

Chemical and microbiological quality of fermented sausages made from camel meat

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Summary

Chemical and microbiological quality parameters of 100 fermented sausage samples made from camel meat were investigated in the Aydın region. The results showed that the mean pH value noted in the sausages was 6.00 ± 0.25 . Additionally, the mean moisture, a_w , fat, ash and salt contents of the sausages were $37.69 \pm 4.32\%$, 0.852 ± 0.02 , $33.6 \pm 4.35\%$, $3.99 \pm 0.47\%$ and $3.28 \pm 0.41\%$, respectively. The mean TVC of the samples was $4.85 \pm 0.47 \log \text{cfu g}^{-1}$, whereas the mean numbers of staphylococci/micrococci, yeast and mould, lactic streptococci, lactobacilli, and coliforms were $4.78 \pm 0.40 \log \text{cfu g}^{-1}$, $2.88 \pm 1.06 \log \text{cfu g}^{-1}$, $4.07 \pm 0.46 \log \text{cfu g}^{-1}$, $2.82 \pm 0.98 \log \text{cfu g}^{-1}$, and $<1.0 \log \text{cfu g}^{-1}$, respectively.

In conclusion, the study found that there were variations in the chemical and microbiological parameters in the investigated sausages. The variations in the microbiological load and chemical results of sausages produced from camel meat may be due to insufficient standardization procedures applied during processing, no starter culture usage and the lack of hygienic practices. Camel meat sausages are a specialty of the Aydın region and thus their production should be standardized. Additionally, providing good hygienic practices during the production process will protect public health and provide healthy sausages for consumers.

Keywords: sausage, camel meat, microbiology

Fermented sausages can be defined as meat products consisting of a mixture of meat and fat particles, salt, curing agents, such as salt, sugar, nitrate and spices: black pepper, red pepper, garlic, cumin, cinnamon etc. which have been stuffed into a casing, fermented (ripened) and dried (14). Dry fermented sausage manufacture is a very important part of the meat industry in many countries. In the European Union, the production of dry fermented sausages may be estimated at about 750,000 tonne in 1995 (21).

Turkish style fermented sausage is a very popular meat product in Turkey, and similar products are also known in most of the Middle East Countries and Europe (13). Generally beef, and the mixture of beef and water buffalo meat are used to produce fermented sausages in Turkey. However, fermented sausages made from camel meat are also consumed in some parts of Turkey. Turkish style fermented sausages are traditionally produced by their natural flora and the predominant lactic organisms in Turkish style sausages are *Lactobacillus sake*, *Lactobacillus plantarum*, *Lactobacillus curvatus* and *Lactobacillus brevis* (16). Fermented sausages produced in Turkey are divided into two groups; pasteurized fermented sausages (heat

application is required) and non-pasteurized (no heat application is carried out). Recently application of heat is generally carried out to reduce maturation period and microbial load of sausages and therefore increase the shelf life of the product (32). Salami, pepperoni and genoa are considered to be similar types of fermented sausages with non-pasteurized Turkish style fermented sausage. The sanitary condition of fermented meat products that do not receive any heat treatment is regulated only by the fermentation and the drying undergo, since the procedures that meat industries carry out cannot guarantee the absence of pathogens in the meat (8, 11).

Although sausages in Turkey are manufactured both by artisanal procedures and on an industrial scale, there is a lack of uniformity in the sausages produced by different firms and industries, and their qualities are very variable. Several studies on the chemical and hygienic quality of fermented sausages were carried out by some authors (8, 9, 12). The authors also stated that there was great non-uniformity in the chemical and microbiological quality of fermented sausages produced by both artisanal procedures and on an industrial scale.

Camel meat is a good source of meat in areas where the climate adversely affects other animals (30). It has been shown that the use of camel meat for sausages making eliminated its toughness. The meat is easily cured and have high protein content. They are also cheaper than sausages made from other meat. Camel meat can be preserved by cutting into strips and allowing it to dry. The dry strips of camel meat are additionally preserved by putting them into clarified butterfat.

Although investigations regarding the microbiological and chemical qualities of fermented sausages, mainly made from beef, have been carried out, no study was found for fermented sausage made from camel meat. This study was conducted to investigate microbiological and chemical quality of sausages produced from camel meat and to observe their potential effects on public health.

Material and methods

A total of 100 sausages made from camel meat with natural casings, of 35 mm diameter purchased from plants in Aydın region. Sausages in after 10th ripening of following production period were used as material. The sausage samples were brought to laboratory in sterile conditions, and then microbiological and chemical examinations were carried out in the same day.

The total Viable Count (TVC), the numbers of Staphylococci/Micrococci, Coliforms, Lactobacilli, Lactic Streptococci, and yeast and moulds on the samples were determined. A 10 g sample was taken from which comminuted, mixed of whole chub and put in into a sterile stomacher bag 90 ml of ml 0.1% peptone water and homogenized in filled up with (Bagmixer, Interscience, France). Serial dilutions were carried out by using 1/4 Ringer's solution, then the dilutions were plated out on suitable media given below.

Plate count agar (PCA, Oxoid CM 325) plates were used to determine TVC in samples. To be able to determine the numbers of Staphylococci/Micrococci, Coliforms, Lactobacilli, Lactic Streptococci, and yeast and moulds, Mannitol Salt Agar, (MSA; Oxoid CM 85), Violet red bile agar (VRBL; Difco B 12) M.R.S agar (Oxoid CM 56), M 17 agar (Oxoid CM 785) and Potato dextrose agar (PDA; Difco B 13) plates were used, respectively. The plates were

incubated at 30 ± 1°C for 3 days for PCA, 37 ± 1°C for 2 days for MSA, 35 ± 1 for VRBL for 3 days, for M 17 at 30 ± 1°C for 2-3 days and for PDA at 22 ± 1°C for 5 days (4, 18, 19). MRS agar plates were poured as double layered (1, 3). Pour plate technique was used to enumerate appropriate colonies. The microbiological procedures were carried out by methods.

Chemical analysis. Physico-chemical features of the camel sausages, such as pH and a_w and, moisture, ash, fat, and salt contents were determined by AOAC (1) methods.

Results and discussion

The microbiological results obtained are given at tab. 1. TVC were between 1.4×10^4 and 2.9×10^6 cfu g⁻¹, the numbers of Staphylococci/Micrococci were 9.0×10^3 and 5.6×10^5 cfu g⁻¹, respectively yeast and mould were respectively between < 10 and 7.5×10^4 cfu g⁻¹, lactic streptococci 1.0×10^3 and 8.3×10^4 , and lactobacilli 10 and 4.8×10^4 .

The physico-chemical parameters: pH, moisture, a_w , fat content, ash and salt content are given at tab. 2. The pH, moisture, a_w , fat, ash and salt contents were ranging between: 5.20-6.34, 29.78-46.24%, 0.81-0.90, 26.07-44.58%, 3.10-4.98% and 2.36-4.50%, respectively.

Microbiological results showed that the numbers of all microorganisms examined had variable standard deviations, especially very high in yeast and moulds. This confirmed the statements of some researchers (8, 9) that there is a non-uniformity in the fermented sausages produced both in Spain and Turkey. Although in the present study camel meat was used, the result did not change probably due to various initial microbiological loads of meat and spices, and the different processing techniques applied. Several authors (5, 9, 10, 24, 31) reported TVC results higher than in this investigation. Çon et al. (9) reported that the TVC of fermented sausages was found to be between 3.0×10^4 cfu g⁻¹ and 2.2×10^8 cfu g⁻¹. Tekinsen et al. (28) also showed that TVC in the fermented sausages were 10^6 - 10^7 cfu g⁻¹. Our results were found to be lower than those observed by Çon et al. (9) and Tekinsen et al. (28). This might be due to the different initial load and hygienic qualities observed during processing.

Tab. 1. The microbiological results (log cfu/g) obtained from commercial sausages produced from camel meat

| | Total Viable Count | Staphylococci/ Micrococci | Yeast and mould | Lactic streptococci | Lactobacilli | Coliform |
|------------------|--------------------|------------------------------|-----------------|---------------------|--------------|----------|
| n | 100 | 100 | 100 | 100 | 100 | 100 |
| $\bar{x} \pm SD$ | 4.85 ± 0.47 | 2.88 ± 0.1.06 | 2.88 ± 0.1.06 | 4.07 ± 0.46 | 2.82 ± 0.98 | < 1.00 |

Tab. 2. Physico-chemical parameters of sausages produced from camel meat

| | pH | Moisture (%) | a_w | Fat content (%) | Ash content (%) | Salt content (%) |
|------------------|-------------|--------------|--------------|-----------------|-----------------|------------------|
| n | 100 | 100 | 100 | 100 | 100 | 100 |
| $\bar{x} \pm SD$ | 6.00 ± 0.25 | 37.69 ± 4.32 | 0.852 ± 0.02 | 33.62 ± 4.35 | 3.99 ± 0.47 | 3.28 ± 0.41 |

Castaño et al. (8) showed the survival of *Enterobacteriaceae* in both hand made and industrially manufactured sausages. *E. coli*, *Serratia odorifera*, and *Enterobacter intermedius* were the only species isolated during curing process of hand made sausage.

ges. However, *E. coli*, *Hafnia alvei*, *Serratia liquefaciens* and *Salmonella choleraesuis* were isolated in the sausages produced on an industrial scale. Çon et al. (9) reported that the number of *Enterobacteriaceae* was between < 10 and 1.1×10^4 cfu g⁻¹, whereas yeast and mould were between 10 and 1.4×10^5 cfu g⁻¹. In our study the numbers of coliforms were found to be lower than 10 cfu g⁻¹ which is not in agreement with the results of others (5, 9, 31).

In this study, the numbers of yeast and moulds were found to be lower than those obtained by Çon et al. (9) in 2 out of 5 firms investigated. In addition, the mean values obtained in our research were lower than Çon et al. (9) findings (1.2×10^4 cfu g⁻¹). When the mean values compared with Yaman et al. (31) 's work, our were found to be lower than their. Bozkurt and Erkmén (7) found the numbers of yeast and moulds in the samples of sausages produced with no addition of starter cultures were between 6.70 and 8.60 log cfu g⁻¹.

The load of Staphylococci/Micrococci in samples of sausage manufactured from camel meat were found to be between 9.0×10^3 and 5.6×10^5 cfu g⁻¹. However, it should be considered that various types of microorganisms could be in the starter cultures of fermented sausages. Generally, it is accepted that the microorganisms of importance during fermentation and maturation of fermented sausages are Gram-positive rod shaped, belonging to the genera *Lactobacillus*, *Micrococcus* and *Staphylococcus* (16). Of these, *Staphylococcus* spp. has great nitrate reductase activity and flavour enhancing capacity. Their main contribution to flavour formation is believed to be related with carbohydrate degradation, amino acid catabolism and fatty acid β -oxidation (6, 23). *Micrococcus* species are enriching fermentative microorganisms during aging of these products in order to enhance the colour stability of the cured-meat and preventing rancidity. The activity of this microbial group reduces spoilage, decreases processing time and contributes to flavour development (22). These microorganisms are responsible for the taste and aroma of fermented sausages. They also contribute the colour formation by reducing nitrate to nitrite (32). In addition, they have antimicrobial activity mainly due to their ability to produce different acids and metabolites. These are: lactic acid and acetic acid, H₂O₂, diacetyl and CO₂ metabolites, acidolin and reuterin (20, 25-27, 29). In the last few years, researchers have focused on bacteriocin and bacteriocin-like metabolites as a possible antagonistic activity mechanism in the LAB group (20, 27).

The numbers of lactobacilli in the our study was found to be lower than those reported by Nazli (24) i.e. 2.1×10^4 cfu g⁻¹ and 1.3×10^6 cfu g⁻¹ during a 15 days of ripening period. The numbers of lactic streptococci were found to be between 1.0×10^3 and 8.3×10^4 cfu g⁻¹. According to Gokalp et al. (15) lactic streptococci might be inoculated into sausages with a level of 10^6 - 10^7 cfu g⁻¹.

The difference between the samples and various studies might be caused by the difference in the initial microbial load of ingredients used, lack of standard production skills, the gaps in the hygiene practices during processing and insufficient care during storage period. This situation could reduce the shelf-life of sausages meanwhile increases the risk of food poisoning.

Castañó et al. (8) reported that the pH values determined in both industrially and hand made fermented sausages were ranging between 5.84 and 6.37. The pH values determined in during this study were higher than those sausages produced by 2 out of 5 firms investigated by Doğu et al. (12), ranging between 4.76 and 6.86, and lower than the values reported by Yucel and Karaca (33), ranging between 4.68 and 5.87. The results also reported that in the samples of sausage no standard pH was present and that even there was a slight increase in the pH of some samples. This might be due to the use of polyphosphates and heat application before fermentation.

The mean moisture result determined for sausages made using camel meat was found to be higher than the mean value (32.95%) found by Yucel and Karaca (33). The moisture levels were between 42.26% and 53.68% in the work carried out by Castañó et al. (8). The moisture contents of sausages determined by other researchers were 15.5% (2), 32% (4), 25.45% (12), and 60% (19).

Determined fat content level, ranged between 23.33% and 32.00%. The mean fat content reported in this study was found to be lower than the results obtained by Yucel and Karaca (33), 36.75% and were higher than the results reported by Doğu et al. (12) 28.09%. Our results were found to be close to the results of Atala (4) (34.64%).

The salt content in sausage is important factor for the typical taste aroma of it. Besides the effects on organoleptic features, it has also effects on the physico-chemical and microbiological reactions occurring during sausage maturation. The water activity of sausage is reduced following salt addition, therefore reducing effect of salt on unwanted microorganisms is also observed (27). The salt contents in the samples of sausages were ranging between 2.14% and 2.80%. The mean salt content was found to be lower than those reported by Atala (4) (3.84%), and Yucel and Karaca (33) (3.48%). But, it was found higher than the results of Doğu et al. (12) 2.5%. Castañó et al. (10) reported the salt contents in sausages ranging between 1.09 and 1.66%.

The drying process occurring during fermentation reduces the growth rate of microorganisms. The inhibition of unwanted microorganisms is provided by reducing a_w . The initial a_w value of sausage is about 0.99 (33). The results obtained by us showed that the a_w were found to be very close to the results of Nazli (24) (0.825 and 0.848). Castañó et al. (8) reported the a_w

value of sausages investigated as ranging between 0.970-0.980. The mean a_w value determined in this study was 0.825 (\pm 0.021).

The variations in the microbiological load and physico-chemical results of determined for sausages produced from camel meat might be due to the insufficient standardization in the processing, no starter culture usage and the lack of high hygienic practices.

As a conclusion, it has been found that there are substantial variations in the chemical, physical and microbiological parameters in sausages investigated. This product is known to be a speciality for Turkey, therefore the production of camel meat sausages, should be standardized. In addition, good hygienic practices applied during production will prevent the hazard to public health and will provide healthy sausages for consumers.

References

1. A.O.A.C.: Official Methods of Analysis Association of Agricultural Chemists Virginia, D.C. 1990.
2. Akol N., Nazlı B., Uğur M.: İstanbul'da tüketim için piyasaya sunulan bazı et ürünlerinde kimyasal analizler. İstanbul Üniversitesi Veteriner Fakültesi Dergisi 1985, 11, 23-28.
3. American Public Health Association: Compendium of Methods for The Microbiological Examination of Foods. Washington D.C. APHA, Inc. 1992.
4. Atala N.: İzmir piyasasında satışa sunulan sucuk ve sosislerin kimyasal nitelikleri. Yağsız et miktarının saptanması üzerine bir araştırma. Etlik Veteriner Mikrobiyoloji Enstitüsü Dergisi 1992, 7, 63-87.
5. Aytakin H.: Konya'da üretilen ve Konya piyasasında satılan sucukların bazı mikrobiyolojik ve kimyasal analizleri üzerinde araştırma. Etlik Veteriner Mikrobiyoloji Enstitüsü Dergisi 1986, 5, 10-12.
6. Berdague J. L., Monteil P., Montel M. C., Talon R.: Effects of starter cultures on the formation of flavour compounds in dry sausage. Meat Science 1993, 35, 275-287.
7. Bozkurt H., Erkmén O.: Effects of starter cultures and additives on the quality of Turkish style sausage (sucuk). Meat Science 2002, 61, 149-156.
8. Castaño A., Fontán M., Fresno J. M., Tornadizo M., Carballo J.: Survival of Enterobacteriaceae during processing of Chorizo de cebolla, a Spanish fermented sausage. Food Control 2002, 13, 107-115.
9. Çon A. H., Doğu M., Gökalp H. Y.: Periodical determination of some microbiological characteristics of sucuk samples produced at some big meat plants in the city of Afyon. Turkish J. Vet. Anim. Sci. 2002, 26, 11-16.
10. Çon A. H., Gökalp H. Y.: Türkiye pazarındaki sucukların bazı kimyasal ve mikrobiyolojik nitelikleri. Gıda 1998, 23, 347-355.
11. Dickson J. S., Anderson M.: Microbiological decontamination of food animal carcasses by washing and sanitizing system. J. Food Prot. 1992, 55, 133-140.
12. Doğu M., Çon A. H., Gökalp H. Y.: Determination of some physical and chemical characteristics of sucuk produced at some major meat plants in the province Afyon. Turkish J. Vet. Anim. Sci. 2002, 26, 1-9.
13. Erkmén O.: Behavior of Staphylococcus aureus in refrigerated and frozen ground beef and in Turkish style sausage and broth with and without additives. J. Food Proc. Preservation 1997, 21, 279-288.
14. Fernández M., Ordúñez J. A., Bruna J. M., Dela Hoz L.: Accelerated ripening of dry fermented sausages. Trends Food Sci. Technol. 2000, 11, 201-209.
15. Gökalp H. Y., Kaya M., Zorba Ö.: Et Ürünleri İşleme Mühendisliği, Erzurum: Atatürk Üniversitesi Yayın No: 786, Ziraat Fakültesi Yayın No: 320, Ders Kitapları Serisi No:70, Atatürk Üniv. Ziraat Fak. Ofset Tesisi 2002.
16. Gürakan G. C., Bozoğlu T. F., Wiess N.: Identification of Lactobacillus strains from Turkish-style dry fermented sausage. Lebensm.-Wiss. Technologie 1995, 28, 139.
17. Hartley J. B.: Camels in the horn of Africa, [in:] Camels. Proc. IFS Symposium, Sudan 1979, p. 109-124.
18. İnal T.: Besin Hijyeni Hayvansal Gıdaların Sağlık Kontrolü. İstanbul: Final Ofset. 1992.
19. Kolsarıcı N., Ertaş A. H., Şahin M. E.: Afyon, Ankara, ve Aydın Yöresi Sucuklarının Bileşimi Üzerine Araştırma. Gıda Dergisi 1986, 11, 34-39.
20. Lewus C. B., Kaiser A., Montville T. J.: Inhibition of food-borne pathogens by bacteriocins from lactic acid bacteria isolated from meat. Appl. Environ. Microbiol. 1991, 57, 1683-1688.
21. Lücke F.: Fermented sausages, [in:] Wood B. J. B.: Microbiology of Fermented Foods, Vol. 2, Blackie Academic and Professional, London 1998, 441-483.
22. Montel M. C., Masson F., Talon R.: Bacterial role in flavour development. Meat Science 1998, 49, S111-S123.
23. Montel M. C., Reitz J., Talon R., Berdague J. L., Rousset A. S.: Biochemical activities of Micrococcaceae and their effects on the aromatic profiles and odours of a dry sausage model. Food Microbiol. 1996, 13, 489-499.
24. Nazlı B.: Researches on the ripening of Turkish fermented sausage using a local starter culture combination. Turkish J. Vet. Anim. Sci. 1998, 22, 393-397.
25. Okereke A., Montville T. J.: Bacteriocin inhibition of Clostridium botulinum spores by lactic acid bacteria. J. Food Prot. 1991, 54, 349-353.
26. Schillinger U., Lücke F.-K.: Lactic acid bacteria as protective cultures in meat products. Fleischwirtschaft 1990, 70, 1296-1299.
27. Spelhaug S. R., Harlander S. K.: Inhibition of foodborne bacterial pathogens by bacteriocins from Lactococcus lactis and Pediococcus pentosaceus. J. Food Prot. 1989, 52, 856-862.
28. Teknşen O. C., Dincer B., Kaymaz S., Yücel A.: Türk sucuğunun olgunlaşması sırasında mikrobiyel flora ve organoleptik nitelikleri üzerinde değişimler. Ankara Üniversitesi Veteriner Fakültesi Dergisi 1982, 29, 111-130.
29. Weber H.: Dry sausage manufacture, the importance of protective cultures and their metabolic products. Fleischwirtschaft 1994, 74, 278-282.
30. Yagil R.: Camels and camel milk. FAO animal production and health paper, Rome 1982.
31. Yaman A., Gokalp H. Y., Çon A. H.: Some Characteristics of Lactic Acid Bacteria Present in Commercial Sucuk Samples. Meat Science 1998, 49, 387-397.
32. Yıldırım Y.: Et Endüstrisi. Kozan Ofset Mat. San. Ve Tic. Ltd. Şti., Ankara 1996.
33. Yücel A., Karaca Z.: Bursa yöresinde üretilen sucukların genel kalite nitelikleri üzerine araştırmalar. Uludağ Üniversitesi Ziraat Fakültesi Dergisi 1993, 10, 41-50.

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