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Microbiological and some chemical features of the pastrami sold in Turkey

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Summary

The microbial quality and chemical parameters of the pastrami sold in Turkey were analyzed. Numbers of total aerobic bacteria (TAB) and Lactobacillus spp in the samples varied between 10^5 and 10^8 cfu/g. Out of 60 samples, 53.3% of the TAB and 48.3% of Lactobacillus spp around 10^6 cfu/g. Staphylococcus and Micrococcus spp. were between 10^3 and 10^7 cfu/g, though 46.6% around 10^4 cfu/g. The levels of Enterobacteriaceae and coliform bacteria varied between < 10^2 and 10^3 cfu/g. Most (63.3% and 90.0% respectively) of these two groups were present at < 10^2 cfu/g while 25.0% were around 10^3 cfu/g, and 8.33% around 10^2 cfu/g, respectively. The levels of yeast and Enterococcus spp. were between < 10^2 and 10^4 cfu/g although 56.6% and 41.6% were present at around 10^3 cfu/g, respectively. S. aureus, E. coli, Pseudomonas spp., sulphite reducing anaerobes, and moulds were < 10^2 cfu/g in all the samples examined. E. coli O157 H7 and Salmonella spp. were not detected in 25 g. pH levels were between 5.39 and 5.80. Moisture was < 50.0% in 41 samples, and between 51.2 and 54.8% in 19 samples. Salt was < 8.5% in 47 samples and > 8.5% in 13 samples. The pastrami examined in this study was generally, of good hygienic and chemical quality, although the yeast levels were higher than those indicated in TS 1071.

Keywords: pastrami (pastirma), microbiological quality, chemical quality

Pastrami (pastirma) is defined as a meat product prepared by subjecting meat from particular parts of carcasses of healthy young adult cattle or buffalo to special technological procedures (8). It is made by salting and drying selected valuable parts, including entrecote and beef steak (m. longissimus dorsi). Salt (5%) and nitrite (125 ppm), combined with drying, and cemen paste are essential parts of the production procedure. Ascorbic acid may also be added to this combination to develop acid stabilise the color during the drying/salting processes. Garlic, fenu greek powder (*Trigonella foenum graceum*), red pepper, and other ingredients in the cemen mixture are also very important. The cemen mixture used in pastrami production directly affects the microbial quality, specific colour, and aroma of the final product. (26, 29). It determines the salt and moisture balance of the dried and salted meat (5, 27). In particular, allicine found in the garlic exhibits an antibacterial effect against several bacteria genera (21-23).

This study aimed at analyzing the microbial quality and chemical parameters (moisture, pH and salt) of pastrami samples obtained from randomly selected retail stores in four Turkish cities, Aksaray, Ankara, Erzurum, and Kars, to determine whether they or not conform to the hygiene standards, and the potential hazards to human health.

Material and methods

A total of 60 pastrami (pastirma) samples, 15 from each city, were collected from the markets in Ankara, Aksaray, Erzurum, and Kars, Turkey. Samples from Ankara, Aksaray and Erzurum were analyzed microbiologically and chemically within 48 h and, those from Kars within 4 h of collection. Samples were kept chilled (+4°C) during the transport. Analyses were performed in the Central Laboratory of Kafkas University, Kars, Turkey.

Each pastrami sample (25 g) was aseptically transferred into a sterile polyethylene stomacher bags containing 225 ml of buffered peptone water (Oxoid CM 509), and was homogenized for 2 min. In addition, a 25 g sample was pre-enriched with 225 ml of modified novobiocin EC broth to detect the presence of *E. coli* O157 H7 in pastrami samples. Aliquots of 1 ml of the homogenate and subsequent serial 10-fold dilutions in buffered peptone water (BPW, Oxoid CM 509) were plated out onto relevant agar media. Bacterial colonies were counted and expressed as colony forming units per gram (cfu/g). Traditional microbiological methods and media were used for the isolation and enumeration of total aerobic mesophile bacteria (TAB), *Lactobacillus* spp. *Enterobacteriaceae*, coliforms, *E. coli*,

E. coli O157 H7, *Staphylococcus* and *Micrococcus* spp., *S. aureus*, *Enterococcus* spp., *Salmonella* spp., *Pseudomonas* spp., yeast and moulds, and sulphide reducing anaerobic bacteria (tab. 1).

Moisture was determined by drying them at 105°C for 24 h. Salt was determined according to the method of the AOAC (7), and pH was measured by the Turkish Standards Institute (TSE) method (6).

Tab. 1. Traditional methods and media used for the isolation and enumeration of bacteria

Bacteria	Media used	Incubation temperature (°C)	Incubation time (h)
Aerob mesophile bacteria (TAB)	Plate Count Agar (Oxoid, CM463)	30	48-72
Lactobacillus spp.	MRS agar (Man Rogosa Sharpe, Merck 1.10660)	30	5 day
Enterobacteriaceae	Violet Red Bile Glucose Agar (Oxoid CM485)	37 37	24-48 24-48
Coliforms	Violet Red Bile Lactose Agar (Oxoid CM107)	37	24-48
Escherichia coli	Violet Red Bile Lactose Agar (Oxoid CM107) Endo Agar (Oxoid, CM479) IMVIC test (indole, methyl-red, Voges Proskauer, and citrate utilization)	37 42	24-48 24-48
Escherichia coli O157 H7	Modified Novobiocin EC Broth (mEC + n, Merck 1.10765) CT-SMAC (Oxoid CM 813 with SR 172 E), Flurocult Violet Red Bile (Merck 1.04030)	42 42 42	24 24-48 24-48
Total *Staphylococcus* - *Micrococcus* spp. and *S. aureus*	Baird Parker Agar (Oxoid CM275), Gram stain, coagulase, DNase and catalase tests, anaerobic utilization of glucose and mannitol, Staphytect latex (Oxoid DR 100M) agglutination tests	37	24-48
Enterococcus spp.	Slanetz Bartley Medium (Oxoid CM 377)	37	24-48
Salmonella spp.	Buffered Peptone Water (Oxoid CM 509) Rappaport Vassiliadis Broth (Oxoid CM669) Serological Salmonella Latex Test (Oxoid, FT 203).	37 43	24 24
Pseudomonas spp.	Pseudomonas Agar (Oxoid CM559+Suppl., Oxoid SR 0103), Oxidase test strips (Oxoid BR 63)	30	48
Yeast-mould	Potato Dextrose Agar (PDA, Oxoid CM139)	25	4-5 days
Sulphite reducing anaerobes	Tryptose Cycloserine Agar (TSC) (Merck 11972 + Flurocult TSC Suppl. Merck 1.04032)	37	24-48

Results and discussion

The results of microbial analysis of the pastrami samples are summarized in tab. 2. The numbers of TAB and *Lactobacillus* spp. varied between 10^5-10^8 cfu/g, although the numbers of TAB in 53.3% samples and *Lactobacillus* spp. in 48.3% samples intensfied at 10^6 cfu/g. *Micrococcus–Staphylococcus* spp. were also present in high numbers between 10^3 and 10^7 cfu/g. In 46.6% samples, they were determined to be 10^4 cfu/g. The levels of *Enterobacteriaceae* and coliform bacteria varied between $< 10^2$ and 10^3 cfu/g. While 25.0% samples had 10^3 cfu/g *Enterobacteriaceae* and 8.33% samples contained 10^2 cfu/g coliform bacteria, 63.3% and 90.0% of the samples contained *Enterobacteriaceae* and coliform bacteria at levels $= 10^2$ cfu/g, respectively. Likewise, the levels of yeast and *Enterococcus* spp. were between $< 10^2$ and 10^4 cfu/g although they intensfied at the level of 10^3 cfu/g in 56.6% and 41.6% of the samples, respectively. In all of the samples examined, *S. aureus*, *E. coli*, *Pseudomonas* spp., sulphite reducing anaerobs, and moulds were determined to be $< 10^2$ cfu/g. Finally, no *E. coli* O157 H7 and *Salmonella* spp. were detected.

The pH levels of the samples were between 5.39 and 5.80, moisture was < 50.0% in 41 samples, and was be-

Tab. 2. Results of pastrami samples' microbiological analyses – n (%)

Level of microorganisms	TAB	Lactobacillus spp.	Staphylococcus and Micrococcus spp.	S.aureus	Coliform	E. coli	E. coli O157 H7	Enterobact.
$< 10^2$	–	–	–	60 (100)	54 (90.0)	60 (100)	60 (100) *	38 (63.3)
10^2	–	–	–	–	5 (8.33)	–	–	7 (11.6)
10^3	–	–	7 (11.6)	–	1 (1.66)	–	–	15 (25.0)
10^4	–	–	28 (46.6)	–	–	–	–	–
10^5	8 (13.3)	15 (25.0)	21 (35.0)	–	–	–	–	–
10^6	32 (53.3)	29 (48.3)	3 (5.0)	–	–	–	–	–
10^7	15 (25.0)	10 (16.6)	1 (1.66)	–	–	–	–	–
10^8	5 (8.33)	6 (10.0)	–	–	–	–	–	–

Explanation: * – not detected

tween 51.2 and 54.8% in 19 samples. Like wise, salt was < 8.5% in 47 samples, and was > 8.5% in 13 samples.

Results of the present study showed that the microbiological quality of the 60 samples of Turkish pastrami sold in retail stores was found to comply with the requirements of TS 1071 (tab. 3), in terms of the criteria for *S. aureus*, *E. coli*, *E. coli* O157 H7, sulphite reducing anaerobes, *Salmonella* spp., and mould levels, although yeast levels in 38 samples (63%) were not desirable (8).

Tab. 3. Microbiological criteria of pastrami in Turkish Standards Institute (TS 1071) (8)

Microorganism	TS 1071 (cfu/g)
S. aureus	10^2-10^3
Salmonella spp.	None
E. coli	5 × 10-2 × 10^2
C. perfringens	10^2
Yeast-mould	10^2
E. coli O157 H7	None

Tab. 4. Chemical standards of pastrami in Turkish Standards Institute (TS 1071) (8)

Parameters	TS 1071
Moisture (%)	< 50
Salt (%)	< 8.5
Fat (%)	< 40
Potasium or Sodium Nitrate	< 500 ppm
Dye	None
pH	4.5-5.8

Literature reports have indicated that the moisture level varies between 34.10% and 60.90%, and salt level between 4.89% and 8.50% (3, 4, 9, 15, 17). Our results have also found similar results, although the moisture in 19 samples in our study (31.6%) exceeded the required levels, according to TS 1071. Although the results of the salt levels conformed to TS 1071 standards in 47 samples, 13 samples did not (tab. 4). Likewise, Aksu and Kaya (1) reported that 42% of the pastrami samples sold in Erzurum city did not comply with the TSE standards in terms of salt levels. They were significantly high as compared to the findings of the current study. The high salt content may be due either to treating meat with too much salt or to inadequate rinsing after the salting procedure. This has also been suggested by Gurbuz et al. (16). Thus, they have indicated that variation in salting techniques and size of the pieces of meat used to make the pastrami might affect the microbial and chemical composition of the final product.

TAB levels in 55 samples (91.67%) examined during this study complied with the findings of the literature reports (5, 15, 19, 24, 25). The production conditions, the technology used, and microbiological quality of the raw meat and the cemen mixture, particularly red pepper and fenu greek powder, are very important influences on the levels of TAB in the finished product. Microbiological examinations of red pepper in Turkey has revealed undesirably high bacterial numbers (13, 14, 28). The decrease seen on the levels of TAB in the last period of drying process when making pastrami might be due to a gradual decrease in available water, an increase in salt levels, or/and, particularly, an inhibition by allicine.

In the 60 commercial pastrami samples, TAB and *Lactobacillus* spp. levels were found to be the primary dominant microflora. These results are similar to those of El-Khateib et al. (15), Kotzekidou and Lazarides (19), Ozdemir et al. (24), and Dogruer and Guner (11) while they are higher than those of Silla et al. (25). The high variability in the *Lactobacillus* spp. levels in our study may be due to the variation in the composition of the initial microflora of the raw meat, the cemen mixture, the technological procedures used, and/or glycogen–glucose level of the meat.

The results of the *Micrococcus–Staphylococcus* spp. levels in the 49 samples were in agreement with those of Kotzekidou and Lazarides (19), Ozdemir et al. (24), Katsaras et al. (18), and Dogruer and Guner (11). However, they were higher than the findings of Silla et al. (25). The *Micrococcus–Staphylococcus* spp. levels in the pastrami samples usually correlate with the levels in the raw meat and cemen mixture used in the process. This is due to the very high resistance of this group to the salt and drying procedure. Because of this, *Micrococcus* spp. are the second dominant population in the pastrami after *Lactobacillus* spp. *S. aureus* was not detected in the samples analyzed. This might be because of the presence of volatile compounds such as allicine in the cemen mixture.

Initial numbers of *Enterobacteriaceae*, coliforms, and *E. coli* in raw meat and cemen mixture are one of the determining factors in the levels of these microorganisms through the processing stages. However, salting and drying processes significantly decrease these levels. Thus, increasing salt levels, and nitrite and allicine in the garlic seem to destroy most of the Gram-negative microorganisms including *Enterobacteriaceae*.

The levels of the *Enterococcus* spp. varied between 10^2 and 10^4 cfu/g in

Mould	Yeast	Enterococcus spp.	Pseudomonas spp.	Salmonella spp.	Sulphite reducing anaerob
60 (100)	12 (20.0)	18 (30.0)	60 (100)	60 (100) *	60 (100)
–	10 (16.6)	14 (23.3)	–	–	–
–	34 (56.6)	25 (41.6)	–	–	–
–	4 (6.66)	3 (5.0)	–	–	–
–	–	–	–	–	–
–	–	–	–	–	–
–	–	–	–	–	–
–	–	–	–	–	–

70% of the samples. Similiar results were also found by other researchers (1, 20, 24). Aksu and Kaya (1) reported levels of *Enterobacteriaceae* and coliforms to be lower than 2.0×10^2 cfu/g while other reports (20, 24) indicated them to be $< 2.0 \times 10^2$ cfu/g in only 55-60% of samples.

The *Pseudomonas* spp. and mould levels in the all samples were found to be $<10^2$ cfu/g, which were lower than the detection limit. No *Salmonella* spp. were detected. This could be due to the decreasing levels of moisture. The *Salmonella* and *Pseudomonas* spp. levels found in the current study were similar to the results reported by Aksu and Kaya (1) and Ozdemir et al. (24).

The sulphite reducing anaerobic bacteria levels were found to be $< 10^2$ cfu/g in all the samples. The combination of salt, nitrite, and ascorbic acid has a very strong inhibitory effect in the cured meat products such as pastrami. This, combined with low water activity (a_w) and increase in acidity seems to effectively inhibit the sulphite reducing anaerobes (19, 21, 22, 25).

The mould levels determined in this study were similar to those reported in the literature (18, 24, 25) but were lower than those found by Kotzakideou and Lazaridous (19). Salt and allicine probably limit mould levels to under 10^2 cfu/g. By contrast, high levels of yeast found in the samples may be due to the yeast multiplying rapidly in the increasingly acid conditions. Studies (18, 19, 24, 25) have showed that yeast levels in these products may vary widely. Katsaras et al. (18) reported that increasing garlic levels in the products might inhibit the yeast multiplication, and varying levels of garlic might explain the variations seen in the current study.

Consequently, various factors including numbers of the types in the initial microflora, the chemical composition of the raw meat (pH etc.), the curing process, the amount and granule size of the salt, pressing and drying times, initial microbiological contents of the red pepper and fenu greek powder in the cemen mixture, cemenizing and drying times, and personal hygiene, directly affect the microbial quality of the products (2, 14), and using nitrate higher than 1% might carry high risks for public health (10, 12). The pastrami examined in this study was generally,of good hygienic and chemical quality, although the yeast levels were higher than those indicated in TS 1071.

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