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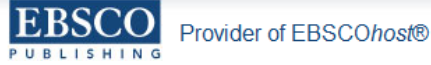
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## The Microbiological Quality of Frankfurters Sold in Tekirdag

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The microbiological quality of meat products is characterized by the presence of aerobes, facultative anaerobes, psychrotrophs and mesophiles which are responsible for spoilage and pathogenic bacteria. Producers should be careful about the microbiological quality and contamination of meat products in all processing stages including production and consumption in order to protect consumer health. One of these processing stages is selling. The aim of this research was to determine the hygienic quality of the packaged (by vacuum packaging) and unpackaged (sausages which have been packaged in modified atmosphere packages as 3000 grams and sold in portions/grams according to customer demand) frankfurters sausages sold in Tekirdag. The samples were investigated for *Staphylococcus aureus*, yeasts and moulds, *Escherichia coli*, and *Salmonella* spp. in order to observe their hygienic quality. In general, the unpackaged sausage samples had higher *S. aureus* and yeast and mould counts than the frankfurters sausages should not be sold in unpackaged form because of low hygienic quality.

**Keywords:** Pathogenic bacteria, emulsified sausages, hygienic quality of the sausages

### Tekirdağ'da Satılan Frankfurter Sosislerin Mikrobiyolojik Kalitesi

Et ürünlerinin mikrobiyolojik kalitesi patojen bakteriler ve bozulmadan sorumlu aeroblar, fakültatif anaeroblar psikrotroflar ve mezofillerin varlığı ile karakterize edilir. Üreticiler tüketici sağlığını korumak için üretim ve tüketimi içeren bütün proses evrelerinde et ürünlerinin mikrobiyolojik kalitesi ve kontaminasyonu konusunda dikkatli olmalıdırlar. Bu proses evrelerinden biri satıştır. Bu araştırmanın amacı Tekirdağ'da satılan paketlenmiş (vakum paketlenmiş) ve paketlenmemiş (3000 gram olarak modifiye atmosferde paketlenmiş ve tüketici isteğine göre porşiyon/gr olarak satılan sosisler) Frankfurter sosislerin hijyenik kalitesini belirlemektir. Örnekler hijyenik kalitelerini gözlemek için *Staphylococcus aureus*, maya ve küfler, *Escherichia coli* ve *Salmonella* spp. bakımından araştırıldı. Genellikle paketlenmemiş sosis örnekleri paketlenmiş sosislerden daha yüksek *S. aureus* ve maya ve küf sayısına sahipti. Frankfurter sosisler hijyenik kalitesinin düşüklüğünden dolayı paketlenmemiş olarak satılmamalıdır.

**Anahtar Kelimeler:** Patojen bakteriler, emülsifiye edilmiş sosiler, sosislerin hijyenik kalitesi

### Introduction

In recent years, there has been an increasing interest for cooked or ready-to-cook products. Sausages and salamis are among the mostly preferred ones due to the ease of consumption (Frazier and Westhoff, 1988). Frankfurters are sausages. They are produced from fresh meat that is cured during processing, fully cooked, and smoked (Güngör and Gökoğlu, 2010). Consumer awareness has increased in recent years for microbiological quality of sausages. It has therefore become important to investigate sausage microbial profile (Korkeala et al. 1989, von Holy et al. 1991, Sachindra et al. 2005). Microorganisms transmitted into sausage from meat, spices, other ingredients, environment, and equipment. Handlers during processing affect the microbiological status of the product. Comminuting also increases microbial contamination to sausages. Processing conditions

such as heat treatment reduce microbial levels. But, recontamination occurs during post-processing, handling and storage of sausage (Korkeala et al. 1989, von Holy et al. 1991, Sachindra et al. 2005). Many of the microorganisms that cause undesirable changes in the product can continue to survive after heat treatment and grow during storage, causing a health risk to consumers (Frazier and Westhoff, 1988). LAB is the major spoilage organism in vacuum-packaged cooked sausages (Korkeala et al. 1989, von Holy et al. 1991, Sachindra et al. 2005). CO<sub>2</sub> and vacuum packaging extend the shelf life of sausages (Borch et al. 1996). Sausages are largely made from meat off-cuts blended with certain herbs and spices, starch fillers and preservatives. This mixture is then extruded into casings to deliver the final product. They are sold

in unpackaged and packaged forms in supermarkets.

The aim of the present study was to determine the microbiological quality of the unpackaged and packaged sausages sold in supermarkets in Tekirdag.

## Material and Methods

Sausage samples were purchased from 5 different supermarkets (fifteen unpackaged samples and fifteen packaged samples) in Tekirdag/Turkey at 2 different times from each producer resulting in a total of 30 samples. Sausages are sold packaged (by vacuum packaging) and unpackaged (sausages which have been packaged in modified atmosphere packages as 3000 grams and sold in portions/gram according to customer demand). The samples were aseptically obtained and immediately carried in an insulated box containing ice to the laboratory, and then subjected to microbiological analysis.

Yeast and mould counts were determined on Potato Dextrose Agar (PDA) (3.5 pH) incubated at 25°C for 5 days. The presence of *Escherichia coli* was determined by transferring 1 ml of each sample dilution to sterile petri dishes followed by pouring 10 ml of Violet Red Bile Agar (with 4-methyl umbelliferryl-β-D-glucuronide (VRB-MUG)) and incubated at 48°C. The plates were swirled, allowed to solidify and overlaid with 3 to 5 of VRB-

MUG and then incubated at 37°C for 24 to 48 h. The plates were examined for typical coliform colonies which were counted to obtain a presumptive coliform count. Isolates that were Gram-negative and produced acid and gas in lactose broth were recorded as confirmed coliforms. These plates were also examined under long wave ultraviolet (UV) light for the presence of fluorescent colonies, indicating possible presence of *E. coli*. Those with positive fermentation and gas production in lactose broth were further characterized as *E. coli* using indole, methyl red, Voges-Proskauer and citrate (IMVIC) identification tests.

The presence of *S. aureus* was tested by surface plating on Baird-parker agar with egg-yolk tellurite enrichment. The plates were incubated at 35°C for 48 h. Suspicious colonies were transferred to slants for *S. aureus* confirmation by Gram staining, catalase reaction and the coagulase test.

For *Salmonella*, 25 g samples were enriched in Selenite Cystine Broth for 24 h at 35 °C and then the cultures were streaked onto Bismuth Sulfite Agar and incubated at 35 °C for 24 h. The typical *Salmonella* colonies were subjected to subsequent biochemical tests by using Triple Sugar Iron and Lysine Iron Agar slants. Due to the some inconveniences, the presumptive *Salmonella* cultures from the agar slants could not be subjected to serological tests for the final confirmation (Anonymous, 1998).

Table 1. Results of microbiological analysis of the unpackaged sausage samples (cfu/g)

Samples	<i>Salmonella</i>	<i>S. aureus</i>	Yeast- mould	<i>E. coli</i>
1	-	3x10 <sup>3</sup>	6x10 <sup>2</sup>	<10
2	-	7.1x10 <sup>3</sup>	8x10 <sup>3</sup>	<10
3	-	1x10 <sup>3</sup>	5x10 <sup>3</sup>	<10
4	-	<10	7x10 <sup>2</sup>	<10
5	-	6x10 <sup>4</sup>	4x10 <sup>2</sup>	1x10 <sup>3</sup>
6	-	<10	1.2x10 <sup>5</sup>	<10
7	-	<10	1.5x10 <sup>2</sup>	<10
8	-	1.1x10 <sup>4</sup>	2.2x10 <sup>3</sup>	<10
9	-	1.5x10 <sup>3</sup>	2x10 <sup>2</sup>	<10
10	-	<10	<10	<10
11	-	1.5x10 <sup>3</sup>	2x10 <sup>2</sup>	<10
12	-	5x10 <sup>3</sup>	2x10 <sup>5</sup>	<10
13	-	2x10 <sup>5</sup>	1.2x10 <sup>5</sup>	<10
14	-	<10	<10	<10
15	-	<10	<10	<10

-: not detected

## Results and Discussion

The results of the microbiological analysis of the sausage samples is shown in Table 1 and Table 2. Only one of the unpackaged samples contained *E. coli* ( $1 \times 10^3$  cfu/g). None of the other samples contained *E. coli*. In this study, the level of *S. aureus* was determined as  $1 \times 10^3$ - $2 \times 10^5$  cfu/g in unpackaged sausage samples. *S. aureus* could not be determined in six of the unpackaged samples could not be determined *S. aureus*. Only one of the packaged samples contained *S. aureus* ( $4 \times 10^2$  cfu/g). The level of yeasts and moulds was determined as  $2 \times 10^2$ - $2 \times 10^5$  cfu/g in unpackaged sausage samples, and  $2 \times 10^1$ - $3 \times 10^2$  cfu/g in packaged sausage samples. Yeasts and moulds could not be determined in three of the unpackaged samples and in four of the packaged samples. None of the samples contained *Salmonella*.

According to the Turkish Food Codex (Anonymous, 2009); yeast and mould counts and *S. aureus* are limited to  $1.0 \times 10^3$  cfu/g and  $1.0 \times 10^3$  cfu/g respectively. The *S. aureus* counts of the 7 unpackaged sausage samples sold in supermarkets were in accordance with the Turkish Food Codex, but 8 unpackaged sausage samples were not in accordance. In terms of *S. aureus*, all of the packaged sausage samples were in accordance with the Turkish Food Codex.

The yeast and mould counts of the 9 unpackaged sausage samples sold in supermarkets were in accordance with the Turkish Food Codex, but 6 unpackaged sausage samples were not in accordance. In terms of yeast and mould, all of the packaged sausage samples were in accordance with the Turkish Food Codex. The significant increase in yeast and mould may be attributed to the contribution from ingredients such as starch and spices. The development of yeast increases when comes in contact with air after the package is opened. This may be the reason for the high yeast counts of the unpackaged sausages. Yeast growth can reduce the quality of the product. In general, the unpackaged sausage samples had higher *S. aureus* and mould and yeast counts than the packaged samples.

Güngör and Gökoğlu (2010) detected microbial contamination sources during sausage processing. Counts of total aerobic mesophilic bacteria, *S. aureus*, *E. coli*, yeasts, and moulds in the vacuum and pasteurized (at 85°C for 10 min) samples were found to be 3.66, 0.73,  $<1.0 \times 10^1$ , and  $<1.0 \times 10^1$  log cfu/g, respectively. The yeast and mould counts of the four packaged sausage samples obtained in this research were similar to the yeast and mould counts of the sausages packed in polyethylene bags under vacuum and pasteurized as determined by Güngör and Gökoğlu (2010). All other microorganism counts were lower than the counts obtained in their studies.

Table 2. Results of microbiological analysis of the packaged sausage samples (cfu/g)

Samples	<i>Salmonella</i>	<i>S. aureus</i>	Yeast- mould	<i>E. coli</i>
1	-	<10	$1 \times 10^2$	<10
2	-	<10	$1 \times 10^2$	<10
3	-	<10	$3 \times 10^2$	<10
4	-	<10	$2 \times 10^2$	<10
5	-	<10	$1 \times 10^2$	<10
6	-	<10	$1 \times 10^2$	<10
7	-	<10	$4 \times 10^1$	<10
8	-	<10	$9 \times 10^1$	<10
9	-	<10	<10	<10
10	-	<10	$2 \times 10^1$	<10
11	-	<10	$1 \times 10^2$	<10
12	-	$4 \times 10^2$	$1 \times 10^2$	<10
13	-	<10	<10	<10
14	-	<10	<10	<10
15	-	<10	<10	<10

-: not detected

A total of 10 samples of cocktail sausage with similar production dates from different batches were collected by Afshin et al. (2011). A study on microbial properties during shelf life from the first week until the fifth week was done. The coagulase positive *S. aureus* count in the first week was within the permissible range of 0 cfu/g. Results of coagulase positive *S. aureus* count means in weeks 1, 2 and 4 showed a significant difference. The yeast and mould counts ranged from  $1.86 \pm 2.92 \times 10^3$  cfu/g in the first week to  $5.37 \pm 5.8 \times 10^5$  cfu/g in the fifth week. No coliforms were isolated from the collected samples during the 5 weeks. The results of unpasteurized sausage samples obtained in this research are similar to results determined by Afshin et al. (2011). The yeast and mould counts of pasteurized sausage samples were lower than the counts obtained in their studies.

Human and animal intestines are the main source of *Salmonella* (Çaklı and Kışla, 2003). *Salmonella* constitute the most common agents involved in human outbreaks of foodborne disease (Mataragas et al. 2008). In this research, none of the samples contained *Salmonella*. According to the Turkish Food Codex (Anonymous, 2011) sausages shouldn't contain *Salmonella* (at 25 g). All sausage samples were in accordance with the guideline.

The main source of *E. coli* is animal and human feces. Waters contaminated with feces causes contamination of foods (Penner 1992). *S. aureus* is found in the nose and throat, on the hair and skin of more than half of the healthy population. Infected wounds, lesions, boils, and mucous spread by coughs and sneezes of people with respiratory infections are other sources of contamination. Any food that requires handling in its preparation can become contaminated. The skins and hides of animals can also harbor *Staphylococcus* and may contaminate the meat during slaughter. Insufficiently treated meat products may be a source of *S. aureus* and *E. coli*.

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One of the major risks of food contamination is the work practices of food handlers. Pathogenic microorganisms present in or on the food handler's body are later transported from the food handler to the food during the handling process (Gordon-Davis, 1998). Improper personal hygiene practices, such as neglecting to wash hands after visiting the bathroom may cause up to  $10^7$  pathogenic microorganisms under the fingernails of the food handler (Nel et al. 2004).

Vacuum packaging is generally used for cooked products. Vacuum packaged products rarely have high yeast and mould counts (Jablonski and Bohach, 1999, Jay, 1992). High yeast and mould may be caused by insufficient or refracted vacuum (Afshin et al. 2011).

## Conclusion

This study showed that emulsified sausages should not be sold in unpackaged form because of low hygienic quality; therefore, consumers should prefer packaged emulsified sausages instead of unpackaged ones. Contamination may have occurred during the displaying of unpackaged products. Packages could be left open. Sales materials may be contaminated. Thus, salespersons must be careful during the sale of unpackaged products and should follow standard hygienic procedures. The salespeople's health must be monitored regularly. The sausages must be stored in appropriate conditions until sold. Consumers must maintain the sausages in appropriate conditions. Otherwise, the sausages could be a potential risk for the public health. Application of vacuum or  $\text{CO}_2$  would further reduce or inhibit the microbial growth and enhance the shelf life of sausage. The product should be immediately consumed after opening the package. Should be less product into the packaging. Fewer products can should be placed into the small size packag in order to be consumed quickly.



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