

The microbiological, serological and chemical qualities of mincemeat marketed in İstanbul

Ömer ÇETİN^{1,*}, Enver Barış BİNGÖL¹, Hilal ÇOLAK¹, Özer ERGÜN¹, Can DEMİR²

¹Department of Food Hygiene and Technology, Faculty of Veterinary Medicine,
İstanbul University, 34320 Avcılar, İstanbul - TURKEY

²Kontrollab Food/Water, Environmental Analysis Laboratory, 34775 Ümraniye, İstanbul - TURKEY

Received: 09.09.2008

Abstract: The objective of this study was to investigate the microbiological, serological, and chemical properties in raw ground beef consumed in İstanbul. For this purpose, a total of 127 samples of ground beef were obtained from different regions in İstanbul. The mean total aerobic bacteria, *Escherichia coli*, and *Staphylococcus aureus* counts were 1.3×10^6 , 2.8×10^3 , and 3.1×10^3 cfu/g, respectively. *Salmonella* spp. were found positive in 4 (3.14%) of the ground beef samples. None of the analyzed samples was found to contain horsemeat or pork, but 4 of them contained poultry, and 8 of them contained mutton. Eight (6.29%) of all the samples were classified as fat-free minced beef and 49 (38.58%) of them as fatty minced beef. Consequently, mincemeat offered to consumers in İstanbul has low microbiological and chemical quality. It was therefore concluded that routine controls (microbiological, chemical, serological) on mincemeat have to be performed in this country.

Key words: Mincemeat, microbiological quality, serological analysis, chemical quality

İstanbul'da satışa sunulan kıymaların mikrobiyolojik, serolojik ve kimyasal kaliteleri

Özet: Bu çalışmada, İstanbul'da satışa sunulan hazır kıymaların mikrobiyolojik, serolojik ve bazı kimyasal özelliklerinin ortaya konulması amaçlanmıştır. Bu amaçla İstanbul'un farklı bölgelerindeki kasap ve marketlerden 127 satışa hazır kıyma örneği toplandı. Mikrobiyolojik analizler sonucunda toplam aerobik mezofilik bakteri, *Escherichia coli* ve *Staphylococcus aureus* sayısı ortalama olarak sırasıyla $1,3 \times 10^6$, $2,8 \times 10^3$ ve $3,1 \times 10^3$ kob/g olarak tespit edildi. Numunelerin 4'ünde (% 3,14) *Salmonella* pozitif bulundu. İncelenen örneklerin hiçbirinde at ve domuz etine rastlanmadı fakat 4'ünde tavuk ve 8'inde koyun eti bulundu. Kıyma örneklerinin 8'inin (% 6,29) yağsız kıyma sınıfına, 49'u ise (% 38,58) yağlı kıyma sınıfına girdiği saptandı. Sonuç olarak, İstanbul'da tüketime sunulan kıymaların mikrobiyolojik ve serolojik açıdan istenen kalitede olmadığı, bu sebepten dolayı ülkemizde satışa sunulan kıymaların rutin kontrolleri (mikrobiyolojik, kimyasal, serolojik) düzenli olarak yapılması gerekliliği ortaya konulmuştur.

Anahtar sözcükler: Kıyma, mikrobiyolojik kalite, serolojik analiz, kimyasal kalite

Meat has an indispensable place in human nutrition due to the high biological value proteins it contains. Meat is particularly important in human

nutrition, because it contains high amounts of exogenous amino acids. With new developments in technology, it has been easier to process meat into

* E-mail: omce@istanbul.edu.tr

meat products, and the variety of products has increased (1).

The microbiological quality of mincemeat depends on the microbiological quality of the meat that is used, the hygienic precautions taken during production, and finally the type of packaging and storage conditions (1). As the meat is cut into pieces according to the technological procedure used in the preparation of minced meat with its surface area enlarged, the microorganisms forming on the surface, microflora, spread all over it and grow under convenient conditions; thus they shorten the shelf-life and cause a potential risk to consumer health (2,3). Moreover, the Turkish standards (4) specify structural elements to be normally present in minced meats (skeleton muscle tissue and a small amount of fat). The addition of unwanted organs, such as the inedible parts with high amounts of fat tissue negatively affect these accepted structural elements along with the quality of the product; it also leads to unfair competition and profit (2).

Meat and meat products are a potential source of risks for specific species of bacteria like *Staphylococcus aureus*, *Clostridium perfringens*, *Campylobacter jejuni*, *Escherichia coli* 0157:H7, and *Salmonella* (1).

Because of its high bacteria level, and its likelihood of keeping pathogenic bacteria, mincemeat is an important meat product that threatens human health. This negative property of mincemeat has been shown in a number of studies (5-7). There are quite a number

of studies conducted in Turkey on this subject as well (2,3,8,9).

The pathogens causing the 190 food poisonings in Auckland, Australia, between 01/07/1999 and 30/06/2000 were *S. aureus* (12%), *C. perfringens* (11%), *Bacillus cereus* (9%) and *Salmonella* (6%) (10). In England, 1.9% of the food poisonings caused by the *Salmonella* group of bacteria are reported to be cattle meat originated (11).

In this study, the microbiological, serological, and certain chemical properties of ready-to-sell mincemeat sold in İstanbul were investigated aimed at the consideration of consumer safety.

The samples were collected in the summer (June, July, and August) from 11 different municipalities in İstanbul, Turkey (Figure).

All samples were carried to the laboratory within sterilized glass jars, kept in ice chests during the transportation, and examined on the same day. A total of 127 mincemeats were sampled after noting the storage of, and inside temperature of all samples (4-12 °C). Portions of mincemeat (25 g) were transferred to a sterile stomacher bag with 225 mL of 0.1% peptone water (Oxoid CM 9, UK) and blended for 2 min in a stomacher (Labblender 400, Model BA 6021, Steward Lab., London, UK). Serial decimal dilutions were prepared using the same diluents up to 10⁻⁷. Plate count agar (Oxoid CM463, UK) was used for detecting total aerobic bacteria counts (12), while *S. aureus* was defined on Baird–Parker agar (BPA -



Figure. Map of samples collected in İstanbul.

Oxoid CM0275) supplemented with an egg yolk-tellurite emulsion (E-Y-T Emulsion - Oxoid SR0054). Spread plates were incubated at 35 °C for 24 h. Colonies with typical *S. aureus* morphology were subjected to Gram staining, examined microscopically, tested for catalyze reaction, and confirmed with DNase Agar (DNase - Oxoid CM0321) incubated at 35 °C for 18-24 h (12). In addition, TBX Agar (TBX - Oxoid, CM0945) was used to determine *E. coli* according to ISO 16649-2 (13). Isolation of *Salmonella* spp. was done according to AOAC International procedures (12). pH, Ca⁺⁺, and fat content were determined according to AOAC Official methods (14), whereas qualitative putrefaction tests were done according to “lead acetate and eber ammoniac test” methods (1). The determination of animal species was carried out using the Agar Gel Immunodiffusion (AGID) test (15).

The results of the microbiological analysis of the mincemeat samples are given in Table 1. *Salmonella* was detected in 4 (3.14%), *E. coli* in 107 (84.25%), and *S. aureus* in 62 (48.81%) samples of mincemeat, respectively. The total aerobic bacteria count (TAB) of microorganisms was between 4.2×10^4 and 3×10^7 cfu/g, and the average of TAB was 1.3×10^6 cfu/g.

None of the commercialized mincemeat samples randomly obtained from markets and butchers in İstanbul were found to contain horsemeat or pork. Four of the 127 analyzed mincemeat samples contained poultry (3.14%) and 8 samples contained mutton (6.28%), while 115 samples were only beef (90.58%).

The levels of degrees exceeded in storage and the inside temperature of the 127 mincemeats collected from various areas in İstanbul were 42 (33.06%) and

95 (74.80%), respectively. The pH values of these samples were between 5.30 and 6.94 and the average pH value was 5.97. The levels of Ca⁺⁺ in analyzed mincemeat samples are given in Table 2. The Ca⁺⁺ levels of 21 of the mincemeat samples (16.53%) were found to be high. The minimum Ca⁺⁺ level was 26 mg/kg, whereas the maximum was 216 mg/kg.

Table 2. The levels of Ca⁺⁺ in mincemeat samples.

Ca ⁺⁺ Levels (mg/kg)	Number of Samples	Percentage of Samples (%)
0-49	45	35.43
50-99	61	48.03
100-149	10	7.87
150-199	8	6.29
> 200	3	2.36

The amount of fat in the mincemeat samples and their dispersion according to animal species are summarized in Table 3. In 12 of the samples examined, 8 (6.29%) contained mutton together with beef fat, while 4 (3.14%) contained poultry together with beef fat. The result of the analysis was 8 (6.29%) of the mincemeat samples belong to the class of mincemeat with no fat, whereas 49 (38.58%) belong to the fatty mincemeat class.

The aim of this study was to determine the elements causing quality destruction in mincemeat and to establish the risks to public health by evaluating the microbiological, serological, and chemical characteristics of ready-to-sell mincemeats sold in different districts of İstanbul. Consequently, it is aimed to achieve customer safety by avoiding product imitation and adulteration, as well as unfair competition and income.

Table 1. The results of microbiological analysis of mincemeat samples (n = 127).

Microorganisms	n	Min (cfu/g)	Max (cfu/g)	Average (cfu/g)	n ^P	Rate of Positive Samples (%)
TAB	127	4.2×10^4	3×10^7	1.3×10^6	127	100
<i>E.coli</i>	127	1×10^1	2.1×10^4	2.8×10^3	107	84.25
<i>S.aureus</i>	127	4×10^1	5×10^4	3.1×10^3	62	48.81
<i>Salmonella</i> spp.	127	-	-	-	4	3.14

n : number of analyzed samples

n^P : number of positive analyzed samples

Table 3. Fat amounts concerning mincemeat samples and their dispersion according to animal species.

Fat amount and animal species on mincemeat	Rate of fat (%)	Number of samples (n=127)	Percentage of fat (%)
No fat mincemeat	≤ 7	8	6.29
Few and medium fatty mincemeat	7 < - ≤ 20	70 (65s + 5d)	55.11
Fatty mincemeat	> 20	49 (42s + 7d)	38.58
Minced beef	≤ 20	73	57.48
Other species of animal mincemeat	≤ 25	12	9.44
Pork mincemeat	≤ 30	-	-

s: Minced beef

d: Other species of animal mincemeat

Even if the meat to be used has been obtained from a healthy animal, it may be exposed to various degrees of bacterial contamination during its processing into meat products like mincemeat, or during storage, packaging, or its offering for sale (1). In mincemeat, microbiological contamination takes place, in big percentages, during the processing stage. A study has revealed that mincemeat prepared at the butcher's contains total aerobic mesophilic bacteria, enterobacter, and staphylococcus 12.5, 20, and 2.5 times more, respectively, than the mincemeat prepared at home (16).

Sancak et al. (17) stated that mincemeat sold in Van province contained a total aerobe count of 2.3×10^5 - 1.4×10^{10} cfu/g, and *Staphylococcus* count of $0.9.2 \times 10^6$ cfu/g; they also found that the average numbers of coliform and *E. coli* were 4.0×10^6 and 4.1×10^5 , respectively. In a study on the microbiological quality of commercial mincemeats in Kayseri province, Gönülalan and Köse (9) found the total bacteria counts to be between 7.4×10^5 and 5.3×10^9 cfu/g, the coliform counts between 8.6×10^1 and 4.5×10^8 cfu/g, the *E. coli* counts between $< 1.0 \times 10^1$ and 5.2×10^5 cfu/g, and the coagulase positive *Staphylococcus* counts between $< 1.0 \times 10^1$ and 6.7×10^6 cfu/g. Başkaya et al. (2) determined that the total aerobic bacteria counts varied from 3.1×10^4 to 6.3×10^7 cfu/g, the coliform count varied from 3.3×10^3 to 6.2×10^4 , the *E. coli* count varied from $< 1.0 \times 10^4$ to 1.4×10^4 , and the coagulase positive *Staphylococcus* count varied from 8.0×10^2 to 8.2×10^3 in 27 ready-to-sell mincemeat samples sold in the Anatolian section of İstanbul. In the same study, *Salmonella* spp. were detected in 3 of the samples (11%), and sulfite reducing anaerobic bacteria in 20 of the samples

(74%). *Bacillus cereus*, yeast, and mould counts were 9.5×10^3 , 1.4×10^5 , and 5.7×10^4 cfu/g, respectively.

Gökmen and Alişarlı (3) investigated various pathogenic bacteria in a total of 200 mincemeat samples obtained from 100 cows and 100 sheep meat and sold in the butcher's and markets of Van province. They reported 3% *Salmonella* spp., 22% *Listeria monocytogenes*, 15% *C. perfringens*, and 7% *B. cereus* in the mincemeat samples from cows, and 4% *Salmonella* spp., 11% *L. monocytogenes*, 9% *C. perfringens*, and 5% *B. cereus* in the mincemeat samples from sheep. In their study, Hinton et al. (5) observed neither *Salmonella* nor *E. coli* O157:H7 conducted on 99 frozen mincemeat samples; on the other hand, they detected that total aerobic bacteria, coliform, *E. coli*, and *S. aureus* counts were 4.92, 1.84, 0.64, and 0.72 log₁₀ cfu/g, respectively.

As stated in the Turkish Food Codex (4), 25 g of meat and meat products should not contain any *Salmonella*; however, 4 of the 127 investigated (3.14%) mincemeat samples contained *Salmonella* (Table 1). While the results of this study have been contradictory to the results of Hinton et al. (5) and Sancak et al. (17), they have been parallel to the other below mentioned studies for the presence of *Salmonella*, even though the percentages were different: Gökmen and Alişarlı (3) 3.5%, Hogue et al. (6) 3.4%, Klein and Louwers (7) 2.9%, Gönülalan and Köse (9) 11%, and Erol (18) 3.3%.

Even in cases where mincemeat is contaminated with *Salmonella* at low levels, *Salmonella* can rapidly proliferate under unfavorable conditions, especially when stored above +6 °C and may cause cross contamination (19). This correlates with the results of

our study; the storage temperature of the 4 *Salmonella* spp. containing mincemeat samples (3.14%) was above +6 °C.

In 107 (84.25%) and in 62 (48.81%) of the mincemeat samples, *E. coli* and *S. aureus* were found. The total aerobic bacteria count was between 4.2×10^4 and 3×10^7 kob/g; the average count was 1.3×10^6 cfu/g (Table 1).

When the results of the study are evaluated according to the Turkish Food Codex (4), only the total aerobic bacteria, *S. aureus*, and *Salmonella* spp. numbers are found to be above the given limits in 11 (8.66%), 13 (10.23%), and 4 (3.14%) of the samples, respectively. All the other parameters have been found to be within the limits given in the food codex. Of the samples investigated, 46 (36.22%) were observed to be at the critical limit for their *E. coli* counts.

Başkaya et al. (2) studied 27 ready-to-sell mincemeat samples in Ankara and observed cartilage tissue in 3 (11.1%) of the samples, and organs belonging to the alimentary canal in another 3 (11.1%) of the samples studied. According to their results, soft connecting tissue was at a very high level in 6 of the samples (22.2%) and at a high level in 5 of the samples (18.5%), while 2 samples (7.4%) contained condense connective tissue at a very high level, and 4 samples (14.9%) at a high level. In the same study, fatty tissue was observed in extremely excessive amounts in 11 (40.7%) of the samples, in excessive amounts in 10 (37.0%) samples, in normal amounts in 5 (18.5%), and in small amount in 1 (3.7%) sample. Yıldız et al. (8) determined little inedible tissue traces in 4 (5.4%) and very little in 2 (2.7%) of the 75 ready-to-sell meatball samples collected in the Anatolian section of İstanbul. In the present study, it was observed that 49 (38.58%) of the total 127 ready-to-sell mincemeat samples contained fat in higher amounts than the level recommended in the Turkish Food Codex. Moreover, 21 samples

contained Ca^{++} in higher amounts. A high Ca^{++} rate may show the addition of non-meat materials, such as ground bone fragments and mechanically deboned meat to the processed meat. Samples rich in soft connective tissue indicate the use of thin animals poor in nutritional value, while the presence of condense connective tissue implies the addition of tissue materials like tendon, fascia, and ligament to the mincemeat. By adding excess fat to the meat, the quality and nutritional value is decreased.

In studies conducted to investigate horsemeat and pork in ready-to-sell raw mincemeat and meatballs, Başkaya et al. (2) and Yıldız et al. (8) could not find any traces of these meats. Cetin et al. (20) studied 223 raw and heat processed meat products and detected that 83 samples (36.8%) contained meat not reported on their labels. Of these, 4 (1.8%) were reported as pork and 78 (35%) as poultry meat. None of the analyzed ready-to-sell mincemeat samples offered for sale in İstanbul contained horsemeat or pork; however, 4 out of 127 mincemeat samples contained poultry meat, 8 contained sheep meat, and 115 contained only beef.

In conclusion, it was observed that the chemical and microbiological quality of ready-to-sell mincemeats in İstanbul is very low. Even though the absence of horsemeat and pork can be considered a favorable finding, the results of the analyses showed the existence of meat of animals not recorded on the labels. In order to produce high quality and healthy mincemeats in compliance with the Turkish Food Codex, it is necessary to obey the ethical values and hygienic rules while processing. In addition, slaughters should be controlled, secondary and cross contaminations should be prevented, continuity of the cold chain during the transfer and storage should be guaranteed, and personnel education and consumer awareness should be targeted.

References

1. İnal, T.: Besin Hijyeni (Hayvansal Gıdaların Sağlık Kontrolü). İkinci Baskı, Final Ofset, İstanbul, 1992; 9-10.
2. Başkaya, R., Karaca, T., Sevinç, İ., Çakmak, Ö., Yıldız, A., Yörük, M.: The histological, microbiological and serological quality of ground beef marketed in İstanbul. *Yüzüncü Yıl Üniv. Vet. Fak. Derg.*, 2004; 15: 41-46. (article in Turkish with an abstract in English)
3. Gökmen, M., Alişarlı, M.: Investigation of some pathogenic microorganisms in minced meat consumed in Van. *Yüzüncü Yıl Üniv. Vet. Fak. Derg.*, 2003; 14: 27-34. (article in Turkish with an abstract in English)
4. Turkish Food Codex: Regulations on fresh meat, prepared meat and prepared meat mixtures. In: Official Gazette, p6. Issue 23960, Ministry of Agricultural and Rural Affairs, Ankara, 2000. (article in Turkish)

5. Hinton, M., Coombs, E., Tucker, V., Jones, S., Allen, V., Hudson, W.R., Corry, J.E.L.: The bacteriological quality of British beef 2. Frozen minced beef. *Meat Sci.*, 1998; 50: 395-402.
6. Hogue, A.T., Dreesen, D.W., Green, S.S., Ragland, R.D., James, W.O., Bergeron, E.A., Cook, L.V., Pratt, M.D., Martin, D.R.: Bacteria on beef briskets and ground beef: correlation with slaughter volume and antemortem condemnation. *J. Food Protect.*, 1993; 56: 110-113.
7. Klein, G., Louwers, J.: Keimstatus von industriell hergestelltem Hackfleisch. 35. Arbeitstagung des Arbeitsgebietes Lebensmittelhygiene, Garmisch-Partenkirchen, 1994; 1: 75-83.
8. Yıldız, A., Karaca, T., Çakmak, Ö., Yörük, M., Başkaya, R.: The histological, microbiological and serological quality of meatball marketed in İstanbul. *Yüzüncü Yıl Üniv. Vet. Fak. Derg.*, 2004; 15: 53-57. (article in Turkish with an abstract in English)
9. Gönülalan, Z., Köse, A.: Microbiological quality of ground beef retailed in Kayseri. *Fırat Üniv. Sağ. Bil. Vet. Derg.*, 2003; 17: 49-53.
10. Anonymous: Food borne illness outbreaks in Auckland 1999-2000, *Food Safety Quarterly Report*, 2001; 4 p.
11. Tompkin, B.R.: Detection of *Salmonella* in foods; past, present and future activities and attitudes of the food industry. *J. Milk Food Technol.*, 1976; 39: 359-361.
12. Andrews, W.H., June, G.A., Sherrod, P.S., Hammack, T.S., Amaguana, R.M.: Food and Drug Administration, *Bacteriological Analytical Manual*, 8th edn., AOAC International, Gaithersburg, USA, 1995.
13. ISO 16649-2 (04/2001): Horizontal Method for the Enumeration of β -glucuronidase-positive *E. coli*.
14. AOAC: Official Methods of Analysis. Centennial Edition. Association of Official Analytical Chemists, Washington, D.C., 1984.
15. USDA: Food Safety and Inspection Service, Office of Public Health and Science. MLG17.02, Agar Gel Immunodiffusion Test, 2005; pp.19-30.
16. Khalafalla, F., Gergis, A.F., El-Sherif, A.: Effect of freezing and mincing technique on microbial load of minced meat. *Die Nahrung*, 1993; 37: 422-427.
17. Sancak, Y.C., Boynukara, B., Ağaoğlu, S.: The microbiological quality of ground meat marketed in Van. *Yüzüncü Yıl Üniv. Vet. Fak. Derg.*, 1993; 4: 73-86. (article in Turkish with an abstract in English)
18. Erol, İ.: Incidence and serotype distribution of *Salmonella* in ground beef in Ankara. *Turk. J. Vet. Anim. Sci.*, 1999; 23: 321-326. (article in Turkish with an abstract in English)
19. Boos, G.: Salmonellen in Fleisch unterschiedlicher Vermarktung. *Fleischwirtsch.*, 1981; 61: 261-265.
20. Cetin, O., Buyukunal, S.K., Cetin, B., Askin, M.V.Z.: Presence of foreign protein in raw and heat treated meat products. *Indian Vet. J.*, 2005; 82: 870-872.