylococcus aureus*. sayısında meydana gelen değişimler. C: Kontrol grubu, %2 Zerdeçal ve %4 Zerdeçal içeren gruplar. Hata barları: ortalama ± standart hata.

The initial *Staphylococcus aureus* counts of the samples were 3.30 log CFU g^{-1}. *Staphylococcus aureus* numbers of the sample groups showed fluctuation during the storage period (Figure 5). When the *Staphylococcus aureus* counts of the samples were analyzed, the difference between the groups and each other during storage was not statistically significant (P> 0.05).

Turmeric (*Curcuma longa*) is widely used as food preservative and colorant in foods in India, China and Southeast Asia (Gul and Bakht, 2015). Wang et al. (2009) examined the antibacterial effect of microcapsule curcumin in their study and as opposed to the study, they showed that

curcumin microcapsules have a highest inhibitory effect against *Staphylococcus aureus* and lowest inhibitory effect against *Escherichia coli* and *Yersinia enterocolitica*.

Lourenço et al. (2013) investigated the effect of turmeric on the reduction of *Staphylococcus aureus* and *Escherichia coli* counts in chicken meats. As a result, they reported that 1% concentration of turmeric added to the samples had no effect on the numbers of *Escherichia coli* and *Staphylococcus aureus*. They stated that turmeric concentrations of more than 1% could be effective against these microorganisms. Shelef et al. (1980) stated that turmeric concentration for inhibition of bacterial growth was range between 1-5%. When taking into consideration the Lourenço et al. (2013) and Shelef et al. (1980), 2% and 4% turmeric were used in the study.

Deb et al. (2013) reported that Gram-negative spoilage bacteria contamination was delayed as a result of the addition of turmeric in yogurt. Mun et al. (2013) stated that curcumin showed antimicrobial activity against all *Staphylococcus aureus* strains according to the antimicrobial susceptibility tests of curcumin against 10 strains of *Staphylococcus aureus* by the standard broth microdilution method. Hosny et al. (2011) evaluated the antimicrobial activity of curcumin (0.3%) in Karishcum cheese, and they found that 2 log reduction in *Escherichia coli* O157:H7 counts.

Arulkumar et al. (2017) investigated the effects of turmeric on biogenic amine formation and shelf life in cuttlefish, and they reported that after 3rd days of the storage, similar with the study, the mesophilic bacteria and *Enterobacteriaceae* loads of the control group was higher than that of the turmeric added groups and that turmeric increased the shelf life of cuttlefish. They also stated that turmeric suppressed microorganisms cause biogenic amine formation.

Buch et al. (2014) examined the effect of turmeric on shelf life in fresh cheeses called “paneer”. They reported that the addition of turmeric at a rate of 0.6% extended the shelf life up to 12 days at 7˚C. Similarly, they stated that the standard plate counts of the control group were higher than the 0.4% turmeric added samples.

Conclusion

Red meat is an important source of protein, minerals, and vitamins. However, meatball, which is one of the meat products, is among the foods that are risky for the consumer in terms of microbial contamination. Natural methods such as the use of herbs and spices are of interest in reducing microbial risk in foods. There are limited studies investigating the antimicrobial effect of turmeric which is an important spice in various foods in different countries. As a result, in this study, it was found that turmeric (4%) used in meatballs made from red meat showed antimicrobial effect and it is thought that the researches about turmeric should be increased.

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